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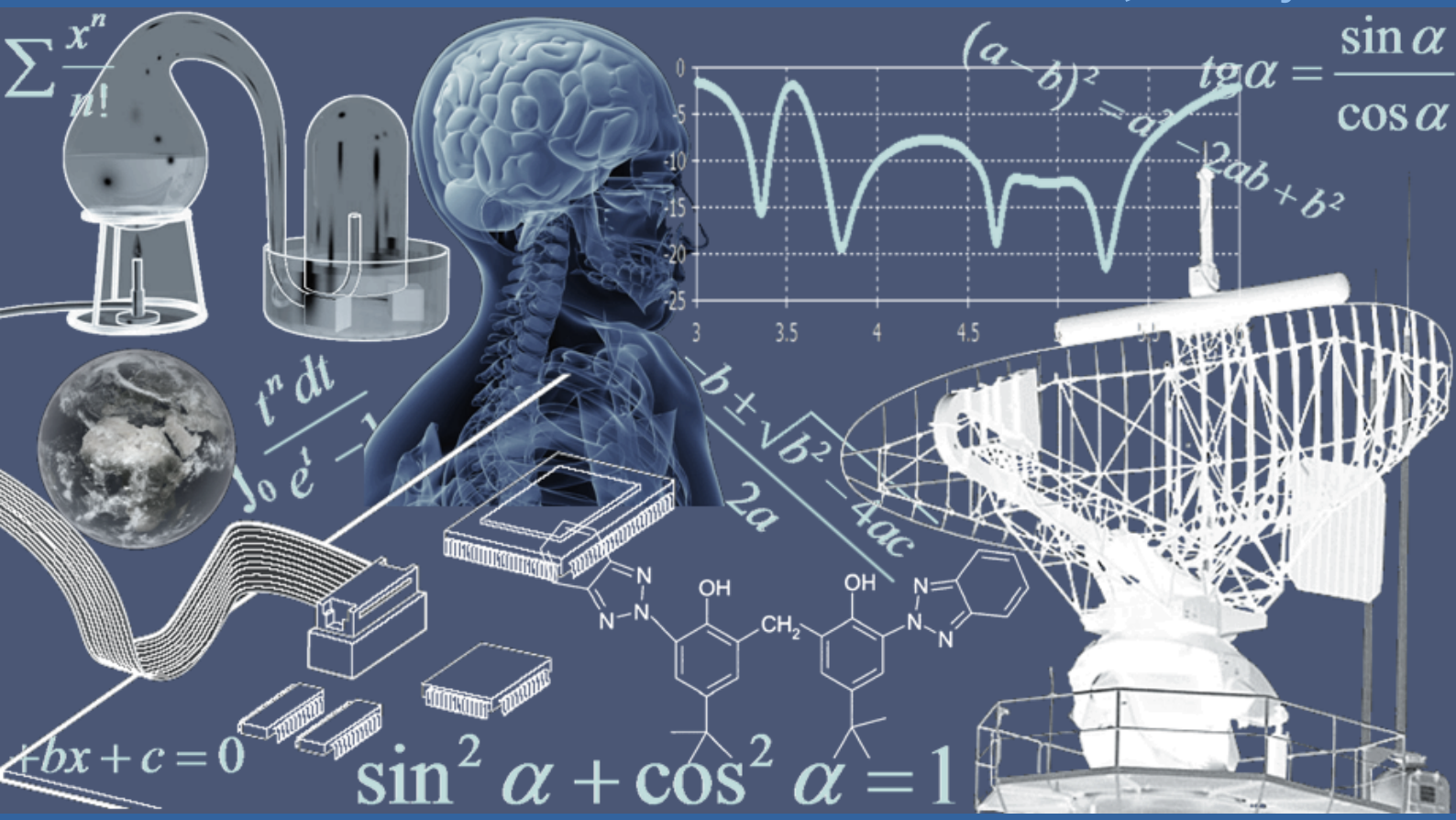

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Floating Measurements In Relation to a New Laboratory Ionospheric Simulator (Ionospektroskop)

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ABSTRACT: Due to the fact that the ionosphere can affect the passage of radio waves, it plays a very important role as a part of the atmosphere. The ionosphere contains different ionized regions (D region, E region, F1 and F2 region). Each region has its own properties and shows distinct influence on the entering radio signals. The importance of the ionosphere is represented by its utilization for communication systems and its effect on satellite communications and navigation systems. There are different kinds of techniques for studying the ionosphere (Ionosonde, incoherent scatter radar, beacons, in situ measurements, etc.) that provide valuable information about the ionosphere. Because the ionosphere has a dynamic and direct response to solar activities, the patches of ionization in the ionosphere are irregular. As a consequence, ionosphere is greatly variable and quite random in its effects. With the help of a new laboratory ionospheric simulator (a so called Ionospektroskop) close studying and investigation of the characteristics of the ionosphere become possible. Ionosphere-like plasma created by the Ionospektroskop has a similar characteristic (no earth connection and no reference point) as the ionosphere holds. In order to investigate this kind of free-floating plasma, a measuring technique called floating measurement is required. With the help of the configuration of the Ionospektroskop and based on this kind of measuring technique, measuring the electrical properties (such as voltage) of the free-floating plasma gets easier. In this paper, an example of a floating measurement related to the Ionospektroskop is given.

KEYWORDS: Ionosphere, laboratory simulation, free-floating plasma, probes, oscilloscopes.

1 INTRODUCTION

1.1 IONOSPEKTROSKOP

The Ionospektroskop is thought of as a new measuring arrangement that provides a laboratory partial simulation of the ionosphere surrounding; it has to handle the adaptation to the ionospheric conditions which must be reproduced in the laboratory. In comparison with the ground-based and satellite-based ionospheric observations, the Ionospektroskop investigations take lower costs and can be considered for supporting other ionospheric observations for the case that intense solar events occur. (Radio wave propagations and satellite communications can be disrupted as consequences of this.) This kind of laboratory partial simulation of the ionosphere shows the advantages of reproducibility and relative stability compared to the actual ionosphere. A simplified schematic view of Ionospektroskop is given in figure 1: 1) Acrylic glass discharge tube (75 cm long and 15 cm in diameter), 2) Upper pencil/needle electrode, 3) Lower pencil/needle electrode, 4) Copper-zinc disk electrode, 5) Copper-zinc spherical electrode, 6) pair of Helmholtz coil in X direction, 7) pair of Helmholtz coil in Y direction, 8) pair of Helmholtz coil in Z direction.

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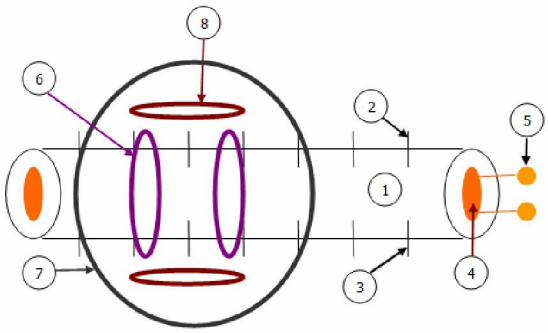

Fig. 1. A simplified schematic view of Ionospektroskop

1.2 BACKGROUND OF FLOATING MEASUREMENTS

Voltage measurements can be categorized into two sub-categories: differential measurements and floating measurements. They are distinguished whether the measurements are ground-referenced or non-ground-referenced. A differential measurement is to determine the voltage difference between two separate points. The floating measurement is a differential measurement where neither point is at ground potential. Floating measurements are mostly needed in power control circuits (such as motor controllers, uninterruptible power supplies, and switching DC power supplies) and industrial equipment. The foremost issue is that--if the measured currents or voltages are high enough--measuring devices could be damaged and the safety of the operator might be at risk. Different techniques for performing high-voltage floating measurements exist. They can be distinguished into Isolated-input Oscilloscopes, Differential Probe Measurement Technique, Voltage Isolator Measurement Technique, “A minus B” Measurement Technique, and “Floating” the Oscilloscope Technique. Each of them has its advantages and disadvantages [1].

Moreover, for the floating measurement techniques, probes also play a very important role. A probe can be considered as a kind of device, network or sensor that physically and electrically connects the test point or signal source to the oscilloscope. It probes or senses signals such as voltage signal (most cases), current, light power, etc. and transmits them to the input of the oscilloscope. Probes are generally made up by probe head, probe cable, and compensation box or other signal conditioning network. Various types of probes exist. They can be mainly distinguished into passive and active probes based on their constructions. A passive probe is constructed of wires, connectors, and according to the needs for compensation or attenuation, resistors and capacitors. In contrast to an active probe a passive probe includes no active components such as transistors or amplifiers. Therefore, there is no requirement for supplying power to passive probes. Due to the relative simplicity of use, passive probes are the most widely applied probe type. Depending on the probing target (signal type), probes can be categorized into standard or common probe types such as voltage probes, current probes, optical probes, etc., and specialty probes such as environmental probe, temperature probes, etc. These probes can be passive or active [2], [3].

Different oscilloscopes demand different probes. Therefore there is a broad selection of probes. Indeed, it is quite easy to become confused by selecting probes without the presence of sufficient professional knowledge and experiences about probes and oscilloscopes. Thus it is better to follow the oscilloscope manufacturer’s recommendations for probes. Furthermore, the usage of probes should have minimum influence on the test points or the circuit; the signal (sensed by the probe tip, transmitted by the head and cable to the oscilloscope input) should possibly keep its fidelity, and the signal loading caused by probes (probing loading) should be minimized. These requirements ask for the appropriate selection of probes as well. The right selection of the probe provides the first step for reliable measurements [2], [3], [4].

2 FLOATING MEASUREMENTS RELATED TO THE IONOSPEKTROSKOP

Due to the fact that the ionosphere has no earth connection and no reference point, the generated plasma has to be free floating in the present case as well. Generating the free-floating plasma is accomplished with the help of a new plasma generation method and the configuration of the Ionospektroskop (seven pairs of symmetric needle electrodes, number 2, 3 in figure 1). Pairs of symmetric needle electrodes are partly inserted in the acrylic glass discharge tube; they are not earth-fixed in voltage and have a direct connection with the created plasma. Their external part can be attached to devices. In other words, needle electrodes provide a kind of measuring bridge between the created plasma and the measuring devices.

In the present case, with the help of appropriate measuring devices such as high voltage probes, which are respectively attached to the external part of the needle electrodes, the voltages at these positions can be sensed. This kind of measurement is considered as *floating measurement*. New measuring methods based on this kind of technique are developed which enable measuring floating potential at each needle electrode pair. With different devices (such as suitable high-voltage passive probes, various oscilloscopes), there are different options available for achieving the floating measurement. Due to the dangerousness for both devices and operators when taking floating measurements, if traditional oscilloscopes are in use, the first choice is combining robust oscilloscopes with less sensitivity (such as HM Analog Digital Scope) with appropriate probes (10 kV high-voltage probes). However, because of the limitation of the HM digital scope, the combining high-end four-channel LeCroy oscilloscope with a suitable high-voltage probe (10 kV or 30 kV) are preferred due to its better measurement accuracy and advanced storage possibility. Figure 2 illustrates an example of a floating measurement setup (left-side) and the measuring results (right-side).

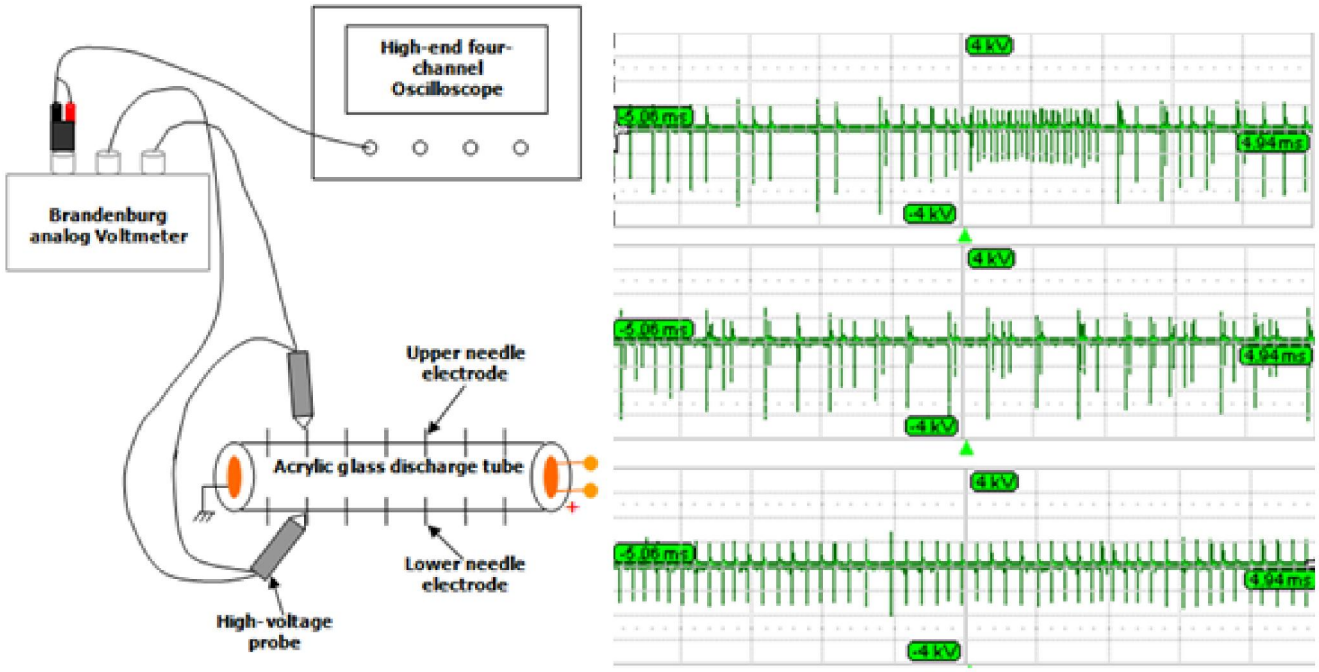

Fig. 2. Example of measurement setup and results

The analog voltmeter in the current setup gives a direct indication for the sensed high-voltage values. They show a voltage fluctuation range from 1 kV to 6 kV (with the choice of positive polarity and with a reading error of ±0.25 kV). The measuring results are taken from three different days. They are collected from one symmetric pair of needle electrodes (one upper, one lower). After the data analysis process, the analyzed results are as follows: the measured maximal positive voltage is 728 V. The measured maximal negative voltage is 128 V. The measured minimal positive and negative voltage shows 1 V respectively. Most of the voltage values in these three days are positive. In other words, the measured floating potential tends to be positive. The polarity of the sensed values depends on the numbers of electrons or positive ions collected by the tip of the needle electrode.

3 CONCLUSION

The analyzed measuring results of the floating measurements represent not only the sensed voltage values at the attached position, but also a repeatability of the ionizing process for generating plasma. The ionizing process should be repeated within an approximate time range from 0.1 to 0.3 ms to reproduce a similar state of the plasma. Seven pairs of the needle electrodes using the same method can be measured one after another. The first needle electrode pair locates in the vicinity of the anode of the acrylic glass discharge tube. The seventh needle electrode pair is in the vicinity of the cathode. Their distance is increased with ascending number of needle electrode pairs. The results follow an approximately inverse linear relationship between the increased distance and the amplitude. Seven pairs of the needle electrodes can also be measured simultaneously using the same method; as a result, an accurate voltage gradient may be determined.

Furthermore, the floating measurement in the current case may be combined with additional devices to determine the electron temperature of the created ionosphere-like plasma.

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Rural Livelihoods in Zimbabwe: Heterogeneity, Diversification and Vulnerability

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ABSTRACT: This study explores the rural livelihoods in Zimbabwe. Taking Moyo Musande as a case study, the study identifies and explores the livelihood strategies of households in the context of contemporary economic and political conditions. The empirical findings unpacked diverse livelihood activities and resources that villagers deploy to construct livelihoods. Contemporary livelihoods are not only located within natural resources and agrarian activities but also constitutes informality, civil society donations, social reciprocity, pensions and remittances. Livelihoods are often jeopardized by numerous challenges namely lack of credit, theft, unemployment and politics. Despite the challenges rural people negotiate and maneuver to secure household economic well being. The study demonstrated that given sound rural development policies, households are very much proficient of constructing their own fruitful sustainable livelihoods. These findings were projected through in-depth interviews which are a genre of qualitative methodology. Theoretically, the paper is underpinned by the Sustainable Livelihood Framework to examine the livelihoods strategies and the vulnerability context that complicates lives and livelihoods of rural people in Moyo Musande.

KEYWORDS: Livelihoods, Assets, Sustainable Livelihoods, Agriculture Intensification, Migration.

1 INTRODUCTION

Zimbabwe has gone through a number of crises in the last two or so decades. The crisis was socially, economically and politically epitomized. The formation and character of the crisis though is hotly contested among scholars, with some scholars arguing that it is due to internal or domestic processes (notably state mismanagement by the ruling party) and others arguing that it is externally generated by imperialist forces. We do not intend to adopt any particular position of the crisis but rather we outline various events where there is agreement. The paper seeks to answer one critical question that is how do Zimbabwean rural poor survive? Through examining the nexus between the natural capital in form of land, paid and unpaid employment, the paper advances that the solution to the question is found in productive activities that rural poor engage in. The paper identifies and explains the sources of livelihood, diversification and vulnerability context.

This paper is structured as follows. The following section (section two) of the paper briefly tackles the events that contributed to the economic collapse of the Zimbabwean economy and how rural livelihoods were undercut. Following that section is section three; it offers the theoretical foundation that informs this paper. Sustainable livelihoods framework is briefly discussed and its analytical strength is offered too. Section four offers a brief description of research significance of this paper and later dwells on describing the research methodology and techniques. Following this section is section five which marks the beginning of empirical data discussion particularly paying attention to natural resource based livelihoods, rural informality, remittances, pensions, social reciprocity and civil society activities. Last section, section six describes the challenges that rural people face including lack of credit, theft, unemployment and politics.

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2 ZIMBABWEAN CRISIS AND RURAL LIVELIHOODS

In 1980 the Zimbabwean Government (GoZ) inherited a dualistic economic development policy. In a bid to redress the colonial legacies and imbalances, the GoZ took on board a socialistic road to economic development (including Growth with Equity of 1982 and the Transitional Development Plans). Amongst the challenges the government was facing included massive income differences along racial lines, rural poverty and the land question. As a result the government was entrenched in huge deficits as it sought to redress colonial blockages for instance infrastructural development, urban-rural divide [1]. Despite these challenges, the economy performed reasonably well in the 1990's. Indeed, this earned the country the name 'bread basket of sub Saharan Africa' although later it was turned into a 'basket case'. Notable progress was envisaged in education, health and agriculture.

A large body of crisis literature has arisen in the last decade. Most of the narratives of the crisis have been explanatory yet there are also some efforts by scholars to theorize the crisis. For instance this crisis has a range of names given to it including 'organic crisis' [2] this emanates from Gramsci's conceptual framework and 'the Zimbabwean crisis' [3]. The historical roots of the crisis have been differently situated within literature; with some arguing preconditions of the crisis were lodged in the early 1990's and late 1990's. As such there is a general agreement among scholars that the crisis arose in 1990 evolving around economics and politics. Amongst the events that were critical to the Zimbabwean down fall is on one hand, the structural adjustment programmes (locally known as economic structural adjustment programme-ESAP). Instead of this neoliberal informed programme to spur economic growth, eliminate inefficiency and increase Zimbabwe's 'competitive edge' on global markets as predicted by the Bretton Woods Institutions- International Monetary Fund and the World Bank the opposite has happened. Economy has contracted, foreign investment has not materialized and hunger has swept across rural and urban spaces.

Towards the close of the 1990's, a political crisis arose, civil societies, trade unions and the Movement of Democratic Change (MDC) questioned and challenged the legitimacy and hegemony of the ruling Zimbabwe African National Union Patriotic Front (ZANU PF) party. Consequently, the ruling party, state and the GoZ was pressurized and was in a deep panic. Reference [4] insists that the state become increasingly authoritarian. To garner support of the citizens, the GoZ paid war veterans[1] a hefty of $50 000 (Zimbabwean dollar by then) which was outside the state's budget. In February 2000, another major event happened, violent seizure of white commercial farms referred to as *jambanja* (locally meaning violence). In so far these two events (including the payment of gratuities to war veterans and the land reform) signified the "balance of class force within the ruling party was tipped in favour of radical nationalist solutions" [5] to agrarian and land reform. Besides the international cry over what they labeled as 'human rights violations' the state continued to safe guard the so called 'sovereignty' through preserving the gains of the *second chimurenga* (land being the primacy of it). The failure by the Fast Track Land Reform Programme to decongest the communal areas as reported by the Presidential Land Review Committee Report (popularly known as the Utete Report) of 2003 has had devastating effects.

This signified the wide spread condemnation of the state and increased isolation which was envisaged through economic sanctions. As the economic crisis loomed and intensified, living standards were greatly compromised, poverty and destitution become the order of the day within rural and urban households. Nevertheless, [6] argues that 'the absence of ESAP in and of itself would not have erased Zimbabwe's post-independence conundrum, although a strong state – which ESAP helped destroy – is necessary to surmount its "transitional" problems. The ESAP laid the preconditions to the crisis that later came, it did not cause these problems. Since 2005, the Zimbabwean economy has been characterized by a high inflation rate, shortage of foreign currency, inadequate investment, budget deficit and stagnating employment [4]. By March, 2007, inflation has reached 2,200 % [1] this threatened both urban and rural livelihoods.

As a result of the crisis, rural livelihoods in Zimbabwe today are characterized with heterogeneity in order to make a living in a country where rural-urban gap is so wide. The decline of smallholder African agriculture for most of the twentieth century was driven by racialized land dispossession and underdevelopment, in order to meet the labour demands of industrial capitalism [7], [8]. Opportunities for smallholder agriculture became undercut by chronic African unemployment amidst Zimbabwean crisis. The structural dynamics of urban-based, retrenchments have only intensified since 2000 causing

[1] A war veteran refers to the people mainly aligned to ZANU PF who took part in fighting the Rhodesian army in what is documented as Third Chimurenga.

an erosion of remittances. The 2011/12 Poverty Income and Consumption Survey (PICES) estimated the head count of poor rural households in Zimbabwe at 76% in 2011. Poverty in Zimbabwe is not only widespread and persistent it is disproportionately rural, the proportion of extremely poor rural households was 22.9%, this fell from 50.4% in 1995/6 and 42.3% in 2001 [1].

The problem of increasing and persistent poverty is one of exclusion rural inhabitants are extremely marginalized from the mainstream economy. The prospects for social mobility in rural areas is inhibited by persistent inequality (including gender) and continuing human development deficits, and the GoZ difficulties in addressing colonial legacies especially the rural-urban divide. Impoverished rural livelihoods are constituted within practices of mobility and migration that have long linked rural African households to urban opportunities and resources in Southern Africa [9]. Rural households might helpfully be viewed as stretched between urban and rural [10], this therefore depicts that households often engage in hybrid livelihoods across space. In this context of limited and declining employment opportunities, how do the rural residents survive and what problems do they face?

3 THEORETICAL FRAMEWORK

The SLF helps to understand the particular livelihoods pursued by people in Moyo Musande which is a focus of this paper. The framework helps to describe what women and men actually do to support households and further understand the different social, economic and political factors and restrict their abilities. This approach builds on people's strengths and works for environmental, economic, social and institutional sustainability. Thus, a livelihoods framework is both a goal : that works to create new ways of living that enable people to meet their varied and interwoven needs without compromising the ecosystems that support them and their community; and an approach : that is rooted in particular people in specific places making decisions about sustaining themselves and their families [11].

A livelihood is defined as a varied way of making a living to meet individual and household needs [12]. Sustainable livelihood framework (SLF) starts with assets owned and controlled by a household. Moser a prominent writer on livelihoods insists that assets are a crucial element of the livelihood framework which enables individual, household or community to survive and further engage in labour markets and participate in reciprocal exchanges with other households [13]. Fundamentally, rural inhabitants of Moyo Musande make use of the natural, social, human, physical and social capitals to earn a living [14] and circumvent poverty. The SLF has been an appropriate and necessary diagnostic tool in relation to conceptualizing rural poverty of the developing countries. A number of livelihoods are adopted and employed by rural poor to make to make a living. These livelihoods can be short term (i.e. for consumption or coping with risk) and long term strategies for future generations. Livelihoods literature identifies three important livelihoods for the rural people including agricultural intensification/extensification, livelihood diversification and migration. Overall, the short and long term are designed to maintain the economic being and social security.

In light of the above the livelihood strategies are designed to cater for the constraints imposed by the market failures, state failures, social norms and exposures to universal risks [15]. Diversification is a contentious concept [16] argues that diversification as a strategy does not fit in a conventional picture since its many attributes defy the straitened notions of sectors, specialization and transition. Conversely, another prominent writer of livelihoods, [17] argues that the rural poor diversify sources of livelihoods in order to make a living in cases of risk and uncertainty. Various factors influence diversification, namely the need to improve livelihood choice [18] and external factors may include the need to survive.

Therefore, necessity and choice are significant as driving forces to diversification. Of importance are the structures and processes that affect livelihoods, they function at various scales and influence access, control to different capitals, certain livelihood strategies and decision making, the terms of exchange between different capitals [18]. Despite the structures and processes, livelihood strategies occurs in a threatening and vulnerable context that may requires livelihood resilience. Vulnerability refers to the insecurity or well-being of individuals or communities in face of changing environments in form of sudden shocks, long term trends or seasonal cycles [17]. An analysis of vulnerability context is significant as it focuses on the opportunities that are available to resist implications of uncertainty and vulnerability; this involves safety nets and a range of activities to supplement existing strategies [14].

4 RESEARCH SIGNIFICANCE, METHODS AND TECHNIQUES

Numerous studies have been conducted in relation to livelihoods particularly in Africa and globally. In the case of Zimbabwe, there are a number of rural livelihoods studies focusing on different unit of analysis. In case of our research site (namely Moyo Musande) there is no existing study known to the researchers. Generally rural livelihood studies in Zimbabwe have focused on climate change and its effects on livelihoods [19], land reform and livelihoods. Such studies have turned

blind eye on the diversification of rural livelihoods apart only from land based livelihoods. An anomaly exists within these livelihoods based studies. Therefore this study is important for a number of reasons, it closes this lacuna and uncovers fresh literature, and in doing so it offers a 'no gender biased' examination (focuses on both female and male activities) and deploys the sustainable livelihoods framework in a manner which is sensitive to both structure and agency. Given the crises that Zimbabwe has undergone, the study views the rural villages not as passive victims of the socio-economic and political turmoil but as active agents seeking household economic stability.

The study identifies, explores and understands the rural livelihoods of the people in Moyo Musande community in Zimbabwe. Methodologically the research is framed within qualitative approach. According to [20] this kind of research "gives a more in-depth description and understanding of events or actions and this helps the researcher to gain insight into why and how these events or actions take place rather than just presenting a phenomenon". The Moyo Musande community is fluid such that it is impossible to draw a random sample of a stable universe. Purposive non random sampling was utilized to identify participants for in-depth interviews. Purposive sampling is a valuable kind of sampling used in exploratory research. Similarly, [20] insists that non probability sampling gives the best chance to get 'rich' qualitative data. With respect to qualitative approach, in-depth interviews with ten respondents were conducted (five females and five males). In-depth interviews allow for greater flexibility in asking questions, therefore the researcher is able to explore the issues under study in a greater detail compared to quantitative approach (es). After the data collection the in-depth interviews were analyzed. In-depth interviews were conducted in the local language Shona[2] and emerging themes were noted. Data was thematically analyzed in such a way that contextual character remains undistorted.

5 RESULTS AND DISCUSSION

This section seeks to outline the empirical data in terms of how the marginalized rural livelihoods survive. The following themes came out: natural capital and agrarian activities, rural informality, social reciprocity, pensions, the role of civil society and remittances (cash and non cash).

5.1 NATURAL CAPITAL AND AGRARIAN ACTIVITIES

There is no doubt that the majority of the rural people still depend on the natural resources (primary source of livelihoods) to construct livelihoods. In-depth interviews carried out in Moyo Musande are reflective of this fact, almost 90% of the respondents reported to be relying on agriculture as their main source of livelihood. Natural capital assets (including water sources and forests) have been identified as important. Agriculture is the mainstay of rural communities and they take full responsibility in utilizing the natural resources to construct a living [12]. Trees play a significant role in the lives of rural people in developing world [21]. This concurs with the results of this study. Natural resources were used for different purposes in Moyo Musande community; land was used for agricultural purposes, forests for firewood and fencing of gardens, wild fruits and herbs for different ailments. The main source of energy was fuelwood mainly for heating and processing food due to the absence of electricity. However, the access and control of some of these natural resources were based on several factors including institutional control (i.e. village head locally known as *sabhuku* restrict cutting down of trees). One of the respondents reported the following

forests are in abundance, we can use it for fire wood, medicine and polls to build kraals for our cattle, but the problem is that the sabhuku does not allow us to cut some of the trees and if you are caught…liable to a fine and some hens (In-depth interview no 2, December 2011).

Despite such restrictions, a number of people were selling polls to other community households who were building new houses. Selling of poles derived from natural resources was another livelihood source of income despite that there was constant conflict with the village head.

Another respondent reiterated the following:

…the elders of this area are too restrictive, some of the land that we are still cultivating is old and it is our wish to clear the other land and start cultivating the new land and increase our yields…look this land has been used for the past 30 to 40

[2] Shona refers to a local language in Chilimanzi, a Bantu language spoken by Shona people

years and it is used now…we need new land but the chief and sabhuku's have agreed that giving people new land will only lead to destruction of forests for nothing (In-depth interview no 1, December 2011).

From the above, it is clear that sustainable livelihoods are hindered by institutional leaders and norms which restrict control and usage of natural resources. These layers of authority have compromised rural livelihoods. One of the most influential is the institution of the hereditary chieftaincy, which continues to exercise authority over large communal areas [22]. Residents of these areas are thus both citizens of formal, civic authority but also the subjects of traditional authorities [23]. This is a major problem in most rural communities particularly ones still controlled by patriarchy (chiefs and village heads). Nonetheless, land remains the primary source of the most rural inhabitants. Vast tracks of land were used to grow maize, millet, sorghum and ground nuts. Growing of these crops was mainly for consumption purposes while a surplus was sold especially in cases of emergency to gain income. One respondent reported the following

where else can I earn a living …no employment, no what…land is the only resource that I have to make a living with my family, I depend on it for maize and other things like vegetables which I grow as relish to sadza (In-depth interview no 3, December 2011).

In sub Saharan Africa most of the rural communities rely on land for livelihoods and food security thereby circumventing poverty. Despite engaging in other livelihoods land remains the mainstay of rural livelihoods despite the lack of inputs to intensify production.

Natural resources in Moyo Musande, have been directly transformed into financial capital after being sold, this include the grass used for thatching, roofing pools and herbs for treating different ailments. This reflects rural people's ingenuity in transforming wild natural resources into financial capital especially in face of rising rural poverty to ensure household economic and social security. Fundamentally, the access to natural resources is gender based, particularly with regard to land. There is a disequilibrium in terms of access to land with this community, female residents of Moyo Musande claimed that land was only accessible through marriage and in cases of death of a husband some of the land is given up to another household to decongest the quest for land. Reference [18] argues that gender is a critical, integral an inseparable part of the rural livelihoods.

Water was another natural resource that was significant to the locals. A majority of women depended on gardening. Most of these gardens were located close to the river banks simply because of the water proximity while some were located at home. A variety of vegetables were grown by different individuals including spinach, covo, tomatoes, onions, carrots and cabbages to mention buy a few. The growing of leafy vegetables such as (*spinach, covo and rugare)* was for the purpose of eating with sadza (cooked mealie meal) and these vegetables were treated as a substitute for meat which is expensive and unaffordable for most rural households. Gardening was done during the entire year although intensified during the rainy season. Gardening was primarily for home consumption while surplus was sold. Our in-depth interviews show that a reasonable amount of income was being generated through marketing of produce. A bundle of vegetables was being sold at R7.00 or US$0.70 while a plate full of tomatoes was sold at US$1 or R10. An estimated amount of R100 or US$10 was generated monthly after selling of the produce. This money contributed towards buying other basic commodities like cooking oil, sugar and salt which were not home grown. Respondents were proud of gardening as it produced quick money to meet household needs and allowed to evade expensive prices of rural stores. Barter trading also occurred. For instance, one household would exchange a plate of tomatoes with a cup of salt or anything equivalent.

Despite gardening which was necessitated by the availability water sources, fishing was also prevalent. This was mainly reported by male respondents in my sample. Fishing was both for household consumption and selling to other households. Fish price is comparably low than the meat price at Siyahokwe growth point. One of the male respondents aged thirty five reported the following:

I started fishing at a very young age…while herding cattle I could spend time fishing and this enabled me to get fish for consumption. Fishing has provided me with money, people flock to my house to buy fish because it is cheaper than meat…when there is a lot of water I catch more fish unlike in a dry season…this has enabled me to send my children to school, buy uniform and other basic commodities (In-depth interviews no 4, December 2011).

The availability of water bodies (as one of the components of natural capital) cannot be underestimated in ensuring food security and income generation. The availability of the natural capital has therefore enabled households and individuals to diversify natural based livelihoods. This has been confirmed by the results of this study. In addition, this concurs with [24] argued that many rural households subsist on a combination of agricultural and fishing activities, but, in most cases, agriculture is the primary strategy, fishing being a secondary or alternative activity. In short, rural livelihoods are mainly based on natural resources although rural inhabitants diversify their livelihood strategies to avoid vulnerability in cases where one livelihood strategy fails to provide sufficient income and security for the household or individual.

5.2 RURAL INFORMALITY

Besides the utilization of natural resource base as a form of livelihoods, rural areas are characterized by complex repertoires of economic activity. It is therefore important to understand rural livelihoods as composed of farm and non-farm activities, informal and formal economic activities. Informality refers to the marginal and low productivity activities that are outside regulatory procedures of the state and tax system [25]. In Zimbabwe informality is plays a pivotal role in providing a source of livelihood for both rural and urban sites although the income is relatively low. Over reliance on the informal sector is symbolic of lack of employment in both private and public sector.

Findings of this study reveal that informality is an integral part of rural livelihoods. One respondent reported that, lack of employment in rural areas has further pushed people to live through informality to supplement income and at times informality being the major source of income. One female respondent reported:

life is not easy in the rural areas…I have started hoarding basic commodities in Gweru [a nearby town in Midlands province] including sugar, salt, tea bags, washing power, second hand clothes and many other things that the rural people need…I have not opened a formal shop because of the rental charges that is why I choose to operate here at home…competition is less at home than the growth point (In-depth interview no 6, December 2011).

Through informality rural people have managed to make ends meet, this is not particularly to the owners only but to the customers as well. This is so because, spazza/tuckshop offer cheap commodities as compared to the well established retail shops at the growth point whose prices are far too expensive for the rural poor. There is a discernible link between informal sector and formal sector in Zimbabwe. This link is envisaged through the basic commodities, all the commodities sold in the informal sector originate from the formal economy. However, there are relatively little or no linkages following from informal sector to formal sector. Income generated through selling of basic commodities was invested in education of children, buying uniforms and some was budgeted for emergency particularly illness of a child.

Despite informality on basic commodities, livestock rearing played a pivotal role. Livestock is a productive asset with the potential of providing households with some resources in the short term (including milk) but greater returns in a long run such as more goats and cows which may yield meat, clothing and skins which can be used for trade or sale. One respondent, a beef producer reported to be selling beef meat and goat meat to the local butcheries and school teachers who had established a beef committee. Each beast costs US$500 (by the time of this study) depending on the quality of meat either commercial or economy, while a goat ranges from US$30 to US$50 depending with the size. In addition the respondent did not wish to be well established to provide beef at a larger scale. Firstly, the provision of beef meat was inconsistent and only resumed when a need arises for instance in case of shortage of money to pay school fees. Secondly, establishing a beef enterprise was a mission impossible because of procedures in acquiring a license to operate.

Traditional beer brewing was another important informal activity employed by rural people. This is commonly prevalent among females. Beer brewing is not a new phenomenon in Shona culture but the rate of over reliance on it as a source of livelihood is highly questionable. Lack of recreational facilities and entertainment in rural sites is attributed to alcohol abuse by rural people. Hence, beer brewing business was never a 'fade away' activity as it provided quick income that will be used for immediate consumption. A greater number of males in the community preferred the local beer (locally known as *seven matanda*) because it was affordable unlike the Western kind of beers or what they called 'clear beer'. The same respondent indicated that competition is sometimes a constraint which suggests that this kind of business is relatively lucrative.

Apart from beer brewing, the respondent diversified too. The respondent responsible for beer brewing engaged into poultry too for meat and egg production. This activity was mainly prevalent during the festive seasons for instance Easter and Christmas holidays. A significant amount of money was gained; approximately a profit of US$1200 (equivalent to R12000) was made when business was good. Although rural economy offered many opportunities for diversifying livelihoods, a majority of these offered little returns. Despite that, rural people have managed to engage in survivalist improvisation to escape rural poverty.

Other sources of income that were reported and observed in the Moyo Musande Community are shown in the table below.

Table 1. Other informal source of income

Informal source of income	ranking
Building	2
Piecework/hired labour	1
Craftwork	4
Ox cart hire	3
Begging	5

Field work December 2011

The activities on the above table can be referred to as minor strategies, villager spent very little or no resources and also yielded little and often unreliable income. Respondents identified strategies such as begging, labour sale in the fields as returning very little. At times working in the fields was exchanged with a bar of soap or cooking oil all depending with the contract or terms of conditions. Reference [18] notes that this type of diversification sees household members undertaking casual and low productivity activities with poor prospects. Reference [26] refers to this as a last resort rather than an attractive alternative livelihood strategy.

5.3 SOCIAL RECIPROCITY

Apart from the natural capital based livelihoods and rural informality, social capital play a pivotal role in maintaining and securing rural livelihoods. Networking with other people therefore becomes significant in constructing livelihoods. One well known writer of social capital [27] describes social capital as an entity formed for the benefit of everyone in a community. Putnam further argues that essentiality of social capital is seen in its "capacity to facilitate coordination and cooperation for mutual benefit" [27]. Declining kinship ties in rural communities have resulted in rural people seeking refuge in non kinship ties for survival. By doing so, rural people have managed to access resources such as food, information and opportunities (including hired labour in the fields). Through the mutual trust embedded within social groups, many villagers have resorted to rotational groups where they contribute a certain amount of money to each other. This system is commonly known as *marounds* (rotational savings group) which depended on relationships of trust between group members. This was commonly among women. Some villagers belonged to more than one group, as there are different kind of groups-including those formed in villages or church.

Contributions were in from of money monthly or in-kind (mainly groceries) contributions. Social groups have acted as 'informal social protection' [28]. One respondent made it clear that they were contributing differently every month depending on group member agreement. With respect to the monthly contributions, US$15 was contributed per individual. Social savings group helped to cushion poverty however one common problem constrained the well functioning of these groups. Rural economy does not provide constant income hence some groups members at times failed to contribute to the group. Given the precariousness of the rural livelihoods, social groupings are important to circumvent vulnerability.

5.4 PENSIONS

Pensions were also reported to be another source of income in rural areas. Prior to the Zimbabwean crisis, rural and urban people relied on steady pension transfers particularly the old who have retired and retrenched from formal work. As the crisis loomed, hyperinflation reduced these transfers merely to nothing. Nonetheless due to the dollarization of the economy in 2009 a steady monthly income was received to all pensioners. Villagers who retired made it clear that the monthly transfers by companies that they once worked for were significant. Without the pension income the villagers claimed that their situation could be miserable. The following is a testimony:

if it was not for the pension I could have died long back…I am old now I can't work in the fields or do any sort of work...I heavily depend on my pension for my survival...I thank the NRZ [a company the old man used to work for] for keeping us alive...at least this money can help although it is not enough to sustain for the whole month. I can say it is better than getting nothing" (In-depth interview no 7, December 2011)

Similarly, another respondent once a headmaster for a primary school reiterated the following:

the ministry of education through the unions have been so supportive after my retirement...since the dollarization I have received all my pension income every month... the system is now efficient unlike during the days of Zimbabwean dollar the money was worthless...you would just withdraw money and before using it...inflation could swipe it away (In-depth interview, no 9 December 2011)

It is apparent that pensions are a source of livelihood for the old people who can no longer venture into other avenues of making a living. Broadly, Zimbabwean government unlike South Africa government has no sound social security system to cater for the older people, vulnerable children and many other groups (physically challenged people). These vulnerable groups of people continue to be marginalised in the main stream economy and this further exacerbates their poverty situation.

5.5 THE ROLE OF CIVIL SOCIETY

The role of civil society cannot be undervalued in as far as rural livelihoods are concerned. It seems scholars concur that the GoZ failed to provide for its citizens during the economic crisis. This amounted to humanitarian crisis, as most of the urban and rural people lived and some died of poverty. The civil society came to the rescue besides the fact that it was politically motivated to garner support for Movement for Democratic Change. Besides the politicisation of the food aid, food parcels distributed to communities were significantly important. This study reveals that people in Moyo Musande were recipients of food aid from different civil societies. Among the things they received was cooking oil, salt, sugar, clothes, maize meal, rice and many others. While resource wise, construction of boreholes for safe, clean drinking water and establishment of community projects like knitting, these helped the community to be self sufficient and fighting food insecurity. Reference [29] views NGOs as potentially critical catalysts for unlocking the energies and resources of the poor and voiceless in their endeavour to build pluralistic and democratic societies. Some of the operating NGOs in the community included World Vision, Care international, Oxfarm and USAID.

5.6 REMITTANCES: CASH AND COMMODITIES

There is no agreed upon definition of the word remittance, but generally speaking it denotes cash or in-kind transfers by workers who have left their area of origin on a short term or long term basis. Rural people have moved in hundreds of thousands over the past decade mainly as economic refugees in urban areas and they have remitted cash and commodities to their village of origin. From the in-depth interviews rural villagers in Moyo Musande community have at times been receipts of these remittances. Out of the sampled respondents it emerged that four of them received remittances from different people including family members (most their children). According to [30], rural to urban and regional to international migrants have contributed a lot to the livelihood and survival of the poor rural people in Zimbabwe. According to [31], in recent years remittance flows have increased due to the growing number of Zimbabwean migrants who transfer cash and goods through both formal (for example, EcoCash agencies and the Post Office) and informal (for instance, through carrying in person or sending with a friend, relative or co-worker) channels. Although, migrants have faced tougher problems in the host countries (South Africa, USA, UK and many other) they have made efforts to remit back home to their poor relatives. Cash transfers have played a significant in the lives of rural people. One of the recipients of remittances aged fifty-six reported:

our children in the diaspora have been kind enough to send money monthly. My daughter who is in Canada sends money every month approximately R2000 through the Western Union money transfer and this has helped me to buy my basic needs for my family. I have been able to establish a small poultry business to raise extra money to take care of my other relatives. I am very happy with the money she sends me...during agriculture season she even sends more money to buy fertilisers and seeds (In-depth interview no 10 December 2011).

In light of the above statement, remittances have enabled rural people to live above poverty line. However, some cash becomes an investment by being channelled directly into informal activities (poultry business) and purchase of commodities for re-sale. Remittances do make a contribution to household sustainability by mitigating the effects of the crisis in Zimbabwean and increasing the purchasing power as well as generating multiplier effects.

Despite the cash remittances from children and other relatives from different geographical spaces, the study revealed that remitters also remitted commodities particularly foodstuff including but not limited to the following maize-meal, sugar, salt, cooking oil, rice, dried fish and other assets (i.e. school uniforms). During the peak of the crisis, many urban people remitted foodstuff back to their village of origin as most growth points were out of stock. Retail shops with stock charged exorbitant prices that were far beyond the reach of the rural poor. Reference [30] adds that most non-cash remittances responded to the specific and immediate needs of their recipients. The non-cash remittances significance cannot be

estimated given the marginalisation of rural economy. As such many rural inhabitants have managed to survive through the non-cash remittances.

6 VULNERABILITY CONTEXT OF MOYO MUSANDE HOUSEHOLDS

Livelihood strategies as discussed above have played a pivotal role in proving a safety net for rural people however livelihoods are not without challenges. These challenges have greatly limited attainment of successful livelihoods and as a result a number of households have been 'in and out' of poverty. Notably among the challenges are lack of credit, theft, unemployment and politics.

6.1 LACK OF CREDIT

The economic downturn of the economy has contributed to limited capacity of the government and other private stakeholders to be supportive. The rural people acknowledge the importance of access to credit. Credit act as a means of increasing income through investing it into income generating activities and small business venture. Despite this, a majority does not have access to credit from banks and other formal credit providers. In Zimbabwe credit is mainly aimed at small to medium enterprises (SME's) and mere rural people such as those of Moyo Musande community are not considered. Banks and NGOs have targeted women as a social class but truly speaking the poor and marginalised rural women have not benefited. The valid reason that possibly limits access to credit is the lack of collateral security set by banks. As a result rural villagers face this obstacle. In addition they lack guarantor with long term and sufficient income to act as security for them and their irregular and unstable income is unacceptable to banks and other money lenders. The lack of credit contributed to limited livelihoods in Moyo Musande and limited accumulation of assets.

6.2 THEFT

Besides lack of credit, theft was noted as another limitation. Due to the lack of employment and increase in poverty theft has become rampant not only in rural areas but also in urban areas. During the year 2011 a number of theft cases were recorded ranging from household property and stock theft. This has contributed to low livelihoods particularly in cases where a productive asset has been stolen. One interviewee noted:

thieves are increasing in this area, some of the them are sons and daughters of our community members who have failed to secure work...this year [referring to 2011] I lost my plough and hoes.. luckily it was not ploughing season, if it was I could have been grounded...if it was not for the NGO that distributed ploughs to all those have high produce...I could be struggling right now (In-depth interview no 8 December 2011).

This sentiment clearly shows that theft was rampant in the area and for this particular interviewee things could have been tougher after losing productive assets. In turn it means the yields were to be greatly reduced.

Another respondent shared the same view:

...they do not even care [referring to thieves] either you are poor or not. I lost all my goats on the same night until now the police have not established the culprits...suspects were called in and were released. Whoever is responsible for this will pay for it? (In-depth interview no 4, December 2011).

This reflects again the inability of the police to deal with matters of theft. Without proper investigation thieves are left to commit other crimes in communities.

6.3 EMPLOYMENT

Rural economies are characterised by limited formal employment due to underdevelopment. This is so, because rural economies are not integrated in the main stream economy so as a result employment tends to be informal. Formal employment may be viable for some of the energetic members of Moyo Musande. However, the prospects of employment are exceedingly limited considering high unemployment rate pegged at 80% in Zimbabwe. The Government of National Unit failed to create jobs. In this regard, one married interviewee highlighted the following:

I was thinking things will get better since 2006 but there has been no change besides the dollarization which has eased things, we are still suffering...NO JOBS NO JOBS [interviewee emphasised] at least if our children get jobs they will be able to take care of us...without jobs our lives are miserable (In-depth interview no 10 December 2011).

The respondent reported that formal employment was better as it comes with stable and reliable income every month. This is despite the fact that formal employment is currently marked by low remuneration limited to cater for all household needs including rent and basic commodities.

6.4 POLITICS

The political climate which has characterised Zimbabwe in the last decades has contributed to vulnerability of rural people of Moyo Musande and the entire rural and urban areas. Political polarisation between ZANU PF and MDC the main oppositional party has compromised livelihoods construction in both rural and urban households. This study reveals that during campaigning days' time of engaging in various livelihoods to secure household security decrease as people involuntarily and voluntarily attend rallies- at times twice a week. Political violence, torture and destruction of shelter compounded with loss of assets to political opponents. This study results concurs with [19] study in Mudzi District which posits that political violence in the district has jeopardised local people's livelihoods.

7 CONCLUSION

This paper commenced by highlighting the critical events that contributed to the downfall of the Zimbabwean economy and it went on to discuss the sustainable livelihood approach that animates this paper. The paper the identified and explored the various livelihood strategies employed by Moyo Musande villagers to secure household economic well being and preserve food security. Given the smaller sample of the study the results therefore are not representative of the entire rural livelihoods. Agriculture in rural areas remains the prime livelihood activity for the rural poor. This was pursued by utilising the natural capital in form of land. The crops grown were mainly for consumption with little being sold. Villagers also simultaneously diversified into other income generating activities to make a livelihood portfolio. The villagers encountered a series of problems in constructing their livelihoods, some relate to economic challenges while some relate to institutional systems-like village headman as such institutional influences have shaped livelihoods. Nonetheless, the villagers often responded to these challenges as-at best-coping mechanisms. Respondents have made significant contributions to their household income and food security but as a grouping they have reported that they were hanging in and hanging on in face of harrowing poverty. The paper has explained the vulnerability context of the Moyo Musande villagers (some relates to the Zimbabwean economy like unemployment).

The empirical findings have implications for development theory. Precisely a sustainable livelihood framework (SLF) is a substantial contrivance for evaluating rural livelihoods. Access and control to different capitals enhance successful livelihood strategies. In particular through the access to land, villagers have increased their food security. In addition through social capital people have managed to supplement their earning by engaging in rotational savings groups (locally known as *marounds*). The SLF therefore was of great theoretical value in terms of conceptualising and understanding the lives and livelihoods of Moyo Musande community. It was deployed in a manner which was sensitive not only to 'structure' but also 'agency' in recognising that although the community is not 'entrenched' in structures but negotiates and manoeuvre their way in and at times beyond structures.

The findings have implications for rural development policy. A supportive environment need to be created and players should acknowledge that short term and long term livelihood strategies make significant contribution to the livelihoods of the rural poor and therefore need not to be undervalued but reinforced. Wild natural resources need to be acknowledged as fundamental to rural livelihoods. Their importance is envisaged in housing, health care and fuelwood energy. Support for these natural resources should be part of poverty reduction and rural development. With respect to agriculture, sound extension services should be established this might include usage of inputs, harvesting and marketisation. Given importance of agriculture, government through Ministry of Lands and Agriculture should prioritise extension services to increase productivity and farming knowledge. With respect to barriers, there is need to minimise regulatory barriers particularly the role of traditional leaders. Access to land and forest must be equitable though sensitive to environmental degradation. Unnecessary barriers created by traditional leaders only lead to poverty stricken households

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Modified thin-film fabrication method using vacuum thermal evaporation and vacuum synthesis: application to preparation of Er-doped fiber amplifiers

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ABSTRACT: This paper considers capabilities of vacuum modification optical materials with application rare-earth elements and manufacturing procedures of optical materials with high concentration erbium active ions. Recently, the problem of increasing concentrations erbium active ions in rare-earth elements doped optical amplifiers without decreasing of their quantum efficiency, gets a major actually. Achievement in the field of ionic-plasma vacuum processing techniques allows practical possibility to establish new generation effective optical amplifiers with extremely high (> 10^{20} sm^{-3}) concentration of rare-earth elements. On basis the technology of vacuum thermal deposition and vacuum synthesis, Er_2O_3 - SiOx - Al_2O_3 multicomponent planar light guide has been manufactured. The multicomponent planar light guide is created on local segment of an optical fiber core. The erbium ion concentration spans from 10^{19} to $8 \bullet 10^{20}$ cm^{-3} in generated optical structure. In experimental thermal deposition processing vacuum chamber parameters did not change. From given experimental results we can consider that, using different impurities SiOx and Al_2O_3 allow reaching high concentration free erbium ions. Spectral characteristics of obtained optical structure with active rare-earth elements provide photoluminescence in the range ~1550 nm. The proposed method allows actualizing local modification of the single-mode optic fibers for the purpose of fabrication of short-distant fiber optical amplifiers, sensors and modulators.

KEYWORDS: fiber amplifiers, planar light guide, optic fibers, rare-earth elements, vacuum thermal deposition, multicomponent films.

1 INTRODUCTION

The problem of obtaining short-distant erbium fiber amplifiers stimulates designing the materials with extremely high contents active ions of erbium. In the pure film of rare-earth oxide Er_2O_3 the concentration of Er ions reaches values ~10^{22} cm^{-3} [1]. That value exceeds the concentration Er in the standard systems alloyed by erbium and allows reaching the extremely high quantity of radiating centers. For realization short-distant amplifiers on basis active fibers it is necessary increasing the concentration of active ions in the glass without considerable deterioration of magnifying properties of the active medium. The purpose of work is modification a section of optical fiber by erbium obtaining multicomponent films Er_2O_3 - SiO_x - Al_2O_3, using the method of vacuum thermal evaporation from erbium and a silicon monoxide. The active section of fiber will have essentially smaller length, than in common fiber-optical amplifiers due to higher contents active ions of erbium in the modified field of the lightguide. In this case we are using the low temperature vacuum methods of synthesis glasses without any heating the glass of fiber.

For creating high-effective light emitting structures it is necessary, that concentration of erbium exceeded 10^{18} cm^{-3}. It is known, that erbium ions clustering is a main factor responsible for deterioration of amplification properties erbium doped optical guides [1], [2].

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At major concentration active ions (> 10^{18} cm^{-3}) it is possible generating clusters, consisting of two and more erbium ions. That becomes to the considerable decrease the quantum efficiency of luminescence the laser transition ($^4I_{13/2} \rightarrow {}^4I_{15/2}$) because of effect up-conversion.

This effect is called by a pairwise interaction closely located ions. There are simultaneously locating in an excited state $^4I_{13/2}$. One of the ions without radiation relaxing to the ground state $^4I_{15/2}$ and another one drives higher energy level $^4I_{11/2}$ [3], [4]. Thus, the part of erbium ions absorbs the radiation of amplified signal and reduce efficiency the fiber amplifier.

In cases of high concentration erbium ions there are existing two methods for struggle against effect of up-conversion. The first method consists in addition of Al_2O_3 in array SiO_2. Impurity of Al_2O_3 changes the structure of glass and reduces the rate of migration excited ions Er^{3+} and positive influences erbium miscibility [5]. The second method uses the low-temperature (without melting) vacuum synthesis of glass at which activator ions has flown down uniformly in array of glass and erbium clusters are not formed. It is obvious, that the efficiency is given by integrating of these two procedures.

2 DESCRIPTION OF EXPERIMENTAL METHOD

In this work the technical implementation of a method preparation optic fiber to alloying by rare-earth elements was shown. This method consists in abrasive polishing on preset thickness the optic fiber with big radius of curvature (R = 180 mm), the control of polishing thickness operates from recording the laser radiation which where entered into the fiber. Polishing stops, when the local section of a fiber is a baring to the core. This moment is defined from the intensity degree of laser radiation at the fiber output.

For deposition of silicon dioxide using the method of electron beam evaporation, that strongly complicates the equipment. Therefore, the technology of silicon dioxide deposition with evaporation silicon monoxide SiO has been applied. The silicon monoxide is easily enough volatilized from a resistive heater boat, unlike silicon dioxide SiO_2. When oxygen is bleeding in working space (at pressure $2\text{-}3\cdot10^{-3}$ Pa), molecules of a volatilized silicon monoxide steam oxidize to silicon oxide (SiO_x), where $1<x<2$.

For obtaining multicomponent Er_2O_3 - SiO_x - Al_2O_3 films on the fragment of optical fiber was applied the technology of vacuum thermal co-deposition with bleeding in oxygen in vacuum chamber. There were using two tantalum boats resistive heating for co-evaporating metal-erbium, a monoxide of silicon and aluminum. The main parameter at the choosing erbium-doped materials suitable for effective light amplification in 1540-1550 nm bandwidth, is ability isolating Er^{3+} ions from each other for attenuation a concentration quenching. As is known, additional doping in quartz glass Al_2O_3 or P_2O_5, increases a concentration limit of entering oxides of rare earth elements [6].

In the current work it was co-doping erbium oxide (Er_2O_3) with using aluminum oxide (Al_2O_3). Al_2O_3 provides magnify refraction index of evaporated film. In our case, it is the positive factor, as it is necessary for "pulling out" optical modes from a fiber core for interaction with erbium ions in the evaporated film. Decreasing the clustering of erbium by co-doping of aluminum oxide promotes reduction in tens times overall dimensions of fiber amplifiers. The additive 2,5 mol.% Al_2O_3 to SiO_2 allows to increase concentration erbium oxide in dielectric layer from 0,1 to 1 mol.% [7]. It has been shown [8], that by using the method of vacuum controllable deposition with reactive gas (oxygen) it is possible to receive amorphous film structures with the big concentration of erbium in which ions Er^{3+} appear uniformly distributed in a glass array.

Application of technology vacuum deposition materials do not allow to formation clusters of erbium, caused by small mutual solubility of oxides of erbium and silicon in melts. Clustering repressing at low-temperature vacuum synthesis occurs at the expense of statistically uniform hit of the molecules, making an optical guide, from a gas phase on rather cold substrate in conditions when migration of particles in material volume is complicated. It is possible to name such glasses structurally unstable. Their annealing with further melting conducts to catastrophic increase the up-conversion, and at the big concentration of erbium to fibration of phases with radical falling quantum efficiency of excitation the main laser transition in Er^{3+} [9].

At sedimentation of multicomponent films in vacuum the control of thickness of evaporated materials and concentration of alloying dopants is very important. In this experiment the radio-frequency method has been applied. This method is grounding on measuring the frequency vibration of a quartz crystal of evaporated material on it [10], [11]. As bottom of quartz measurer serves the plate of the quartz resonator defining frequency of the stable self-oscillator. The generated frequency depends on mass of the quartz resonator, it is possible to define thickness of the film which have deposited on a quartz plate.

Accuracy of a method measuring mass of deposited layer with application the quartz resonator in many respects is defined by stability of generator frequency included in the schema quartz resonator. For example, for a crystal with

resonance frequency f = 5 MHz, mass m_g = 100 mg sensitivity ($\Delta m_c / \Delta f$) is equal 0,02 mg/Hz. Registering a frequency drift of the quartz resonator on 1 Hz, it is possible to check a mass gain in a microgram. The range of gauged depths for serial devices lays in limits from 10 to 10000 nm with accuracy 5-10% [12]. The method of the quartz resonator allows adjusting a procedure of manufacturing of films in advance given depth.

The most powerful sources of an error at measuring are the methodical (multiplicative) error and an error from temperature action. Existence of a methodical error is caused by that the sensor and a metallic surface with fragment of fiber optic are in various points of vacuum chamber. In this operation the methodical error is compensated by means of optimization of a standing of sensors and the account of their angular arrangement concerning evaporators (see figure 1).

Two boats of resistive heating have been applied to controllable evaporation of deposited components of a film. Between boats there is a screen from a foil, arranged along a line (AB), pairing a centre point between evaporators and the middle of a processed optical fiber. The foil does not allow the evaporable material to get from one heater on the sensor, which checking evaporation from the second resistive heating boat.

Quartz plates of thickness gauges are arranged under angle in 30º from a line (AB). It is known, that density of a deposited film inversely proportional to a cosine of drift angle from a line (AB) and to a quadrate of distance from a radiant of the evaporated material. The processed surface of a fiber optic and two quartz plates of thickness gauges are arranged on identical distance from boats of evaporators. Therefore, if to consider a cosine of drift angle from a line (AB) it is possible to check precisely enough a relation of the evaporated components on a fragment of an optical fiber.

As crystal of quartz are sensitive to temperature changes, in this procedure the cooling system for data sensors is used. Compensation the influence of a thermal radiation from the evaporator on a resonator frequency drift in the evaporation process allows to measure thickness of the deposited layer with accuracy about ~ 5%. The device for vacuum adjustable evaporation is simultaneous from two resistive heating boats is shown on figure 1.

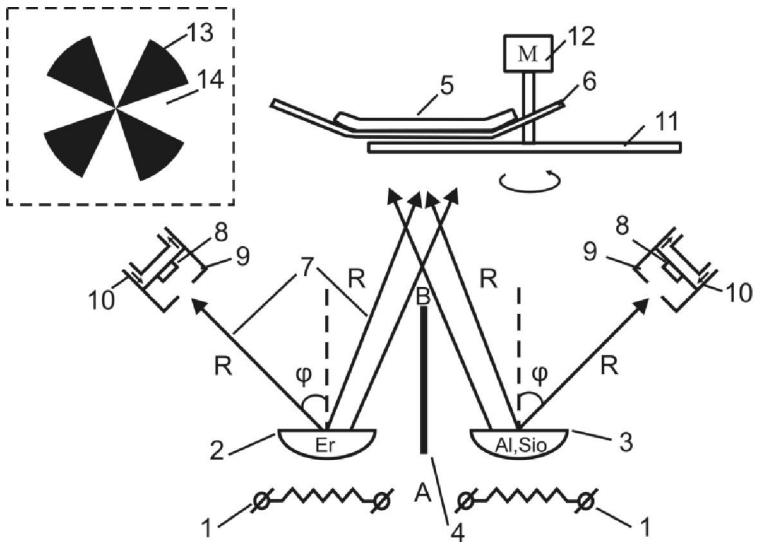

Fig. 1. Equipment for vacuum controllable deposition of multicomponent films

1 – the resistance tantalum radiator; 2 – the container with metal erbium Er; 3 – the container with metallic aluminum Al and with monoxide of silicon SiO; 4 – the shield parting compartments (AB); 5 – a metal background; 6 – an optical fiber fragment with a open core section; 7 – directions of evaporation steams of materials from containers; 8 – quartz plate; 9 – covering diaphragm; 10 – a water radiator; 11 – a disk - an obturator with four gashes; 12 – the motor with a gyration frequency control; 13 – a disk general view - an obturator; 14 – the gauged triangular gash on a disk.

Evaporation of erbium and silicon monoxide were spent on vacuum installation by means of heating of different tantalum boats at pressure of working gas (oxygen) 0,25-0,35 Pa (about $3 \cdot 10^{-3}$ mm Hg) and temperature 1300-1600 ºC.

In the first container (2) has been seated metal erbium in additive 5 mol.%, from total quantity of evaporated substances. In the second container (3) the powder of silicon monoxide and aluminum bronze are placed simultaneously, in a prospective ratio for process vapor deposition a films. Obtaining of films SiO_x - Er_2O_3 different composition was carried out at changing the rate of evaporation erbium, whereas the rate of evaporation silicon monoxide and aluminum was supported at constant value. The rate of evaporation erbium, silicon monoxide and aluminum was fixed by means of two quartz resonators (8). Speed of deposition of a film varied from 5 to 20 nm/sec. The disk-obturator (11) rotated with frequency 3000 sec^{-1}. This method has allowed receiving planar optical fiber with deposited components in the form of a wedge with good indexes of geometry.

The method of controllable vacuum deposition has allowed providing the precise control composition of glass on planar light guide, and also possibility to create high concentrations of alloying additions (18 mol.% Al_2O_3 and up to 1 mol.% Er_2O_3) [13].

In our experiments of vacuum deposition the temperature of planar light guide carrier was supported with accuracy ±1 % by means of the radiator and system of a feedback on the basis thermoelectric couple. The stabilized temperature of a planar light guide carrier ensures equal requirements for deposition silicon, aluminum and erbium oxides on a surface planar light guide. It means that glass on a bearing area is shaped directly of a deposited phase, passing the melting stage. The planar wave guide made by an offered technique (5) represents a thin film on a planar light guide carrier which on the end is narrowed (see Figure 2). Laser radiation (4) propagates on a core (1) of single-mode optical fiber. The cladding of an optic fiber (3) is removed by means of absorption polishing from a local fragment of a fiber. The refractivity index of the deposited multicomponent film reaches 1,54-1,56. It allows to "pump out" effectively energy from a core of (1) single-mode fiber. For the cuneiform geometry of a film (7) the significant part of radiation (8) is returned in a core (1) after interaction with the rare-earth components. The rare-earth film optically have been pumped by external radiation (10) (λ = 980 nm), providing signal gain. The electromagnetic wave (6), falling on narrowed edge (7), continues to propagate in zigzag trajectory. In result, in some point, the angle becomes less critical and optical radiation (9) starts over again to get to a core of an optical fiber (1).

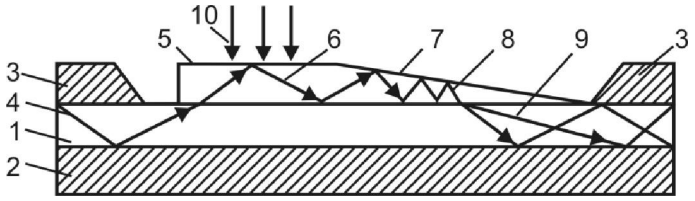

Fig. 2. A thin-film planar lightguide with the narrowed edge, generated on a fragment of a core of an optical fiber

1 – an optical fiber core; 2 – an optical fiber cladding; 3 – an optical fiber cladding, with a remove fragment; 4 – the radiation in a fiber; 5 - the generated planar optical fiber; 6 – the path of radiation in a planar optical fiber; 7 – cuneiform narrowing; 8 – the path of radiation in cuneiform narrowing; 9 - the radiation which has come back to a core; 10 - the radiation of optical pump (λ = 980 nm).

Efficiency of the matching can reach 65-75 %. Thickness of a film is picked up in such a manner that allows to define distribution of a path of incident beam, therefore efficiency of radiation returned in the fiber can be big enough and provide gain of a signal by erbium on 5-10 dB from a site in 2-5 cm.

3 EXPERIMENTAL RESULTS AND DISCUSSION

The experiment results on modified optic fibers have shown the photoluminescence on wavelength 1540-1550 nm. A spectrum is characterized by the basic peak on wavelength ~1540 nm. Measurements were spent at indoor temperature (T=300 K) and without any preliminary annealing. It points possibility of activation erbium ions (Er^{3+}) without using high-temperature operations. The observable result can be explained as higher concentration of optically active ions Er. The form of the received spectrums will be coordinates with literary data [14], [15].

The spectral characteristic of multicomponent film Er_2O_3 - SiO_x - Al_2O_3 are shown lower in figure 3.

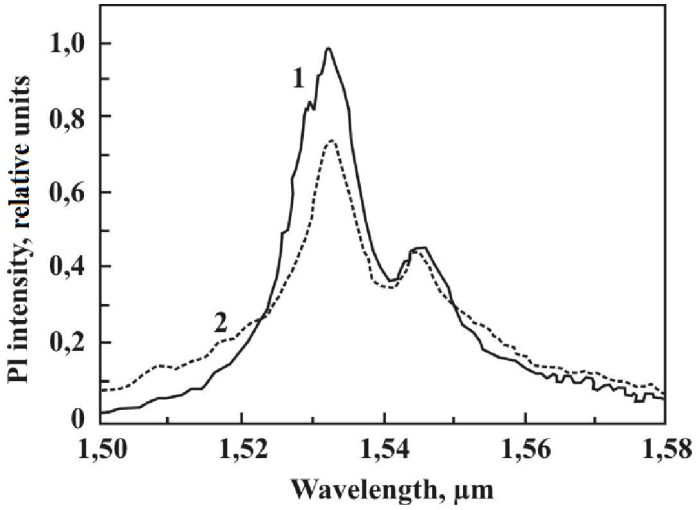

Fig. 3. Spectral characteristic of a film (Er_2O_3 - SiO_x - Al_2O_3) on the fragment of optical fiber

1 - optical medium alloyed 10 mol.% Al_2O_3 and 3000 ppm Er_2O_3, 2 - optical medium alloyed 1,5 mol.% Al_2O_3 and 3000 ppm Er_2O_3.

In experimental equipment as the signal source semiconductor laser with the peak output power 5 mW and λ=1540 nm was used. In the capacity of the pumping source the output power up to 250 mW semiconductor laser with fiber yield and λ=980 nm was applied.

Quantitative limiting concentration Er_2O_3 in glass SiO_2-Al_2O_3 defined by measuring results the efficiency conversion of a pumping radiation in a signal (hereinafter efficiency of amplification). The higher amplification of samples (rather to light guide length) in comparison with the light guides alloyed by MCVD technology, shows, that Al_2O_3 at vacuum deposition allows to reduce clustering of ions Er in a quartz glass. The given method allows precisely controlling the concentration of dopants in glass, and creates demanded refractive index [7], [13].

Value of losses modified planar light guides has 100 dB/km, in this case at 10 cm length their influence on efficiency of the laser makes no more than 0,001 %.

It is established, that vacuum synthesis at moderate temperatures in a vacuum bench (150-200°C) allows to receive planar light guides with concentrations up to $8 \cdot 10^{20}$ cm^{-3}.

The following stage of experiment includes an experimental research modified optic lightguide on temperature operations. Figure 4 represents effects of heating the samples in a muffle furnace and some variations in a photoluminescence of ions Er.

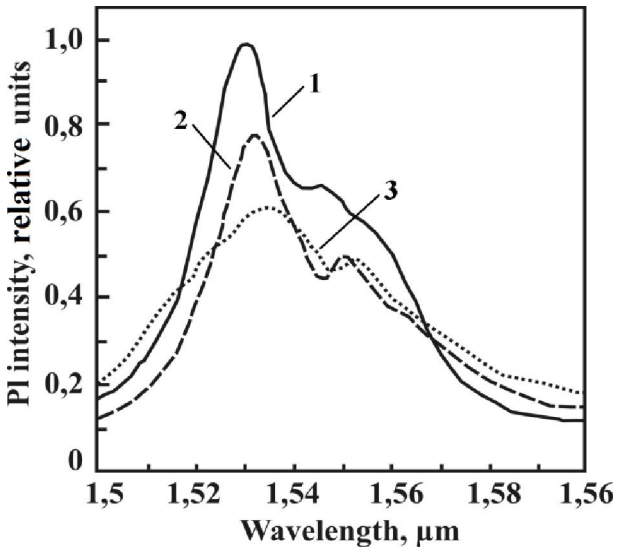

Fig. 4. Spectral characteristic of a film (Er_2O_3 - SiO_x - Al_2O_3) on the fragment of optical fiber in heating

1 - without heating, 2 - with heating at 400 °C, 3 - with heating at 700 °C.

As seen in Figure 4 the glass emolliating calls erbium clustering that has led to wide a luminescence spectrum. On basis the spent measurements the dependence of quantum efficiency of samples modified optical fibers on erbium ions concentration has built (Table 1).

Table 1. Results of measuring quantum efficiency active planar light guide from erbium ions concentration with various impurity densities Al_2O_3

Er_2O_3 ppm / Al_2O_3 mol.%	Amplification efficiency in relative unit								
	10	**50**	**100**	**250**	**500**	**1000**	**3000**	**5000**	**10000**
0	1	0.77	0.61	0.38	0.07	–	–	–	–
1.5	1	0.94	0.92	0.79	0.60	0.29	0.02	–	–
2.5	1	0.98	0.96	0.92	0.80	0.69	0.30	0.13	–
10	1	0.98	0.96	0.94	0.85	0.73	0.34	0.15	0.03
15	1	1	0.98	0.96	0.91	0.81	0.43	0.23	0.10
18	1	1	1	0.98	0.96	0.88	0.56	0.32	0.18

In the table results of measuring the efficiency of amplification samples modified optical fibers, in relative units are given. For relative units received the highest amplification at the maximum doping by aluminum oxide and at optimum doping by erbium oxide [15]. A condition of deposition of films was identical, at various concentrations of aluminum oxide and erbium oxide, with the control of composition of films. In spite of the fact that at high concentration of aluminum oxide the relative efficiency of amplification decreases, it is possible to reduce length of the planar fiber amplifier to 5-10 cm at the expense of the high considerable quantity of erbium ions radiating centers.

4 CONCLUSION

Possibility of direct vapor deposition rare-earth oxides allow to magnify to the maximum limit concentration of active ions erbium. In rare-earth oxide concentration Er^{3+} reaches value ~10^{22} cm^{-3}, that in many respects surpasses value of concentration of the erbium concentration received by other doping technique. Ability of vacuum methods uniformly to precipitate and in co-evaporate any oxides of rare-earth and other elements in the form of free ions, possibility the control of thickness of a deposited film allows to magnify to a limit of concentration of active ions rare-earth elements, thereby to reach giant quantity of the radiating centers.

The magnifying of concentration of erbium allows reducing a length of an active section in erbium in rare-earth elements doped optical amplifiers. Possibility of obtaining active waveguides with extremely high contents of erbium stimulates development new short - distant optical amplifiers on the basis modified optical materials. Besides, the properties of erbium oxide (Er_2O_3) as, a tall transparency in wide area of an IR-range, the big index of refraction and photoluminescence properties, do its perspective for application in photonics, integrated optics and telecommunication.

The yielded device can be used for gain and processing of optical signals, for example, in integral-optical switches, modulators, amplifiers and control sensors.

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Heating Mode Effect on Perpendicular Magnetic Recording

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ABSTRACT: Micromagnetic simulation study has been conducted on the perpendicular material ferromagnetic $Pt_xMn_ySb_z$ by completing Landau-Lifshift Gilbert equation. Choosen ferromagnetic material has some parameters such as anisotropy constant as large as 4.5×10^5 erg/cm^3, magnetic saturation of 2100 G, Curie temperature of 373 K, and finite-dimension of 50×50×10 nm^3. The use of perpendicular anisotropy media with appropriate properties value are intended to increase the storage capacity of the hard disk without ignoring its thermal stabilty. At writing information, ferromagnetic material is induced by magnetic field for reversing the direction of magnetization and all at once also heated by thermal pulse which was designed matches closely the reality. To examine thermal fluctuation effects, twenty random number for magnetization was adopted in calculation and probability of magnetization reversal was introduced for determining the theshold field. Evaluation of reversal mechanism has been done for the variations of temperature of 299.0-372.9 K. Heating exceeds 368.0 K capable to lowering the threshold field up to 90 % through the declining of energy barrier. Investigation also has done for some heating interval i.e. 62.5-1000.0 ps on the temperature which approaches to Curie temperature. As a result, in a span of heating were yielded that reversal field required for reversing the direction of magnetization is only about 250-300 Oe.

KEYWORDS: HAMR, perpendicular magnetic anisotropy, magnetization, threshold field, reversal probability, threshold field.

1 INTRODUCTION

Before 20th Century, the Magnetic Recording (LMR) technology has dominated the storage technology on Hard Disk Drive (HDD) [1]. LMR uses Longitudinal Magnetic Anisotropy (LMA). Although once dominated, but since 2005 to 2009 there had been decreasing consumers of HDD with LMR technology. Just as shown in Figure 1, the reason is that it has limited storage capacity [2].

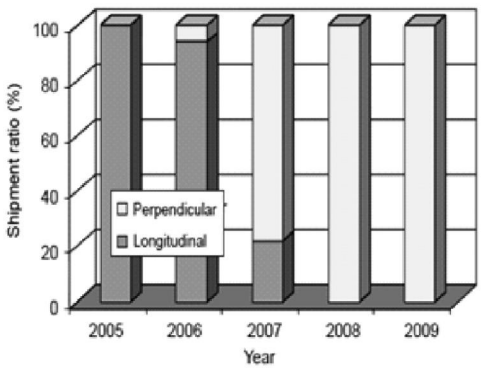

Fig. 1. The comparison of shipping ratio changes for HDD per year between perpendicular and longitudinal technology

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The storage capacity is determined from how small unit cell needed to store a bit of information. It means that the size of storage media should be reduced to nano size to realize a hard disk with a bigger capacity. But when the size of memory cell units are reduced into nano order, it result problem on thermal stability [3], that is the magnetization tendency to change direction spontaneously even in room temperature, thus hindering the data recording process. To tackle this problem, it needs Perpendicular Magnetic Anisotropy (PMA) that has a large magnetic anisotropy so that the magnetization bearing will be more stable even though in room temperature [4]. As it grows, 2006 has become a new era for industry of Perpendicular Magnetic Recording (PMR) that using PMA as storage media [5]. The use of this technology gives hope to bring in the storage media with capacity in Tbit/in^2 level [6], [7].

However, the use of PMA as a recording media with PMR technology still remains a critical issue, namely the need for a large current field in an attempt of PMA magnetization reversal as a result of the strong magnetic anisotropy materials [8]. One promising solution to solve the problem is by adding heat in the process of reversal magnetization then cooled rapidly to "freeze" the written information or called as Heat Assisted Magnetization Reversal (HAMR) [9], [10]. The process of writing data on TAMR technology uses laser to help raise the temperature of the media to a certain temperature [11].

In order to study the mechanism of heat-assisted reversal magnetization, a quantitative study is needed to understand the relationship between microstructure with magnetic properties in nano-sized materials with the help of numerical and computational techniques [6]. This technique, in a lot of thought, has received many praises as one of the foremost experimental tools in order to understand the mechanism of magnetization reversal which defines the performance of nano-sized materials in accordance with the fact [6]. The purpose of this research is to study numerically the influence of thermal field, both high temperature and duration of the heating towards the required field reversal with micromagnetic simulator.

2 METHODOLOGY

Magnetization reversal behavior on the perpendicular anisotropy nano-dot magnetic materials is investigated by solving the equation of Landau-Lifshiftz Gilbert [12]:

$$\frac{d\mathbf{M}}{dt} = -\frac{\gamma}{1+\alpha^2}\mathbf{M}\times\mathbf{H}_{eff} - \frac{\alpha\lambda}{(1+\alpha^2)M_s}\mathbf{M}\times\left(\mathbf{M}\times\mathbf{H}_{eff}\right) \quad (1)$$

With M as the magnetization vector, M_s as the saturation of magnetization, α is the constant of gilbert muffle (0.3), γ is the gyromagnetic ratio as much as 1,76×10^7 oe^{-1}.s^{-1} and $\mathbf{H}_{eff}$ is the effective field. On Equation (2), $\mathbf{H}_{eff}$ is the vector resultant of anisotropy field ($\mathbf{H}_k$), magneto-static field ($\mathbf{H}_M$), interaction exchange field ($\mathbf{H}_{ex}$), external field ($\mathbf{H}_{ext}$), and stochastic random field ($\mathbf{H}_T$) [13].

$$\mathbf{H}_{eff} = \mathbf{H}_k + \mathbf{H}_M + \mathbf{H}_{ex} + \mathbf{H}_{ext} + \mathbf{H}_T \quad (2)$$

The influence of temperature towards the constant behavior can be formulated in Equation (3) [14].

$$A(T) = A(0)\left(\frac{M_s(T)}{M_s(0)}\right)^2 \quad (3)$$

Consecutively, the dependency of magnetization and anisotropy constant on temperature related to magnetization changes is expressed as follows [15]:

$$M_s(T) = M_s(0)\sqrt{\left(1-\frac{T}{T_c}\right)} \quad (4)$$

$$K_\perp(T) = K_\perp(0)\left(\frac{M_s(T)}{M_s(0)}\right)^2 \quad (5)$$

With is the $K_\perp$perpendicular anisotropy constant and T_c is the Curie temperature. The total fluctuation field with zero temperature and assumed in Gaussian distribution with amplitude expressed through dissipation-fluctuation theorem just as seen on Equation (6-8) [15].

$$\left\langle H_T^i(t)\right\rangle = 0 \quad (6)$$

$$\left\langle H_T^i(t)H_T^j(t)\right\rangle = \delta_{ij}\delta(t-t')\sigma^2 \quad (7)$$

$$\sigma = \sqrt{\frac{2k_B T\alpha}{\gamma V M_s \Delta t}} \tag{8}$$

With $\delta(t)$ is the dirac delta function, δ_{ij} is the Kronecker delta, indexes i and j are component vectors, k_B is the Bolltzman constant, Δt is the time difference (0.25×10^{-12}s),and V is the volume of nano-dot.

Perpendicular anisotropy material used as model in this research is $Pt_xMn_ySb_z$ with magnetic parameter $K_\perp$= (3,0−4,8)×10^5 erg/$cm^3$and $4\pi M_s$=2100 G [16]. Dimension nano-dot from $Pt_xMn_ySb_z$ is a square field with 50×50 nm^2 size and has thickness of 10 cm with Curie temperature is 373 K.

In the framework of understanding the influence of heat, either the temperature level of writing (T_w) towards the extent of reversal field, simulation scheme designed to approach the heat pulse shape and the external magnetic field exactly as shown in Figure 2.

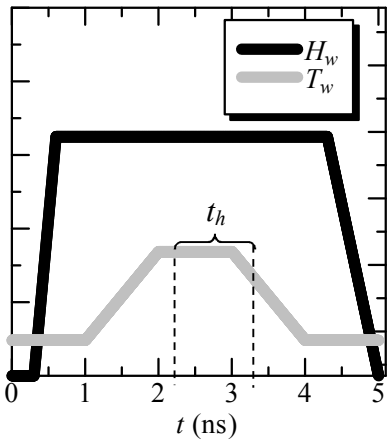

Fig. 2. Magnetization of heat-assisted reversal micromagnetic simulation scheme

As for evaluating the influence of fluctuations due to temperature, the inverter field was calculated for 20 different series of random numbers. The minimum so that the inverter field reversal of opportunities to 20 the number of 1 are known as threshold field (H_{th}), which can be associated with the reversal field.

3 RESULT AND DISCUSSION

3.1 REVERSAL MAGNETIZATION ON HIGH TEMPERATURE

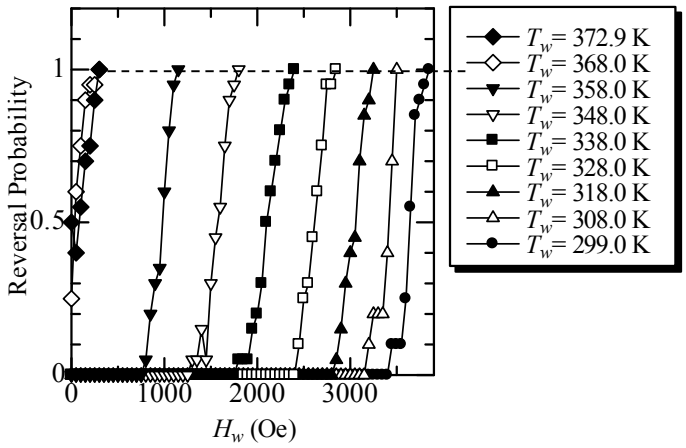

Fig. 3. The likelihood of magnetization reversal against the inductive field on $K_{\perp}$= 4.5×10^5 erg/cm^3, 4πM_s=2100 G with several variances of temperature of writing (T_w)

Figure 3 shows the nano-dot magnetization reversal probability from $Pt_xMn_ySb_z$. The increasing of temperature level of writing will add the nano-dot magnetization reversal probability. When the temperature at below 385 K where the field of writing has not been given, there are no likelihood of nano-dot magnetization reversal and this probability appears when the temperature of writing approaches curie temperature. This indicates an increase in writing temperature also affects on the increasing of magnetization reversal probability even with no help from external field.

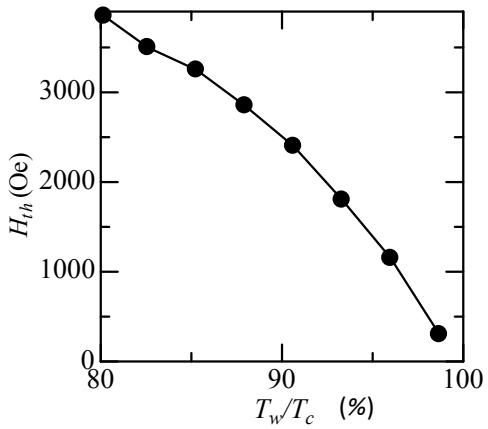

Fig. 4. The profile of threshold field towards the temperature on $K_{\perp}$= 4.5×10^5 erg/cm^3, 4πM_s=2100 G , and T_w=298.0–372.9 K

Figure 4 shows the influence of temperature against threshold field. The increasing of writing temperature can decrease threshold field extremely up to 90% and start saturating when writing temperature approaching its curie temperature. This can be understood from Figure 5 that illustrates the decrease in the amount of barrier energy when added temperature. As the barrier energy decreases caused by the increasing of reversal field, the needed writing field becomes so small so that it is as the solution for the limited writing field on harddisk head of which technically the resulted maximum field as much as 17 kOe [17].

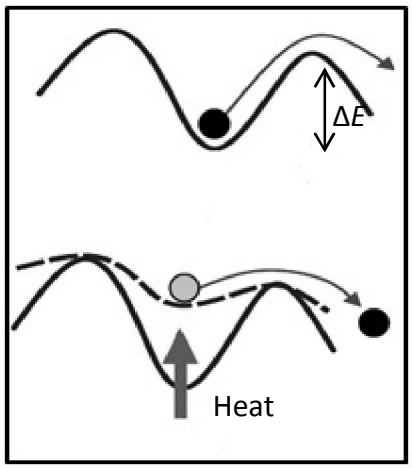

Fig. 5. The mechanism of barrier energy barrier decreases caused by the effect of heat addition (a). barrier energy without the help of heat, (b) barrier energy during heating process

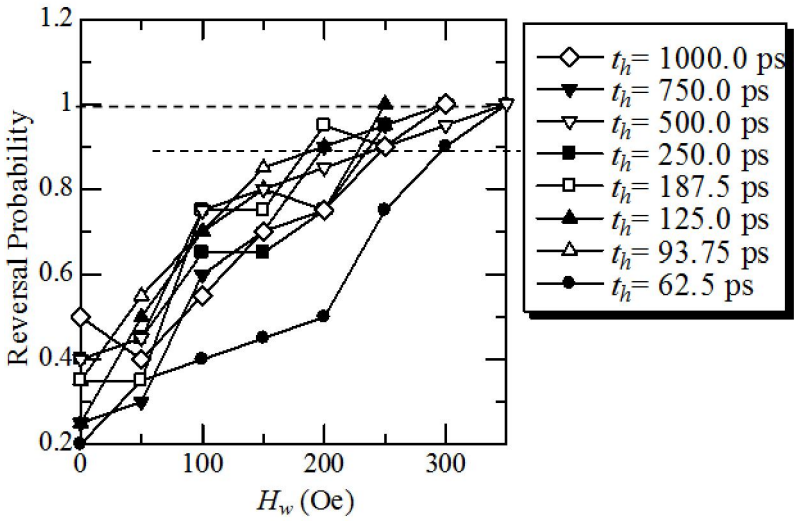

Fig. 6. Profile of H_w against the likelihood of reversal towards $K_\perp$= 4.5×10^5 erg/cm^3, 4πM_s =2100 G on variances of heating time (t_h)

In numeric study of heat-influencing mechanism on materials with several variances of perpendicular anisotropy ferromagnetic heating, simulation has been conducted with of heating time (t_h). Figure 6 shows the probability of nano-dot magnetization reversal on some diversity of heating time. It can be seen that the length of heating influences the probability of nano-dot magnetization reversal when there is no reversal field. The increasing of writing field has affected on the probability of nano-dot magnetization reversal. The extent of effective reversal field to make probability of reversal into 1 is around 250−300 Oe. When the heating time is more than 97.3 ps and has not been given a reversal field, there has been a chance of reversal.

Figure 7 represents the relationship between the size of threshold field needed for some heating time. Variant of heating time does not affect much on the threshold field. This information can be seen on the curve that tends to be constant more or less 300 Oe threshold field.

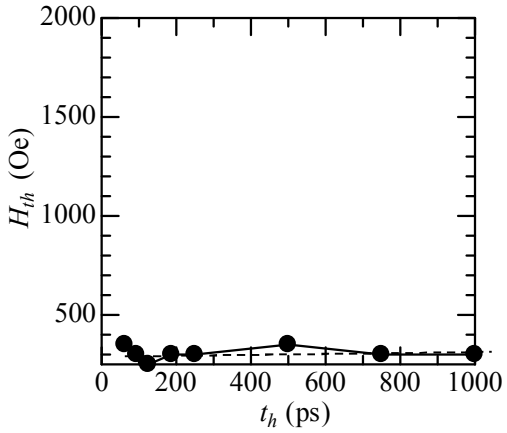

Fig. 7. Profile of $t_{heating}$ towards H_{tw} in a temperature variant for $K_{\perp}$= 4.5×10^5 erg/cm^3 and 4πM_s =2100 G value

4 CONCLUSION

Has done a micromagnetic simulation of thermal field effect, both high temperature and duration of warming of the necessary reversal of field. This can be concluded from the micromagnetic simulation of heat assisted magnetization reversal in ferromagnetic materials with perpendicular anisotropy for the value of $K_{\perp}$= 4.5×10^5 erg/cm^3 and 4πM_s =2100 G on curie temperature heat-up to range of heating 62.5−1000.0 ps effectively capable of lowering the field author until the range 300 Oe or 500% under the maximum field which is capable of being produced by the hard disk head writer at this time.

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Assessment of Anopheles Larval Source Reduction Using Cow Dung: Environmental Perspective on Pro-poor Tool for Malaria Vector Control

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ABSTRACT: This paper presents the results of a field experiment, whose aim was to investigate the potential of dissolved cow dung to cause anopheles larval population reduction in Yala swamp, western Kenya. Field experiments were conducted in two fish ponds located within the drained part of a wetland, and two swamp pools in undisturbed parts of the wetland. The experimental pond was treated with decomposed cow dung, while control pond and swamp pools were not treated. Data collection involved regular larvae sampling and water quality measurements in order to compare mosquito larval densities among the habitats based on variations in physic-chemical parameters. The species of anopheles mosquitoes identified were *Anopheles gambiae* complex and *Anopheles funestus.* The distribution and abundance of mosquito larvae was significantly associated with water quality parameters such as pH ($r = -0.48$; $P < 0.01$), DO ($P < 0.01$), Conductivity ($r = -0.11$; $P < 0.01$) and Turbidity ($r = -0.57$; $P < 0.01$). The results show that cow-dung treatment significantly reduced *Anopheles* species population in the experimental pond without diminishing the dissolve oxygen concentration levels required for diverse biota. Thus, cow-dung has potential to control aquatic stage of malaria vectors, and further experiments could help to refine its use as a tool for larval source reduction in rural settings. This can facilitate community-based vectors control in rural areas where numerous transient mosquito breeding habitats occur.

KEYWORDS: Anopheles larvae, Source reduction, Cow-dung treatment, Water quality, Yala Swamp.

1 BACKGROUND

Malaria is a hurdle in achieving millennium development goals, as it impedes global effort aimed at promoting overall human development in the developing countries, especially sub-Saharan Africa. The disease is a major public health problem to the global community. Evidently, the burden of malaria on the human society is felt disproportionately between developed and developing nations, urban and rural populations [1], [2], as well as within household disparities between men and women, children and adults [3], [4]. In Africa, malaria remains predominant in the rural areas of sub-Saharan region [5], [6], where the poor have very limited financial assets and consequently fare worse when malaria attacks and persists [7]. It is estimated that malaria deprives Africa resources worth U.S $ 12 billion every year [8]. This means that Africa's over reliance on conventional approaches to malaria control, which hugely targets the parasites and adult mosquito vectors, is not yielding much needed results with visible socio-economic land marks. Research focus on a set of interventions for malaria that integrate larval source reduction rather than pursuing the conventional approach is now required.

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Larval source reduction is a very old mosquito vectors control strategy, and has worked so well in efforts to eradicate malaria in developed countries [9]. This approach, however, has not been successful in Africa [10]. For decades in the United States of America (US), Canada, throughout Europe, Brazil and Singapore, larval control yielded positive results for malaria control [11], [12]. Strategies such as marsh drainage, ditch clearing, use of larvivorous fish, (Gambusia affinis), intermittent irrigation and *Bacillus thuringiensis var. israelensis* (Bti) yielded positive results in Italy, USA, Israel, Indonesia and some parts of Brazil [9], [10], [13]. Most of these approaches are expensive and hence require huge sums of money to undertake on a large scale. A strong view is emerging that larval source reduction strategies used in developed countries may have succeeded due to the level of industrialization in those countries, and consequent urbanization. This is likely so, because studies have shown that the popular approaches that have been used to reduce suitable mosquito breeding places in urban areas are practically inappropriate in rural settings [14], [15], [16]. However, it is a common knowledge that the highest percentage of African population resides in rural areas. Thus, any mosquito control initiatives that can bear significant reduction of malaria transmission, in Africa, should consider pro-active involvement of the rural population as crucial entry point.

As happens in most African rural settings, mosquitoes' breeding sites are often small, numerous, scattered and shifting with the season and indiscriminate human activities [17]. Elimination of mosquito breeding in majority of such wide variety of temporary water collections, over sufficiently large area, will require active involvement of the entire community. Ultimately, this cannot be achieved without fronting a supplementary tool for larval control that is simple, cheap, effective, less labor intensive, environment friendly and culturally acceptable.

Further, recent studies show that malaria is declining in some African countries [18], and this is attributed to integrated malaria control approach employed for the last few decades. The approach involved advocacy for and use of insecticide treated mosquito nets (ITNs), use of indoor residual spray (IRS) as well as timely diagnosis and effective treatment. In this regard, renowned scholars now call for new intervention initiatives that could be added to the existing vector control strategies in order to facilitate speedy eradication of malaria on the continent [19]. Furthermore, the above global malaria control strategies are targeted at the parasites (pathogen) and the adult mosquito vectors which maintain the ecological cycle of malaria transmission [20], [21]. Recently some scholars have expressed their great concern that larval source management has been long neglected in Africa, despite being one of the oldest malaria control strategies [10]. Accordingly, it is widely acknowledged that less effort has been turned on mosquito larval control in developing countries and Africa in particular. A recent study recognized that in order to maintain the gains made in the fight against malaria, while pursuing further reduction of malaria transmission, there needs to be additional tools for vector control [22].

The existing mosquito larval control measures require trained personnel and are generally expensive. Thus, relying entirely on the current approaches to larval source management might continue to alienate communities from participating in larval control programmes. Evidence shows that *Bacillus thuringiensis var. israelensis* (Bti) is expensive, requires frequent repeat applications and cannot control pupae [23], [24]. Even the use of fish predator for mosquito larvae control might only work in relatively large and less transient water pools, which are usually less preferred for anopheles breeding. What is more, serious concerns have been raised about the threats of exposure to chemicals when people use indoor residual sprays such as DDT. What is more, studies have also demonstrated that DDT use resulted in the emergence of resistance strains of mosquitoes, with potential negative effects on biodiversity [25].

Overall, despite the challenges, a renewed call for large scale larval source reduction is lately gaining momentum [26], [27], [28]. This is contrary to pessimists' opinion that an area specific approach might bear results [29], [30]. Both approaches have their own strengths and weaknesses, but most importantly implementing either approach still presents an uphill task especially in Africa. This is so, because distribution of larval habitats and their potential for anopheles larvae productivity varies widely between regions at different spatial and temporal scales [31], [32]. An area wide treatment with larvicides requires greater care not to harm the wider aquatic ecosystem compared to an area specific treatment. On the contrary any area specific treatment necessitates accurate information on productive anopheles larval habitats, which at the moment is not refined [33]. It is on this background that this paper presents the preliminary findings of an innovative research evaluating the potential of decomposed cow-dung to hinder anopheles larval production as a strategy to reducing malaria transmission.

Therefore, the use of cow-dung is aimed at fostering area wide control of mosquito breeding grounds, using locally available material without any financial constraints or technicalities, thereby allowing active involvement of communities in the fight against malaria. This paper presents the evaluation of physic-chemical parameters of dissolved decomposed cow-dung treated pond and their effect on Anopheles mosquito breeding in Yala swamp wetland of western Kenya.

2 MATERIALS AND METHODS

2.1 STUDY AREA

The study was carried out in Yala swamp, Siaya district of Western Kenya. The district lies between latitude 0° 26 South to 0° 18 North and longitude 38° 58' east and 34° 34' west. Yala swamp is the third largest deltaic wetland in Kenya after the Lorian swamp and Tana River delta. The swamp has been massively encroached for agricultural purposes. Commercial agriculture goes on in the wetland despite the fact that it is the most valuable riparian and floodplain wetland in the delta of River Yala within the Lake Victoria ecosystem, covering a geographical area of 17,500 ha (175 km²). This raises fear that changing land use system may create suitable habitats for Anopheles mosquito breeding, thereby increasing malaria prevalence in a region that is remote, poor and has ill-equipped health facilities.

2.2 EXPERIMENTAL DESIGN

Study sites were selected for regular sampling of mosquito larvae from two ponds and two small swamp pools in an experimental design. Study sites were identified and demarcated in March 2006 followed by establishment of experimental and control ponds in drained parts of the wetland. The small swamp pools were identified in undisturbed parts of the wetland for regular larvae and water sampling. Experimental and control ponds, each measuring 300 cm x 400 cm at a depth 75 cm, were constructed. Each pond was then filled with fresh water to capacity and left for free flying mosquitoes to colonize and breed. The yala River water was pumped into the ponds from farm irrigation channel using generator. The experimental pond was treated with dissolved decomposed cow dung before the commencement of mosquito larvae sampling in April. Approximately 2kg of decomposed cow-dug was added to 10 litres of water in a plastic tub and mixed thoroughly before extracting the filtrate for the pond treatment (Table 1).

Table 1. Pond treatment with dissolved decomposed cow dung against mosquito larvae

Species targeted	Material used	Application rate-unit/9m³ of pond water	Duration (Days to re-treatment)
An. gambiae *An. funestus*	Dissolved decomposed cow dung	10 Litres	15 days

Source: Field experiment adopted modified version [34].

The pond treatment with cow dung (organic fertilizer) was informed by the study findings of Garg and Bhatnagar [35], which investigated the effect of five different doses (5 000, 10 000, 15 000, 20 000, 24 000 $kgha^{-1}$ $year^{-1}$) of cow dung on pond productivity and fish biomass in still water ponds. A third dose of 15000 $kgha^{-1}$ $year^{-1}$ yielded higher species diversity (zooplankton and phytoplankton) and fish biomass. It was also observed that dissolved oxygen remained significantly high at 4.7 mgl^{-1}, but the decline of the above parameters occurred with the increase of treatment doses (20000-24000 $kgha^{-1}$ $year^{-1}$). It was further observed that, at the application rate of 15000 $kgha^{-1}$ $year^{-1}$, the residual effect of cow dung decreased after 60-75 days. The duration of experiments we carried out between seasons 9wet and dry) fell within the number of days required to minimize residual effects of cow dung. Going by the rate of cow dung application Garg and Bhatnagar used [35], a pond measuring 12 m² requires 18 kg.

2.3 DATA COLLECTION

2.3.1 MOSQUITO LARVAE SAMPLING

Regular mosquito larval sampling was carried out in three categories of habitats (Control pond, treatment pond and swamp pools which occurred in undisturbed parts of the wetland) within the study area. Mosquito larvae were sampled twice a week from April 2006 to August2006 between 8.00 hours and 12.00 hours. Larvae in third and forth instar stages of mosquitoes' development were collected by dipping (using standard dipper). The dipper of capacity 400 ml was used as a survey tool for sampling mosquito larvae as recommended by Claudia [36] and Service [37]. Dipping was done at the rate of 6 dips per m² of water surface area. This was applied in small swamp pools where two such pools were identified and marked for regular sampling. For large habitats (control pond and treatment pond) 30 dips were taken within 5 m² areas along the

edges and around floating substratum on water surface. During larvae sampling, vegetation and any substrate on water surface of each habitat was noted on every sampling day for the whole period of study. They included dense mats of floating vegetation, *Cyperus papyrus*, *Typha*, grasses and herbaceous plants. We also noted potential predators of mosquito larvae during the study. These included water bugs (*Diplonychus* sp, Hemiptera: Notonectidae), water beetles and water beetle larvae (*Dytiscus* sp, Coleoptera: Dytiscidae), dragonfly larvae (*Pantala* sp, Odonata: Libellulidae), as well as Toads and tadpoles (Table 2).

Table 2. Mean bio-physical conditions of mosquito larval habitats during the study period

Habitats	Bio-physical Conditions of Larval Habitats		Water Conditions	
	Vegetation	Predators	Colourless & foul	Coloured & foul
Control pond	40(3.79±0.12)	40(2.75±0.11)	†	
Treatment pond	40(4.01±0.22)	40(3.15±0.26)		††
Swamp pools	40 (4.65±0.28)	40(3.08±0.29)	††	

Values on predators and vegetation are given in mean frequency and standard deviation of occurrence in each habitat, while water condition is presented using symbol (**†** for a single condition: colour without smell, **† †** for both conditions: colour and smell).

2.3.2 PHYSICO-CHEMICAL VARIABLES

Selected habitats namely control pond, treatment pond and swamp pools were positive for mosquito larvae, and were consequently evaluated for physico-chemical characteristics. A water sample was collected from each breeding site concurrently with the collection of mosquito immature, between 08:00hrs and 12:00 hrs on each sampling day. Key water quality parameters measured were phosphorus (PO_4^-P), nitrogen ammonia (NH_4 - N), nitrate (NO_3^-N), temperature (ºC), dissolved oxygen (DO), hydrogen ion concentration (pH), electrical conductivity (EC) and turbidity. Initial readings were made from a freshly collected water sample in the dipper itself after sorting the larvae and were analyzed within 3-5 hrs of collection in Lake Victoria Environment Management Programme (LVEMP) laboratory, Kisumu. Elsewhere in Pakistan, a study demonstrated no significant differences in physico-chemical parameters of mosquito breeding water within 12 hours after collection [38]. Thus, it was assumed that any significant physico-chemical changes would not occur within the short time lag between collection and analysis in the LVEMP Laboratory. However, due to long distance and lack of reliable public transport from the study area to Kisumu town where LVEMP Laboratory is located, only parameters that could be measured directly in-situ were tested further during larval sampling. Accordingly, three of the initial eight parameters measured (PO_4^-P, NH_4 - N, and NO_3^-N) were not tested further (Table 3).

The Temperature, pH, Conductivity, Dissolved Oxygen (DO) were measured using M90 multi-probe meter. Turbidity was measured in Jackson Turbidity Units (JTU), Renn CE [39]. Temperature (ºC) and hydrogen ion concentration (pH) were determined in-site at the time of collection, die latter using BDH pH-paper. Other parameters such as dissolved oxygen, turbidity and conductivity were analyzed during field sampling exercise using M90 multi-probe meter. Turbidity was measured in Jackson turbidity units (JTU).

Table 3. Data of water quality parameters tested in Lake Victoria Environment Management Programme Laboratory, Kisumu.

Parameters	Date Sampled	Larval Habitats: Control Pond	Larval Habitats: Treated Pond	Larval Habitats: Swamp pool	Unit of Measurement
Temp.	26.04.2006	26	26.3	26.7	ºC
pH	26.04.2006	6.7	5.8	7.5	pH scale
COND	26.04.2006	108.1	219	235	µmhos/cm
Turbidity	26.04.2006	10.6	26.7	320	J.T.U
DO	26.04.2006	5.4	5.2	4.3	mg O_2/L
PO_4^-P	26.04.2006	0.089	0.09	0.08	mgP/L
NH_4 - N	26.04.2006	0.06	0.063	0.095	mgN/L
NO_3^-N	26.04.2006	0.002	0.004	0.061	mgN/L

2.3.3 MOSQUITO IDENTIFICATION

The mosquito larvae were identified in the field as either anopheles or culicine larvae using the keys of Gillies and DeMeillon [40]. The identified larvae were recorder by habitat type, hour of the day and day of sampling. The immature mosquitoes were then put in plastic vessels containing water from their respective sampling sites. The contents of plastic vessels were then closed in a cool box and transported to a nearby health center (Ratuoro Health Center) for indoor breeding. The intension was to rear larvae to adult stage for mosquito identification to species level. However, some larvae drowned during transportation due to long walking distance from the sites in swamp land. From the percentage larvae that drowned, culicine larvae had higher rates of larval mortality (52%) compared to anophelines larvae (36%). Six mosquito cages measuring 30 cm length by 30 cm width and 30 height were locally made for mosquito rearing. Three cages for anopheles larvae each containing samples from one habitat for three habitats, while the other three were for culicines divided by the number of habitats. During rearing the larvae were fed on particles of biscuits, as the development of immature mosquitoes is known to benefit from sugary substances. Since the focus was on mosquito vectors of malaria parasite, only adult anopheles mosquitoes were further identified to species level using the keys of Gillies and DeMeillon [40]. The adult anopheles mosquitoes were identified morphologically with the aid of a light microscope at the center for insect physiology and ecology (ICIPE), Mbita district. The mosquito body features considered in the identification exercise included veins of wings, speckled legs and number of bands, as well as laterally projecting tufts of scale on the abdominal segments.

2.4 STATISTICAL ANALYSIS

Statistical analysis was done using SPSS for windows version 17.0. Descriptive measures of central tendency and spread were analyzed in terms of means, range and standard deviation. Association of immature mosquitoes' distribution and abundance with the physico-chemical variables in breeding waters (habitats) was examined by bivariate factor analysis. Mosquito larval species abundance (expressed as mean number of immatures/sample size) in different breeding habitat types was examined for significant mean differences between habitats using Post-Hoc analysis of variance (One Way ANOVA). The influence of water quality parameters such as temperature, dissolved oxygen, pH, turbidity and conductivity on the occurrence and abundance of *Anopheles larvae* and *Culine larvae* was analyzed using Pearson correlation "r" test (significance represented by ρ-value) for parametric variables. All numbers of sampling units per habitat, including those with no larvae, were included in the pupation abundance analysis.

2.5 ETHICAL CONSIDERATION

This study did not involve the use of human subjects for experiments and, as such, we considered the dignity of people involved at various stages of the study, as well as the integrity of the ecosystem to be of paramount importance in the research context. In this regard, research clearance to conduct this study was obtained from the Ministry of Education, Science and Technology - Kenya, prior to the commencement of field experiments. Research clearance No. MOEST 13/001/36C 37/2 was registered in the name of Nina Pius Mbuya.

3 RESULTS

A total of 1531 mosquito larvae were sampled from the three habitats (control pond, treated pond and swamp pools) during field work. Of this number, 987 (64.5%) were from control pond, 418 (27.3%) from treated pond, while the swamp pools had the least larvae samples of 126 (8.2%). Anopheles larvae accounted for 57.7% (884), while culicine larvae accounted for 42.3% (647) of all mosquito larvae sampled from the beginning of April to the end of August 2006. Figure 1 shows distribution of adult mosquitoes against larvae population that was reared indoors, marked by respective habitat of their origin. The results summarized in figure 1 show that only 570 (65%) adult mosquitoes emerged from all larvae reared in cages indoor (877), indicating high larval mortality at 35%.

A good number of reared mosquito larvae, 360 (63.6%) out of 566 immature anopheles mosquitoes, survived to adult stage, while 210 (67.5%) out of 311 culicine larvae survived to mature stage of mosquito development. Anopheles larvae collected in clean water environment of control pond were more likely to survive to adult stage (70.02%) compared to anopheles larvae from treatment pond (19.23%) and swamp pools (11.76) respectively. The trend was similar for culine larvae, except for the treatment pond which showed high culicine larvae survival rates. For the culine mosquitoes, control pond had the highest culicine larvae survival rate at (84.16%) followed by treatment pond (60.22%) and swamp pools (20%). The probability that a sampled anopheles larvae would survive to adult stage was highest for larvae collected from control

pond and lowest for larvae collected from the swamp pools. Thus, much as treatment pond contained some anopheles larvae, the results show that their chance of survival was in fact very low.

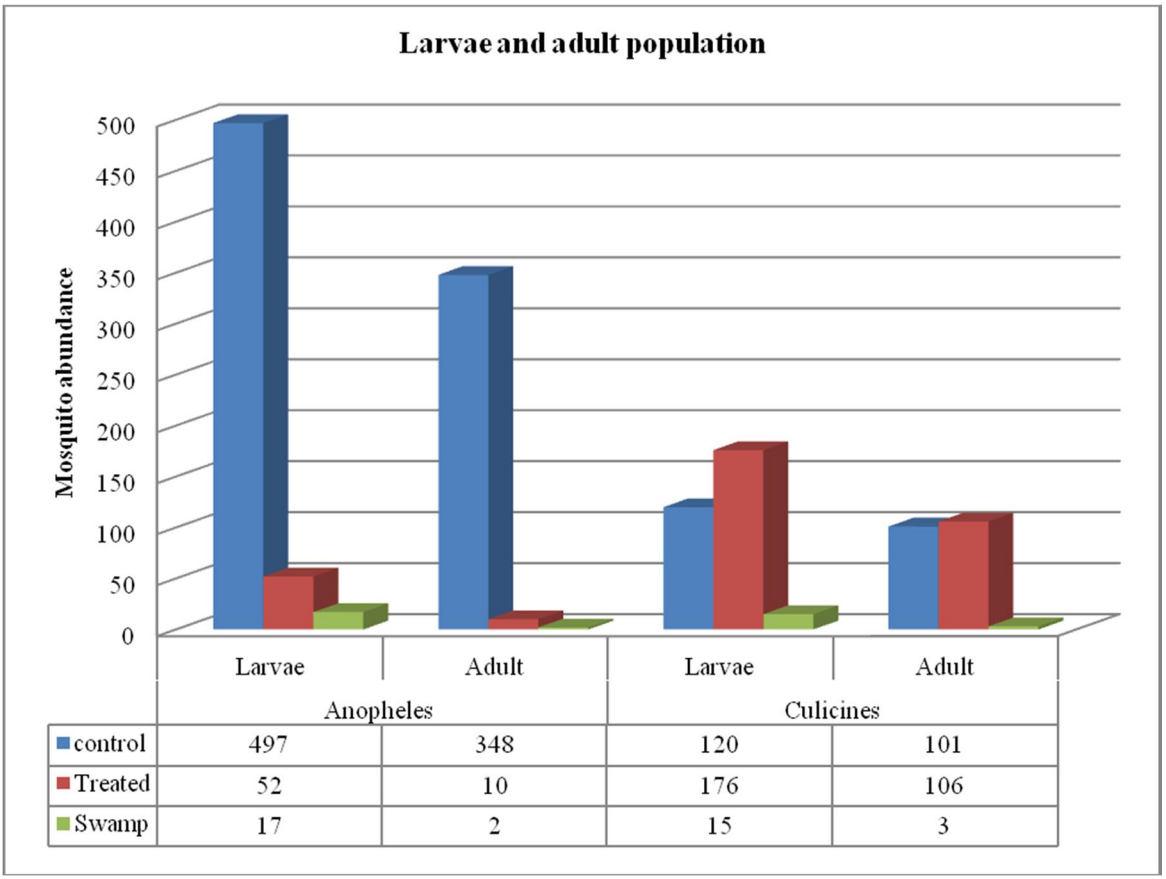

Fig. 1. Emergent adult mosquitoes from the larvae reared in cages indoor

Table 4 provides the details of physic-chemical conditions of mosquito breeding waters where anopheles and culicine larvae were collected during the study. The table 4 also shows disparities of mosquito abundance between habitats, we attribute to variations in Physico-chemical parameters tested in breeding waters that were positive for mosquito larvae. As the results indicate, conditions in control pond, which had comparatively higher concentration of dissolved oxygen and lower pH value, favored anopheles mosquitoes' breeding. On the contrary, culicine larvae occurrence in the same control pond was comparatively lower in abundance. Rather, higher abundance of culicine mosquitoes was recorded in cow-dung treated pond, which had comparatively higher level of turbidity.

Overall, the swamp pools were least preferred by both groups of mosquitoes breeding in Yala swamp wetland. The swamp pools which had the highest levels of tested water quality parameters such as Temperature, pH, conductivity and turbidity also had the lowest larvae collection. Other than the water quality parameters, biotic factors (vegetation and predators) might have played some role, by influencing habitat preference for breeding of gravid mosquitoes. However, the population mean of potential predators of mosquito larvae was higher in treated pond compared to both control pond and swamp pools. This means that non-biotic factors played significant role during the study period.

Table 4. Mean mosquito larval population by water quality parameters in each habitat

Variables	Mosquito Habitats		
	Control pond n = 40	Treated pond n = 40	Swamp pools n = 40
Anopheles larvae	20.38 ± 0.41	1.29 ± 0.23	0.41 ± 0.10
Culicine larvae	4.29 ± 0.26	9.16 ± 0.32	2.74 ± 0.29
Temp (ºC)	25.82 ± 0.59	25.93 ± 0.55	26.14 ± 0.46
pH	6.1 ± 0.18	6.27 ± 0.15	7.43 ± 0.191
Dissolved Oxygen (D.O)	5.34 ± 0.22	5.28 ± 0.19	4.34 ± 0.13
Turbidity	26.76 ± 0.34	178.63 ± 1.45	320.75 ± 1.69
Conductivity	190.5 0 ± 2.18	73.11 ± 0.64	236.15 ± 1.01

**The values are given as mean plus or minus the standard error of mean.*

Further statistical analysis of physic-chemical parameters revealed that there were significant differences in water quality between habitats during the study ($p < 0.05$), except for temperature. It was possible that the disparities in water quality between habitats created conditions which were either favorable or unfavorable to individual species of mosquitoes breeding in Yala swamp. Although the minimum and maximum ranges of selected physico-chemical characteristics of mosquito habitats did not show major variations within habitat ($p > 0.05$), significant association between mosquito abundance and specific physico-chemical parameters was detected (Table 5).

The results of Pearson correlation analysis show that anopheles larval density had strong and highly significant association with Water quality parameters such as pH, dissolved oxygen and turbidity (Table 5). Among the water quality parameters examined for mosquito breeding, only temperature was not an important factor explaining anopheles larval production in the study area. In particular, Temperature did not have significant influence on the distribution and abundance of anopheles larvae ($r=-0.01$, $P>0.05$). On the contrary, temperature was significantly associated with culine larval production in Yala swamp wetlands. The other water quality parameters important for anopheles mosquitoes' breeding (pH, Do, Turbidity and Conductivity) were not significant factors for culicines, except water pH. Table 5 shows very positive strong association between anopheles mosquito breeding and dissolved oxygen ($r = 0.677$, $p < 0.001$), and equality strong but negative significant association with water turbidity ($r = -0.854$, $p < 0.001$).

Table 5. Association of mosquito larval population with each water quality parameter

Mosquito Larvae		Water Quality Parameters				
		Temp	pH	D.O	Turbidity	Conductivity
Anopheles larvae	*Pearson correlation*	-0.010**	-0.611**	0.677**	0.854**	0.348**
	Sig.	0.915	0.001	0.001	0.001	0.001
	No. of Samples	40	40	40	40	40
Culicine larvae	*Pearson correlation*	-0.371**	-0.256**	0.163**	0.836**	0.836**
	Sig.	0.001	0.005	0.076	0.578	0.540
	No. of Samples	40	40	40	40	40
Total larvae	*Pearson correlation*	0.45**	0.762**	0.436.**	0.436.**	0.436.**
	Sig.	0.085	0.001	0.001	0.001	0.001
	No. of Samples	40	40	40	40	40

** *Pearson correlation is significant at 0.01 (Two-Tail)*

From the results of Pearson correlation analysis of the relationships between mosquito distribution and water quality parameters, it became necessary to understand if there were significant mean differences of water quality parameters between habitats. The results of Post-Hoc analysis of variance (ANOVA) of five physic-chemical parameters examined during the study, indicating mean differences of water quality between habitat (control pond, treated pond and swamp pools) are

presented in table 6. The results in table 6 show that there were significant mean differences of water quality parameters between mosquito larvae habitats for the three sites ($p < 0.05$). Significant variations noted on mosquito distribution among the three habitats are reflected in the differences observed on water quality parameters tested during the study. Water quality results indicate that all parameters measured had significant variability of mean values between habitats ($p < 0.05$). Therefore, variation of mean water quality parameters between immature mosquito habitats is likely influencing anopheles mosquito breeding in control pond, treatment pond ans swamp pools.

Table 6. Mean differences of water quality parameters between mosquito lavae habitats

Variables	Habitat (I) n = 40	Mean Difference of Water Quality Parameters: Habitat (J) n = 40	Mean Diff (I-J)	S.E	P -value
Temperature	Control pond	Treated pond	-0.35	0.14	p = 0.012
		Swamp pools	0.3	0.14	p = 0.030
	Treated pond	Swamp pools	0.65	0.15	p = 0.001
pH	Control pond	Treated pond	-0.26	0.03	p = 0.001
		Swamp pools	-1.38	0.03	p = 0. 001
	Treated pond	Swamp pools	1.12	0.03	p < 0.001
Dissolved Oxygen	Control pond	Treated pond	0.31	0.04	p < 0.001
		Swamp pools	1.12	0.04	p < 0. 001
	Treated pond	Swamp pools	0.81	0.04	p < 0.01
Turbidity	Control pond	Treated pond	-151.3	0.29	p < 0.001
		Swamp pools	-294	0.29	p < 0. 001
	Treated pond	Swamp pools	142	0.29	p < 0.001
Conductivity	Control pond	Treated pond	58.09	22.82	p = 0.012
		Swamp pools	107.09	22.82	p < 0. 001
	Treated pond	Swamp pools	49	22.82	p = 0.034

**The Mean difference is significant at the 0.05 level. Values are given to the nearest decimal where mean difference is significant at P < 0.05 based on LDC Pos-Hoc analysis of variance (ANOVA).*

The results of initial water quality analysis suggest that there was little evidence of organic pollution with cow-dung in treatment pond. These results are presented in table 3, showing relatively low levels of ammonia (0.063 mgN/L), nitrate (0.004 mgN/L) and phosphate (0.09 mgP/L) in both control and treatment ponds compared to swamp pools. The results achieved with appropriate volume of cow-dung filtrate added into the pond water marked 'treatment pond' is evidenced by anopheles mosquitoes' less preference of treatment pond water.

Table 7 summarizes the mean differences of mosquito densities between habitats in the study area. Overall, there was high significant mean difference of mosquito density between control pond and treated pond ($p < 0.001$), control pond and swamp pools($p < 0.001$), and between treatment pond and swamp pools ($p < 0.05$). A highly significant mean difference of mosquito abundance between control pond and treatment pond shows that treatment with cow-dung had significant influence on mosquito breeding during the study period.

Similarly, the significant mean difference of larvae abundance between treatment pond and swap pools indicates that water pools in undisturbed wetland are not preferred anopheles breeding grounds. This is likely so, because both control and experimental (treatment) ponds were located in the drained part of Yala swamp, whereas swamp pools were identified within the undisturbed parts of the wetland.

Table 7. Mean mosquito population differences by habitat type

Dependent Variables	Habitat (I) n = 40	Mean Difference between Habitats: Habitat (J) n = 40	Mean Diff (I-J)	S.E	P -value
Anopheles larvae	Control pond	Treated pond	18.85	0.82	p < 0.01
		Swamp pools	21.4	0.81	p < 0.01
	Treated pond	Swamp pools	0.91	0 .83	p > 0.05

Culicine larvae	Control pond	Treated pond	-6.14	0.53	p < 0.001
		Swamp pools	-0.26	0.52	p > 0. 05
	Treated pond	Swamp pools	8.48	0.53	p < 0.01

**The Mean difference is significant at the 0.05 level. Values are given to the nearest decimal where mean difference is significant at P < 0.05 based on LDC Pos-Hoc analysis of variance (ANOVA).*

4 DISCUSSION

The findings of this study show that of all mosquitoes breeding in Yala swamp wetlands, in western Kenya, *Anopheles* species were the most abundant mosquitoes. Other mosquito species of culicine origin only occurred in very small numbers in the three habitat categories investigated during the study. In particular, *Anopheles gambiae* complex was the most dominant malaria vector followed by *Anopheles funestus*. The two groups of anopheline species of mosquito are known vectors of malaria in the Afro-tropical regions [41]. In Kenya, the pathogen causing malaria, *Plasmodium fulciparum* is most often transmitted by *Anopheles gambiae*, with *Anopheles funestus* as another major vector [42], [43], [44]. Thus, significantly higher abundance of these species of mosquitoes present a real risk of malaria transmission in the study area.

Of all mosquito larval habitats, control pond was the most productive for mosquitoes breeding in Yala swamp. Anopheles species of mosquitoes made the most use of control pond compared to other mosquito species. Second habitat with high mosquito abundance was the treatment pond, while the swamp pools had the least number of mosquitoes sampled during the study period. On the other hand, the results of biophysical conditions observed during the study show that vegetation was present in all the three habitats. Both vegetation and predators were recorded in each of the three habitats investigated for mosquito larvae during the study period. Summary of bio-physical factors (Table 2) indicate that slight variability exists between habitats, but the variability observed on vegetation and predators were fairly narrow and not statistically significant between habitats. Earlier study [45] implicates biotic factors such as vegetation types and proportion of coverage as better predictors of larval abundance than the physicochemical factors. Subsequent studies also linked the abundance of a number of mosquito specie to the presence of specific plants [46]. For instance, the observations made in previous studies revealed that dense mono-specific stands of *Typha* (cattail) with an accumulation of submerged dead stems and isolated pockets of water are suitable for mosquito breeding [47].

Although several studies have applauded significance of vegetation in mosquito habitats, including acting as larvae hide outs from predators as well as providing food materials, this study does not confirm such direct linkages. Vegetation might also create stagnant conditions by decreasing water movement, especially for the streambed breeding mosquitoes. Instead, the results of biophysical factors suggest that it was not likely that vegetation cover and predator abundance were significantly influencing mosquito larvae distribution between habitats.

On the contrary, water quality parameters varied significantly between habitats, as did dissolved oxygen (DO), pH, Turbidity and electrical conductivity (EC). There could be no doubt that the range and relative abundance of *Anopheles* species and culicine larvae are influenced differentially by ecological parameters. In this study we found no evidence that biophysical factors bear significant influence on anopheles larvae distribution in mosquito habitats investigated. Similarly, much as the effect of water quality and external factors on both the vectors and parasites of malaria are established facts, some previous studies on the ecology of malaria transmission yielded different results. As to which ecological factors are most responsible for the distribution and abundance of *Anopheles* species, significant variability between physic-chemical parameters have been observed. In this study, for instance, temperature had no significant influence on the distribution and abundance of mosquito species found in Yala swamp.

However, unlike other water quality parameters, the effect of temperature on mosquito larval development has been applauded in many studies investigating the links between water quality and mosquito species distribution and abundance [48] . In Yala swamp the mean temperature was 26 degrees centigrade during the study period. Other studies found that the optimum temperature for mosquito development is between 25 and 27 degrees centigrade [49], and the maximum temperature range for both vectors and parasites of malaria is 40 degrees centigrade. Thus it can be argued that since the mean temperature range in both wet and dry season were close to the physiological tolerance limit of malaria vectors. Accordingly, slight temperature differences among the habitat types did not therefore produce any statistically significant association with the mosquito population density in Yala swamp.

There are several published studies linking water quality parameters and mosquito abundance: In India [50], Senegal [51], Kenya [52], and in Accra, Ghana [53]. All bring out the importance of water quality parameters for *Anopheles* species

breeding. Dissolved oxygen of water quality measurements showed positive and significant correlation with the distribution and abundance of mosquito vectors of malaria in Yala swamp.

Although the study findings applaud the influence physic-chemical factors have on mosquito breeding, literature on larval habitat generally demonstrate that *Anopheles* species exploit specific habitat types, with very different biological, chemical and physical characteristics. In Yala swamp, our study shows a similar trend as the abundance was greater in the control pond habitat where the conditions were optimum for anopheles larval development. However, there is scanty and inconclusive information on different water quality ranges for *Anopheles gambiae* and *Anopheles funestus* from other areas of their geographical occurrences. Thus, from the results of field experiments we observed that, of all the habitats investigated for mosquito larvae, control pond presented the most suitable habitat for *Anopheles* mosquito breeding in Yala swamp.

The treatment of pond water with cow-dung resulted in slightly acidic water with fairly clear and moderate nutrients content. These conditions are assumed to have persisted throughout the study and had the potential to influence mosquito distribution and abundance in the pond. The treatment pond was the most preferred by gravid culicine mosquitoes for their breeding compared to the other two habitats. During the study, the quantity of cow-dung material used (Table 1) resulted in significant reduction of mosquito breeding in treatment pond in general. The findings show that cow-dung polluted water was not favoured by gravid anopheles mosquitoes for breeding, yet anopheles species were the most productive group of mosquitoes in Yala swamp. The cow-dung treatment dosage ensured that material applied on experimental pond was within the range that can support diversity of important aquatic biota. While very low levels of nutrients in a local environment may affect the population and vigor of the organisms present, excess nutrients may impact negatively on desirable aquatic populations while increasing the production and growth of vector organisms. It has been established that mosquito larvae filter-feed on algae, particulate organic matter and bacteria suspended in the water [54]. In fact, previous studies showed that development of algae, and the growth efficiency of bacteria (critical components of the mosquito larvae diet) is dependent respectively on the availability of nitrates and phosphorus in the lakes [55]. Indeed past studies [56] give concentration between 0.1 and 4 mg $NO_3^-N\ L^{-1}$ for lakes and other natural water bodies, with most unpolluted waters having less than 1.0 mg/L mg $NO_3^-N\ L^{-1}$. Accordingly, the level of nitrate and phosphorus in the cow dung treated water pools was within the limits of less than 1.0 mg/L mg $NO_3^-N\ L^{-1}$.

Furthermore, the dissolved oxygen and turbidity showed positive and significant correlation with the distribution and abundance of mosquito vectors of malaria in Yala swamp during the study. Indeed, to be more precise, the mean value of dissolved oxygen in the treated pond was 5.23 mg/l during the study period; hence, it was a good fit for biodiversity of aquatic fauna and flora. According to APHA [57], the dissolved oxygen concentration above 5.0 mg/l is suitable for the support of diverse biota. Thus, while the level of pollution with dissolved cow dung was within environmentally acceptable limits, it significantly diminished the chances of mosquito breeding in standing water pools in the farmed parts of the swamp.

This study recognized the fact that an important gap exists in the entomological information regarding potential long term impact of cow dung on targeted species of *Anopheles* mosquitoes. However, we are also aware that development of resistance strain of vectors, if at all, is not likely to occur over night due to cow dung use. What is more, besides being cheap and readily available, cow dung is a more biodegradable compound for the environment. Accordingly, this study adds a voice to the existing views that sustainable malaria control program needs to strategically address a complex range of environmental and social determinants in a cost-effective manner.

The focus of this study was to emphasize the fact that effective control of a disease of public health concern requires mobilization of all segments of the society. Previous studies suggest that active and informed participation of the intended beneficiaries is paramount for effective vector control [58], [59]. Environmental manipulation is among the practices that have been tried in an attempt to inhibit breeding of mosquitoes of public health concerns. Accordingly, effective suppression of the population of malaria vectors requires active participation of the vulnerable communities. For instance, there is a need to eliminate virtually all breeding sites within 2 to 3 kilometers of a settlement, which is advisable because adult mosquitoes can fly long distances [60].

5 CONCLUSION

The results of this study show that *Anopheles* species were the most abundant group of mosquitoes breeding in Yala swamp, followed by culicines which occurred in significantly low densities. Control pond was the most productive for mosquitoes breeding in disturbed part of Yala swamp wetland, with anopheles species making the most use of it. Of all the anopheles mosquitoes sampled during the study, *Anopheles gambiae* complex was the most important species found almost exclusively in control pond which had the lowest turbidity and pH levels. Except for the variability of water quality

parameters between habitats, there was no significant differences in mean frequency of other habitat conditions such as biotic factors. What is more, much as culicine larvae occurred in all the three habitats, overall their population was very low. A fairly higher abundance of culicine mosquitoes was recorded only in the treated pond compared to other habitats. This suggests that use of cow-dung might create suitable habitats for mosquitoes of culicine origin, thereby increasing local biting nuisance. However, a significant reduction in anopheles population has the potential to benefit public health consideration for advancing human wellness in order to achieve sustainable development.

These results may be useful in the mosquito larval habitat management for malaria control, which emphasizes pro-active involvement of local communities. As explained in the introduction section, managing larval habitats for malaria vectors' population reduction may facilitate significant decline in malaria prevalence in western Kenya. This is important, especially in the regions of Africa where evidence portrays malaria prevalence in a declining trend. Adopting a strategy which allows the local communities to participate in larval source reduction from the forefront of intervention has the potential to achieve a wider coverage. Ultimately any significant reduction of anopheles mosquitoes' population in expansive rural settings bears the potential to minimize risk of contact with mosquito vectors of malaria pathogen. In the end, reduced human-mosquito contacts would significantly result in low mosquito biting rates and eventually bring down infection with malaria causing parasites.

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Pre-Weaning Performance of Lambs under Traditional System of Production in Northern Ghana

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ABSTRACT: The study was carried out in three communities namely, Pekyi, Kokpong and Cheyohi in the Tolon Kumbungu District (TKD) to assess the growth performance of lambs kept under the traditional system of production. The parameters studied were birth weight, pre-weaning weight gain, ewe weight at birth, and pre-weaning ewe weight. Data was collected from 26 animals (14 lambs and 12 ewes) and analysed using anova, regression and graphs. The study lasted 12 weeks. Lambs had a mean birth weight of 1.6 kg, pre-weaning average weekly gain was 742 g and pre-weaning mean weight at 12 weeks was 10.7 kg. Mean birth weight (1.5 kg), mean pre-weaning weekly gain (730 g) and mean pre-weaning weight at 12 weeks (10.2 kg) of male lambs were lower than those of females which were 1.9 kg, 770 g and 11.2 kg respectively. Also single born male lambs had significantly higher birth weight (1.7 kg), pre-weaning average weekly gain (773 g) and pre-weaning weight at 12 weeks (11.1 kg) than female lambs which were 1.4 kg, 620 g and 9.3 kg respectively. With better management practices by the farmer, lambs under the traditional system could be improved greatly.

KEYWORDS: Communities, growth, lambs, pre-weaning, conventional system.

1 INTRODUCTION

Studies by [1] revealed that, animals do not only serve as a buffer in times of crop failure but also as a temporary and long term store of wealth. Again animal protein for growth and development in our human bodies is not only provided by the livestock sector, but livestock also offers opportunities like employment for millions of rural and urban dwellers engaged in any form of livestock production and marketing [2]. In spite of the potential productivity per unit of sheep, their contribution to the national economy is relatively low. Reference [3] stated that inadequate feeding and poor quality feed are regarded as major factors limiting sheep and goat production in the tropics.

Reference [4] noted that with a gestation of 5 months and an interval of 1 to 2 months from parturition to the resumption of estrous activity (in the breeding season), sheep have the potential to lamb every 6 months. Two good reasons for various weaning ages include cost reduction and rapid growth but these must be balanced against feed intake stress and labour. Since overall productivity may be determined by several factors such as numbers of lambs surviving from birth through pre-weaning and post-weaning, growth performance, feed cost, labour, medication, overheads etc. it is critical to have an idea of pre-weaning performance as this is ultimately linked to post-weaning performance.

Information on traditional pre-weaning performance that reflect the actual situation of the small scale production systems prevailing in the rural setting is scanty in Ghana. This study therefore set out to investigate how the pre-weaning performances of lambs fare *in sittu* under the tradition system of production.

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2 METHODS AND MATERIALS

2.1 STUDY AREA

The study was conducted in three communities in the Tolon-Kumbungu District of the northern region of Ghana between the months of November 2011 to January 2012. The communities included Pekyi, Kokpong and Cheyohi. The District lies on latitude 9^{o} 25'N and longitude 1^{o} 00'E and at altitude of 183m above sea level in the Guinea Savannah ecological zone of Ghana. The area experiences a unimodal rainfall pattern which begins from April/May to September/October respectively. The average annual rainfall is about 1043mm and a monthly mean of 88mm with the peak in August and September. The temperature generally fluctuates between 15^{o} C (minimum) and 42^{o} C (maximum) with a mean annual temperature of 28.3^{o} C. The mean annual day relative humidity is 54% [5]. The dry season sets in around October and runs to March. The vegetation cover of the study area is mainly woody Guinea Savannah. The predominant grasses found in the area include *Panicum maxicum* (Guinea grass) and *Andropogon gayanus* (Gamba grass).

2.2 SAMPLING PROCEDURE

Purposive sampling was used because only farmers that had at least one pregnant ewe in their flock were considered. These ewes were adjudged to be close to lambing by the farmers themselves. A total of 12 farmers (4 from each of the 3 communities) constituted the sample size.

2.3 TRADITIONAL MANAGEMENT SYSTEM

The animals were housed only during the nights to protect them from harsh weather conditions, predators and thieves. Animals were tethered in bushes and under tree shades near their homes to avoid damage to crops. They were fed with fresh grass and leaves. After the cropping season, animals were allowed to browse and scavenge freely along roadsides and pockets of grazing lands and got back to owners' homes during the night either by themselves or by the help of the village children. There was no supplementation neither was there any routine health regime in place.

2.4 PARAMETERS CONSIDERED IN THE STUDY

2.4.1 BIRTH WEIGHT

This is the body weight of a newborn lamb at birth. This was taken within 24 hours post-partum.

2.4.2 TYPE OF BIRTH

This was classified into either singles or twins.

2.4.3 SEX

This is observed as maleness/masculinity or femaleness/femininity of a lamb.

2.4.4 AGE OF EWE

Age of ewes were determined by the number of lower incisors.

2.4.5 AVERAGE PRE-WEANING WEEKLY WEIGHT GAIN

The difference in weight of lambs between the week in question and the previous week was determined and considered as the weight gain for the week. At the end of the experiment (12 weeks after birth), the weekly gains were summed up and the average taken to determine the average weekly weight gain.

2.4.6 DAILY WEIGHT GAIN

The average weekly gain was then divided by the number of days in a week (7 days) .

2.5 STATISTICAL ANALYSIS

The data was analyzed using Analysis of Variance (ANOVA) and regression using the generalized linear model.

3 RESULTS

3.1 SEX, BIRTH WEIGHT, WEIGHT AT 12WEEKS AND PRE-WEANING AVERAGE DAILY WEIGHT GAIN OF LAMBS

There were more male lambs (71%) compared to females (29%). Most lambs (72%) had birth weight between 1.5 kg and 2.0 kg (Fig. 1) with the mean birth weight being 1.67kg. Also 21% of the lambs had their birth weight from 0.5 – 1.0 kg while the remaining (7%) had birth weight of 2.5 kg to 3.0 kg.

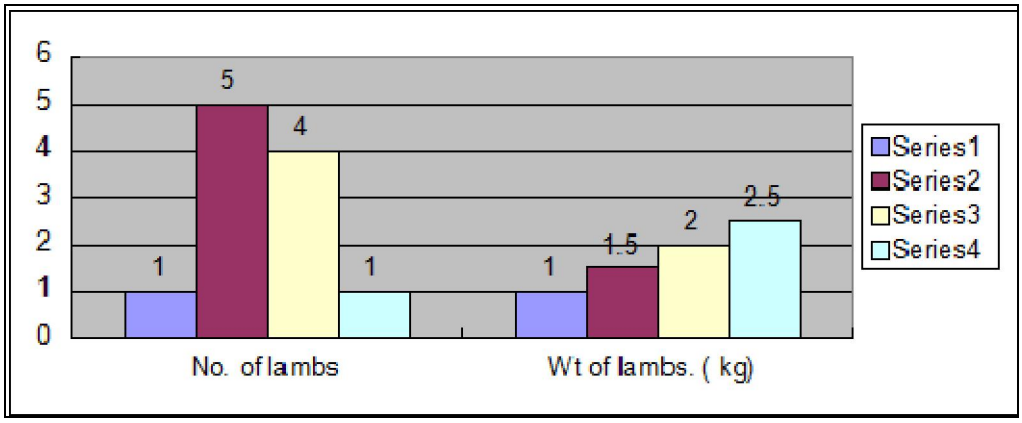

Fig. 1. Birth weight distribution of lambs

At twelve weeks, about 7 lambs (77%) had pre-weaning weights between 8.5 kg and 12.5 kg. About twenty three percent (2 lambs) had weights of 13 kg and 14 kg respectively.

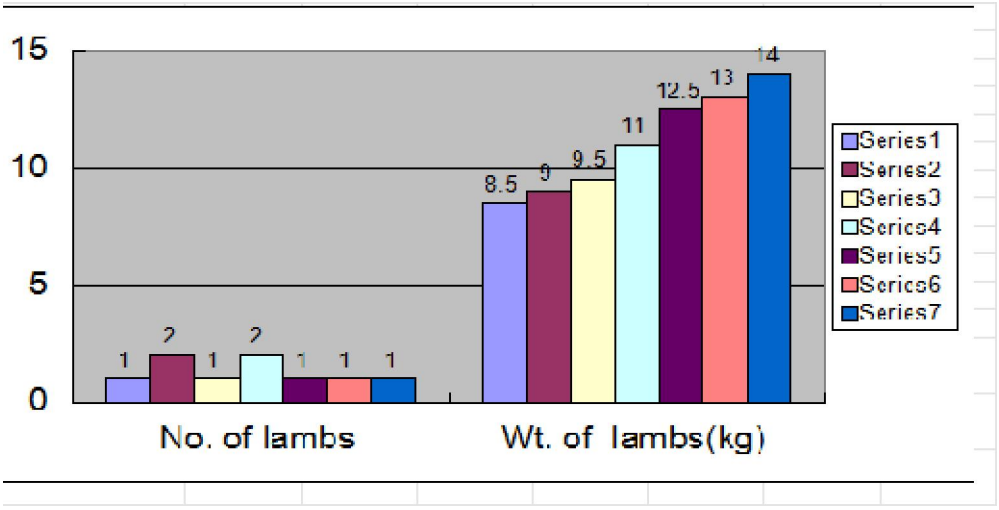

Fig. 2. Distribution of pre-weaning weight in lambs at twelve weeks

The study also indicated that half (50%) of the lambs had their pre-weaning average daily weight gain between 81 g and 100 g. Thirty percent had pre-weaning average daily weight gain of 101 g to 120 g. The highest range of pre-weaning average daily weight gain recorded was between 121 g and 160 g for 20% of lambs.

3.2 BIRTH TYPE AND APPROXIMATE AGES OF EWES

Majority (83%) of ewes had single births as against twin births for 17% of ewes. Ages of ewes were estimated by dentition method to be in the ranges of 3.5-4 years (58%), 2.5-3 years (34%), and 1.5-2 years (8%).

3.3 MEAN GROWTH PERFORMANCE OF LAMBS

Mean birth weight was 1.6 kg and mean pre-weaning average weekly gain was 742 g. At twelve weeks, mean pre-weaning weight gain of the lambs was 10.7 kg.

Table 1. Mean growth performance in lambs

Parameters	Number of animals	Average
Birth weight (kg)	14	1.6
AWWG (g)	10	742
APWWG at 12 Wk	10	10.7

3.4 REGRESSION ANALYSIS

Response variate: WtL1_kg

Fitted terms: Constant + WtE_kg + Farmer + Wks

Summary of analysis

Table 2. Anova table for regression analysis

Source	d.f.	s.s.	m.s.	v.r.	F pr.
Regression	23	1116.96	48.5636	103.65	<.001
Residual	91	42.64	0.4685		
Total	114	1159.60	10.1719		

Percentage variance accounted for 95.4

Table 2 show the analysis of the various fitted terms; the constant, weight of ewe, farmer and weeks, with a very high R^2 value of 95.4%

The summary clearly shows statistically that there was a significant relationship between the weight of ewe, farmer and weeks ($p < .001$).

3.5 MORTALITY

Four (28.5%) out of the 14 lambs died and 3 (25%) out the 12 ewes also died.

4 DISCUSSION

The birth weight of lambs was varied, ranging from 1.5kg to 3.0kg (Fig.1). Reference [6] reported that birth weight is affected significantly by the birth year, age of dam, sex and type of rearing of flock. Similarly [7] mentioned that the birth weight of lambs differed significantly due to year and season of birth, age of the dam, birth type and sex of lambs. In addition birth weight is influenced by breed, sex of lamb, birth type, age of dam, feeding conditions and production system [8]. In this

study factors that could affect birth as alluded to by these researchers were easily applicable and may thus explain the observed differences.

There were more ewes aged 2½ to 4 years in this study. Since parity of a dam has high influence on lamb pre-weaning growth rate [9], [10], it could be said that the pre-weaning growth rate (above 77.0kg/day) in this study compared to findings by [11] who stated that pre-weaning growth rate of lambs increased from the first parity (67.1g/day) to the fourth parity (72.1g/day) after which it began to decline, suggests that the higher pre-weaning growth rate recorded in this study may be due to ecological or breed differences.

Reference [9] stated that lambs born to multiparous ewes had significantly higher weaning weight than those born to primiparous ewes. This assertion is similar to that made by [12] in Djanlloke lambs. In this study pre-weaning growth rates on average were high i.e.106g/day (Table 1) compared to findings by [11]. Pre-weaning weights reported from West Africa on Djallonke sheep, were 1.9 kg for birth weight (BWT) and 10.2 kg for weaning weight at 90days (WT90) in improved village flocks located in the Ivory Coast [13]. Reference [11] reported 2.2 ±0.02 kg for BWT and 9.1 ± 0.05 kg for WT80 for participating farms of an open nucleus improvement programme in the Ivory Coast. Mean weaning weight at 84 days (WT84) i.e. 12 weeks was 10.7 kg (Table 1 and Fig. 2) in this study. This figure fell within the range 10.2 kg and 17.0 kg of weaning weights observed by [13] and [14]. Notwithstanding, it was slightly higher than what was found in Ivory Coast, even though weaning was at 90 days in Ivory Coast as against a lesser period of 84 days in this study.

Reference [15] found that the lambs born as singles were heavier by 15.1%, 19.4%, 19.7%, 9.40% and 7.14% as compared to lambs born as twins for weight at 60, 120, 180, 240 and 300 days weight, respectively. This fact of singles being heavier than twins agreed with the results of other authors in the tropics [16], [17] and as in this study too.

Lamb and ewe mortalities were low, 28.5% vrs 25% respectively compared to findings by [18] where lamb mortality was up to 50% but in agreement with findings by [19].

The R^2 (the explanatory power of the model) of 95.4% showed a highly fitting model (Table 2). It also confirms findings by [6] that birth weight is affected significantly by the management practice which is represented by the farmers in this model. Whereas models from other researchers [6], [7], [8] have concentrated on the age of the dam, this model has clearly shown that the birth weight of the lamb is significantly affected by the weight of the ewe (Table 2).

5 CONCLUSION AND RECOMMENDATION

Birth weight, pre-weaning daily weight gain, and pre-weaning weight at 12 weeks of lambs under the traditional system compared favorably with performance of lambs elsewhere. Mortality of both lambs and ewes were also comparatively low. The birth weight and pre-weaning weight of lambs could be predicted with a high degree of accuracy when the weights of ewe and farmer management types are known.

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Using Abstract Color Paintings Expressing Feelings to Design Textile Prints Showing Emotional Human Factors of Design and Considering Differences of Color Perception between Humans

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ABSTRACT: This research is a Practice led research. It is made of two parts. First some experimental art paintings were made by the artist, based on abstract style, and using colors expressing various emotional feelings. These art paintings are made with power of human feelings and with the spiritual concentration to express these feelings especially into colors. These art paintings are made with the intention to express and also to transfer the spiritual mood of the concept in each case, to the viewers of art and the users of the final product. Next, these art paintings are being used to design textile prints that will keep, and even exaggerate these human emotional factors, that would provide emotional semantics to the users of the product. The designer of the textile prints will consider the slight differences between the colors on the canvas of the paintings, and the colors on the computer screens, and also the final colors on the output fabric material.
The designer and the artist will also consider in the computer stage of design the differences of perception of colors between humans in order to avoid any wrong interpret of color that might lead to expressing a different mood, semantic massage, to the user. This experiment will include a final comparison between the colors in the art paintings and the colors on the final textile print products to measure how accurate the stages of production.

KEYWORDS: Colors perception, Abstract Color Paintings, Emotional Human, Repetition styles, Textile Prints.

1 INTRODUCTION

Art painting is a unique experience, design work needs mental awareness of the concept of art. In this practice led experiment, some explanation of the concept of the work has been provided to the printing designer, to help understanding and keep representing the same concepts and feelings resulting, while working from these art works into designs.

2 METHOD

2.1 ABSTRACT COLOR PAINTINGS

Abstract art uses a visual language of form, color and line to create a composition which may exist with a degree of independence from visual references in the world [1].

The art paintings and the concept provided to the designer before starting to design [2];

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Fig. 1. Original paintings

(Figure 1) Activity; this painting represents the power of starting to move, activity of letting go, and opening up to freedom, all starting from a point in the center, that is the center of well and determination to achieve goals. The power of the centre is dark because all the power is concentrated in. At the explosion of power shows more vivid color like the cadmium yellow used and other light colors, like the pistachio, and other. Some brown lines show the direction of explosion, it is dark and concentrated as going out from the center. The small brush strokes like writing is achievements in reality after this activity rush, its in reds, that is the thing attractive to the eye, not the hard working of activity, being represented as a back ground.

Passion; This painting expresses feelings of love flowing rapidly from the heart that is hidden now by the feelings flowing every where and in all directions, dancing around the heart. All are representing the experiment in the light blue space of life in the background.

Confusion of heart; Confusion and emotional hesitation scattered the poor heart that became now like an empty cage with few week blood arteries and veins, not protecting any thing, but there is some light in the core, maybe from the soul, from faith, giving optimism to this situation.

Night Sparkles; This painting is a scene for a small place with the lights in the night glowing through the darkness, the leaves of the surrounding trees are moved b the soft are, making the yellow lights even sparkle more in the darkness.

Rush; Rush is represented here in dark, un-straight sharp brush strakes, showing tension and hesitation at the same time. Separating strong opposite colors like red, green, cadmium yellow, white, and brown, ordered in a way that the strong struggle is between the red and green areas. The white space is in the centre of rush lines and spaces, expressing the final moment of release and settlement after all.

2.2 Different Styles of Repetition

The definition of repetition is a re-doing the thing time after time; we considered a kind of rhythm, which represents a repetition to a certain idea in certain way combining between change and unity [3]. The first degree of rhythm is repetition, which is the entrance of the artist to achieve the rhythm in design. The repetition may include the diversity so that the pattern of repetition is not automatic and boring, and the work of art does not lose its appeal and dynamics [4].

The repetition has multi manifestation start from simple to more complex, and from part to all, the parts are arranged in the colleges according to the multiple iterations.

The artist of textile printing used different Styles of Repetition such as Identical Repetition where shape, colour, size, texture and direction are repeated in a horizontal direction. This type of repetition is more unified in style.

Alternative Repetition has been more widely used. This type of repetition allows the artist to change for breaking the monotonous of repetitive elements which have one shape and one systems .In the sense that the form may be one alternated in the position and sometimes in direction.

The Progressive Repetition appears that the element increase or decrease one of its characterize regularly in one direction or centrally [3] such as progress from light colour to dark or range value of surface texture from fine to coarse The advantages of this kind that contain the change as alternative repetition, but more movement and given the impression of depth .

The Status of Repetition which used by textile printing designer in design are also varied It is intended to trend repetitive element growth by analyzing the relationship part of the whole, One of these status is Refracted Repetition The motifs and colours which following the line in the direction of the refracted specific angles and may be different angles. In addition, Repetition in a vertical direction, Repetition in a diagonal direction the adjacent units iterates in the direction of the slant angle.

Repetition in the horizontal and vertical directions (Quarter) also used. Circle Repetition appeared in two different ways the first circle repeats in center, And the second Repetition in a circle direction by rotating around the square in the center of the design to make attention to it.

2.3 DESIGN STYLES

Designs and styles of repeatation in design making, in (Figure 2).

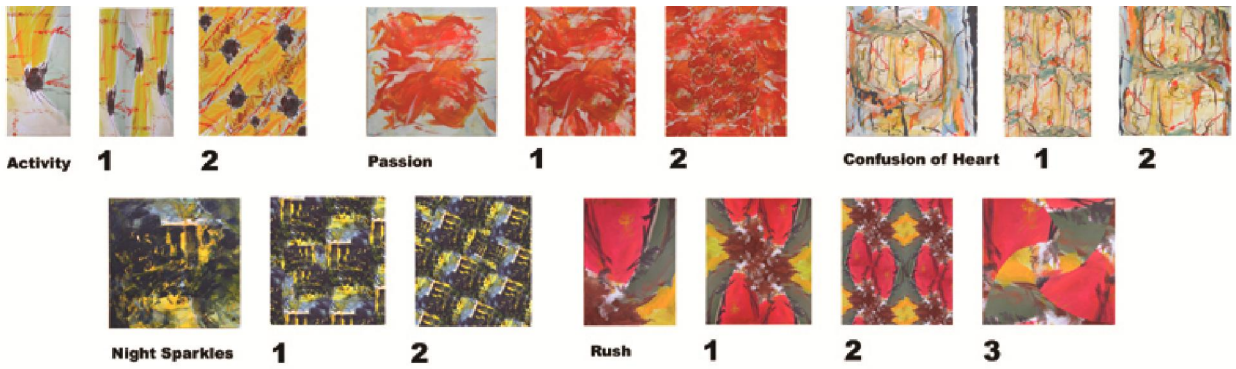

Fig. 2. Designs from the original paintings

Activity; 1: Alternative Repetition (alternating) in position and direction is vertical. **2:** Diagonal repetition that suggests to fall and fall, meaning certain movement doing an activity, alternating repetition comes between two bands: the first is the center of well and determination to achieve the goal with dark color because it holds all the power stored inside in a small space so it is loaded with a lot at the starting and rush towards the goal and the launch of this determination shows the lightest dynamic colors such as light green, light yellow. The second is zigzag lines in red color, reddish-brown represent the achievements that are realized and filled with detail (the zigzag lines that resemble writing).

Passion; 1: Progressive repetition from the center where increasing brush strokes away from the center of the board in side horizontal and vertical flows so the overlap increases the red and grades. **2:** Cyclic distribution in the middle (center) of the red color, and in the parties Brush strokes distributed in multiple directions at the form of arcs it means gradient from the dark red in the center to the lightest in outward direction.

Confusion of Heart; 1: Repeated in more than one direction. Horizontal: repeated alternating in space. Vertical: repeat alternating in the direction. **2:** Repeated zigzag lines and colored spaces which Included in a vertical direction.

Sparkles of night; 1: Identical Horizontal repetition in shapes, colors, texture and direction. **2:** Alternative repetition organized in a vertical direction, stressing on the movement of the refracted line.

Rush; 1: Repetitions around the horizontal and vertical axis in different direction .**2:** Regular quarter repetition in horizontal and vertical direction. **3:** Repetition in circular direction for strong lines in black color and for spaces with contrasting red, green and yellow color by rotating around the square in the center of the design, the square appears in white color to reflect the arrival of the rush to the top in the white space that combines these lines and rallies to represent a moment of peace and stability in the end.

2.4 CORRECTING COLORS AND PRINTING SAMPLES

Colors have been scaned by an accurate spectrophotometer called "Gretag Macbeth Spectro Eye" (Figure 3) , then all colors have been digitally corrected on the Photoshop software (Figure 4).

Fig. 3. Gretag Macbeth Spectro

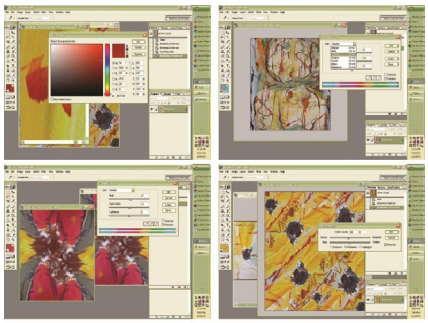

Fig. 4. Correcting colors

The printing samples included two types of cloth: Master 400 g, and Satan 160 g, and a comparison between print and real paintings has been done to correct for printing option and reprint again (Figure 5) .

Fig. 5. Comparison to original paintings and printing materials

2.5 DESIGNS IN CASE OF VISION DEFICIENCY

Color vision deficiency, is the inability or decreased ability to see color, or perceive color differences, under normal lighting conditions. There is no actual blindness but there is a deficiency of color vision. [5] The most usual cause is a fault in the development of one or more sets of retinal cones that perceive color in light and transmit that information to the optic nerve.

We used guides for how color vision deficincy would see real color to modify the colors of the designs, and the paintings as well. Using the same software but with diferent tools to change specific colors, [6] where is an option to compare the real natural colors of the image and an editable one as the user modifies the colors and compares; shown at the colored lined of the tool box opened at (Figure 6), the results of how people with color deficiency would see the designs and paintings are shown in (Figure 7).

Fig. 6. Modify to color deficiency vision

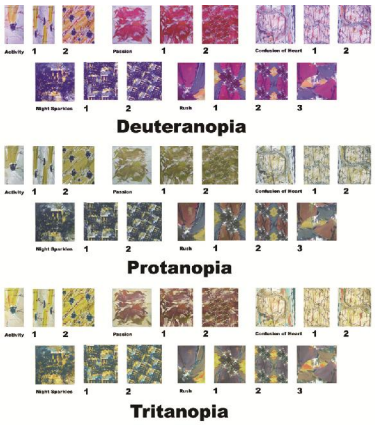

Fig. 7. Color deficiency vision

3 RESULTS AND DISCUSSION

Human Feelings expressed in works of art have been transferred into printed design products, with some color correction and compares.

People with vision deficiency will see different colors but with the contrast of hues and tones would still view the concept of the product.

Art paintings with simple, direct, and strong color, are good material for applied design.

4 CONCLUSIONS

Humans see color diferently, some humans have vision deficiency, but artist and designer can manage to prepare their work to get the meanings delivered better to these people.

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Role of Platelet Rich Plasma Gel in Bone Healing of Black Bengal Goats

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ABSTRACT: The study was conducted to evaluate homogenous platelets rich plasma (PRP) gel in the bone healing process. There are limited researches on the use of biomaterials to assist healing process in Bangladesh done earier. Therefore, this experiment was carried out to exploit the therapeutic effects of PRP gel on healing process. For bone healing study, total 6 oblique tibial fracture cases in goats were created. Goats were divided into three groups with two animals in each group bearing weight 15-20 kg and age 1-3 years. Among these two groups were treated with homogenous PRP gel and one group was untreated served as control and fracture cases were corrected with open reduction and internal fixation using bone plate with screw and surgical stainless steel wire (18 Gauze) suture. Goats showed a satisfactory result on bone healing after using PRP gel. Post operative radiography confirmed that bone fragments were well maintained until healing occurred and radiograph showed negligible callus at 30 days, complete healing occur. On the other hands, it takes 60 days for immobilization in untreated group. In treatment groups there was no periosteal reaction at the fracture site. No postoperative complication was observed at surgical site. This study could help veterinarians to consider natural biomaterial product specially homogenous PRP gel for a good healing of bone with minimum complications. Further studies are necessary for the molecular investigation of healing process and proper establishment of commercially available of PRP gel in our country and easyiest way of application.

KEYWORDS: Platelet rich plasma gel, therapeutic effect, fracture, immobilization, goat.

1 INTRODUCTION

Fracture is a common surgical affection of goats in Bangladesh. In our country the effective treatment of fracture is not developed properly. Here nearly limited facility to reach the modem treatment of fracture for their livestock resulting improper healing of bone and decrease the value of animals. Under the circumstances, platelet-rich plasma (PRP) gel is very much effective to bony reconstruction, it provides adhesion for the consolidation of cancellous bone and comminuted fracture segments [1]. Reference [2] shows that PRP gel is capable of improving soft tissue healing and positively influencing bone regeneration. Reference [3] shows that the application of PRP gel promoted new bone formation in goat. Animal and human studies have demonstrated that PRP enhances and accelerates soft tissue repair and bone regeneration [4], [5]. In the field of bone tissue surgery, a recent study, Reference [6] shows that the effect of autologous PRP on bone regeneration in mandibular fractures. He concluded that direct application of the PRP along the fracture lines may enhance bone regeneration. Platelets have been demonstrated to be the natural storage vessel for several growth factors and cytokines that promote blood coagulation, tissue repair, and the process of bone mineralization [7]. Degranulation of platelets by proteins such as thrombin causes them to release transforming growth factor-ß (TGF-ß1), platelet-derived growth factor (PDGF), fibrinogen, epidermal growth factor (EGF), histamine, and hydrolytic enzymes [8], [9], [5], [10]. Platelet-rich plasma (PRP), containing various growth factors, may speed up bone healing in goats [11]. Use of PRP enhanced the bone healing considerably in goats [12]. Moreover, there is limited number of researches of the use of PRP gel in black Bengal goats. Based in these reasons, we hypothesized that bone fractures in goats treated with PRP gel enhanced bone healing compared to control. Therefore, the present research theme has been directed to prepare a low-cost method of platelet-rich plasma (PRP) gel and to exploit the therapeutic effects of PRP gel on bone healing of black Bengal goats.

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2 MATERIALS AND METHOD

A series of experiments were performed in black Bengal goat to find out the effect of platelets rich plasma (PRP) gel in healing of bone. The proposed research works were conducted at Department of Surgery and Obstetrics, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. The duration of the study was from January to June, 2013. Six apparently healthy black Bengal goats were used for the experiment. The age of those animals ranged from 1-3 years and body weight of the animals ranged from 15-20 kg. All the animals were maintained at the Surgery and Obstetrics departmental facilities throughout the experiment.

2.1 PREPARATION OF PLATELETS RICH PLASMA (PRP) GEL

Reference [10] shows the preparation procedure of the PRP gel. It has been followed. Fresh blood of goat was collected in tube containing 10 ml blood for platelet-rich plasma before the surgical procedures. The blood was preliminary stored in Falcon tube containing 3.8% sodium citrate anticoagulant. The tube was centrifuged at 3000 rpm for 10 min promoting the separation of the plasma from red blood cells.

After that, 2 ml of plasma was removed from the superior part of tube and removed to another tube called tube A. This part was used to obtain the autogenous thrombin. To the tube A 600 µl of 10% calcium gluconate was added and incubated at 15 min at 37 ºC. The tube A contained thrombin rich substrate and all the volume was used

The remaining plasma with white blood cells was transferred to another tube called tube B to obtain the PRP. This tube was maintained at room temperature. Then the volume of tube B was resuspended and homogenized by voltexing. Then contents of tube A and tube B mixed at the ratio 1: 2 (1 ml of thrombin : 2 ml of PRP). After 40 min resting at room temperature the PRP gel was formed.

Fig. 1. (a) Blood collection from goat, (b) Centrifugation, (c) Plasma separation from RBC, (d) Collection of Platelet-rich plasma (PRP), (e) 300 µl of 10% calcium gluconate, (f) Platelet-rich plasma (PRP) gel

(a) In front of Surgery and Obstetrics Department, at garden, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh, (b+c+d+e+f) In Community-based Dairy Veterinary Foundation (CDVF) Field Fertility Clinic Laboratory at BAU Campus, Mymensingh, department of Surgery and Obstetrics, Bangladesh

2.2 EXPERIMENTAL DESIGN

Six apparently healthy black Bengal goats were used for the experiment and total six tibial fracture cases were made on the six goats. They were divided into three groups, each group containing two animals. Group A and B were treatment group and group C was untreated (control). **Group A** containing animals were treated with homogenous PRP gel prepared according

to a standardized protocol and fracture was immobilized using full cerclage by surgical stainless steel wire (18 Gauze) suture and bone plate with screw together. **Group B** containing animals were treated with PRP gel and fracture was immobilized using only bone plate and screw. **Group C** containing animals untreated, served as a control, no application of PPP gel and immobilization was performed using full cerclage by surgical stainless steel wire (18 Gauze) suture and bone plate with screw. Radiographic monitoring after closing immediately, at 5 days, 2 and 3 weeks and 4 weeks and after 2 months were done. To monitor fracture healing and bone formation overtime radiographic analysis was performed up to healing.

2.2.1 SURGICAL TECHNIQUE

The animal was sedated with Xylazine Hydrochloride 2% (Rompun® Bayer, Leverkusen) @ 0.1 mg/kg body weight. After clipping and shaving, the operation site was washed with soap water and then painted with antiseptic solution (Povin®, Opsonin Pharmaceuticals Ltd., Bangladesh). Local anaesthesia was performed with 2% Lignocaine Hydrochloride (Jasocaine®, Jayson Pharmaceuticals Ltd., Bangladesh). Then a tourniquet was tied over the operation site. Intravenous normal saline (DNS®, Opso Saline Ltd. Bangladesh) was given to avoid the hypovolumic shock due to excess hemorrhage during operation. After draping of operation site, a longitudinal incision was given on the lateral side of tibial part on hind leg to make fracture. After creation of artificial fracture, PRP gel was applied and further immobilized using different internal fixator (full cerclage by surgical stainless steel wire (18 Gauze) suture, bone plate with screw). Before final immobilization, again PRP gel was applied in fractured part. All types of process were placed according to reference [13]. Muscle and fascia were sutured using catgut 2-0. Sulphanilamide powder was applied locally (Sumid vet®, Square Pharmaceuticals, Bangladesh) then skin was closed by using cross mattress or simple interrupted pattern with nylon. A saline tube also inserted for drainage. Tr. bezoin seal was applied over the suture line and then modified Thomas Splint was applied in all cases for additional support for immobilization of the limb and of weight.

2.2.2 POST OPERATIVE CARE AND OBSERVATION

The animals were completely restricted and only limited movement was allowed. After 8 days, skin stitches were removed. Animals were allowed to move freely in an open enclosure after 15 days. During the postoperative period, the animals were closely monitored for the presence of fever, severity of pain, their tolerance to the fixators by their degree of weight bearing and lameness, and the range of movement of the adjoining joints. Periodical radiographic assessment was carried out to evaluate reduction and alignment of bone fragments, and callus formation and complications, if any. In all animals the wires, bone plates were kept *in situ.*

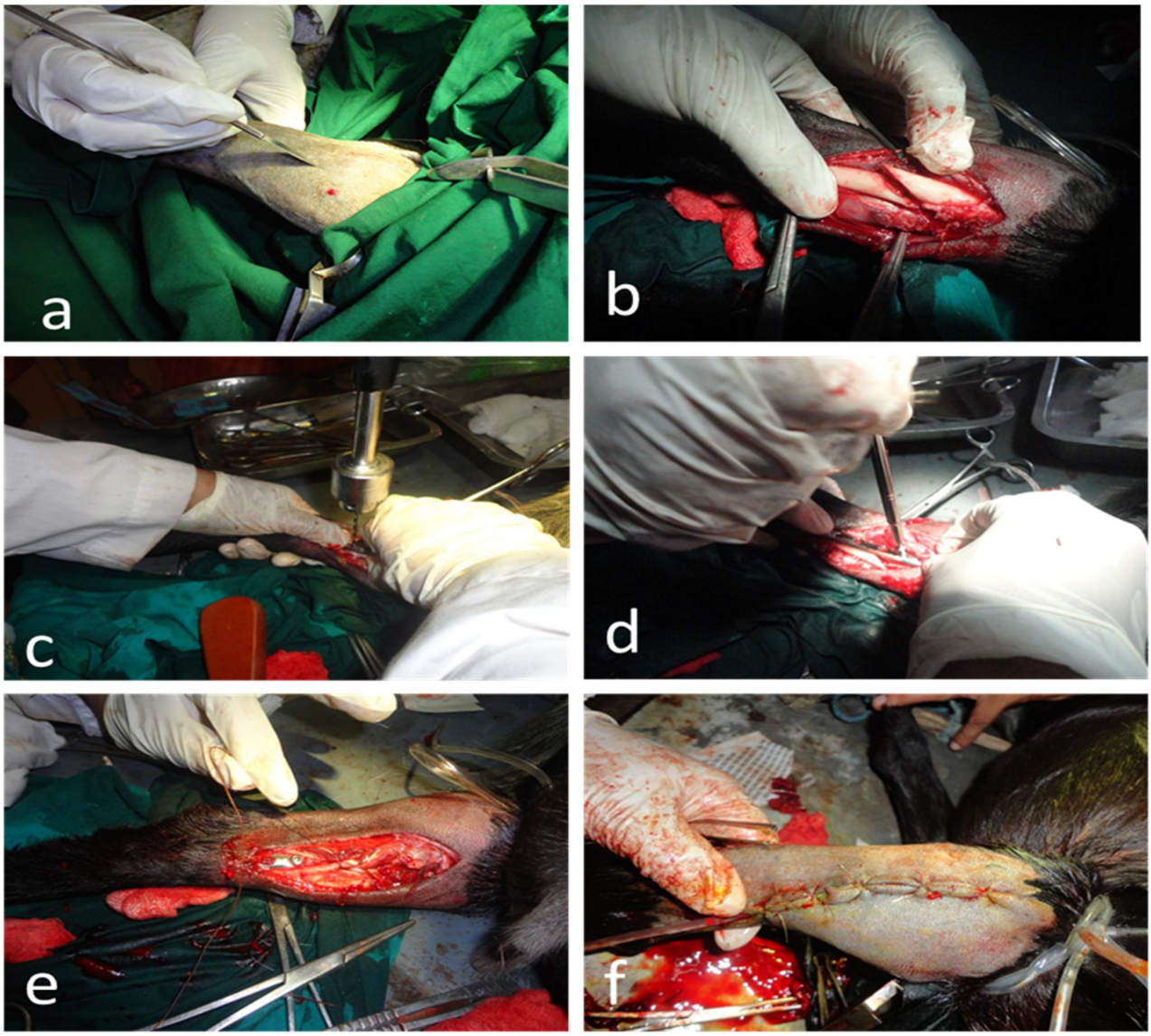

Fig. 2. Operation procedure of fracture (a) During incision on skin, (b)Fractured tibial bone, (c) Bone drilling for screw adjustment, (d) During screw setting, (e) Suture of muscles and soft tissue with simple continuous using catgut no. 2-0 and (f) skin suture using simple interrupted with nylon

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3 RESULTS AND DISCUSSION

The study was undertaken to evaluate the feasibility of a simple, inexpensive platelets-rich plasma (PRP) gel application on fracture heals. Table 1 shows the characteristics of fractures cases in goats treated homogenous PRP gel by open reduction and internal fixation methods in this study.

Table 1. Results of the effect of PRP gel

No. of goats	Treatment group	Loaction, Type of fracture	Technique	Post operative observation		
				Cure period	Repeat Intervention	Observation
4	PRP gel	Mid shaft of the tibia (oblique)	(a) Full cerclage wire suture and bone plate (2 cases) (b) bone plate and screw (2 cases)	(a) 4 weeks both Cases union (b) 4 weeks 1 Case union, 1 case non union	amputation	Myiasis occur in one case, no support by muscle, excess callus and false bone formation finally amputation
2	Untreated (control)	Mid shaft of The tibia (oblique)	Full cerclage wire suture and bone plate (1 case) bone plate and screw (1 case)	2 month union		

During the study period, fracture site were observed regularly. In treatment group, three cases were cured within near about one month. Successfully fracture immobilization with bone plating and full cerclage wire suture were performed.

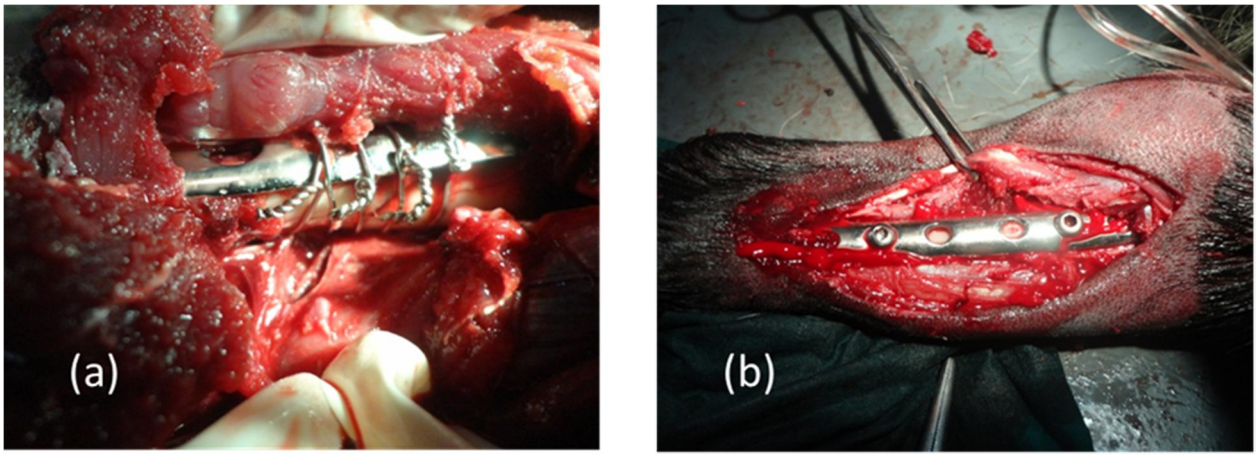

Fig. 3. (a) Full cerclage wire suture with bone plate and screw (b), Bone plate and screw

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Three goats showed a satisfactory result after using PRP gel. All goats showed good weight bearing in the immediate post-operative period (Figure 4a). Severe pain was noticed for first 3 postoperative days in all goats, which gradually lessened and subsided by 14^{th} postoperative day in almost all goats. The fixators applied to different bones were well-tolerated, and the animals could lie down, stand and walk freely with the fixator without any problems after 4 weeks (Figure 4b). On the other hands, in control group, it takes near about 2 months for fracture immobilization.

Fig. 4. (a) Goat immediately after surgical operation and (b) After 30 days of surgical operation

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Post operative radiography confirmed that bone fragments were well maintained until healing occurred and radiograph showed negligible callus and proper healing at 30 days (Figure 5a and 5b). There was no periosteal reaction around the wire suture at the fracture site. No exudation was observed at surgical site in any goats during removal of suture. There was no detectable lameness by 30 day in 3 goats. One case was amputated after 2 weeks due to myiasis, there was no support by muscles and skin. The leg was amputated, excess callus and false bone formation was found.

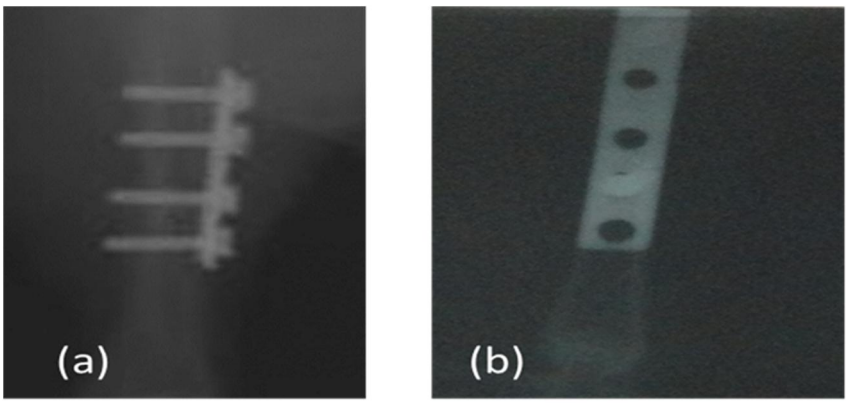

Fig. 5. (a) Radiograph around the bone plate at the fracture site at 28 days lateral view (b) and dorsal veiw after 28 days; 55 kV, 10 mA, 4s.

Radiograph was taken by portable X-ray machine at 55 kV, 10 mA, 4s in X- ray room and film processesing were performed at dark room.

In this study Platelets rich plasma (PRP) gel preparations (biomaterials) are used for bone healing process. Role of PRP gel on fracture healing was evaluated through clinical observation and radiographical findings. Fracture is one among the common orthopaedic affections encountered in domestic animals and pets. References [14], [15] show that most of the fractures are seen in tibia, metatarsal or metacarpal bones, which have less muscle covering. Therefore, in our study, we created oblique fracture in tibia planned with the objectives to evaluate bone fixation treated by PRP gel which are immobilized as internal fixation techniques for the correction of long bone fracture and to compare the outcomes with untreated (control) group. In this study, untreated group with delayed healing, in contrast PRP gel treated group was very quick healing within one month. Reference [2] shows that PRP gel is capable of improving soft tissue healing and positively influencing bone regeneration. Reference [3] shows that the application of PRP gel promoted new bone formation when autogenous bone used in a goat spinal transverse processes implant model. Reference [12] shows that shows use of PRP enhanced the bone healing considerably. When PRP gel is applied to bony reconstruction it provides adhesion for the

consolidation of cancellous bone and comminuted fracture segments [1]. Reference [16] shows that moderate periosteal reaction is present at healing site in most of the animals and have been due to the in stability at the fracture site leading to excess callus formation. In this experiment, PRP gel is a combination of biomaterial substance having no side effect showed excellent healing score without any postoperative complication and plays a beneficial role in bone healing. However, this study could help veterinarians to consider use of biomaterial substance in bone regenaration.

4 CONCLUSION

This study concludes that Platelets rich plasma (PRP) gel preparations (biomaterials) are inexpensive and effective for bone healing, PRP gel homogenous treated fracture provides good alignment and stabilization of fracture fragments, rapid union of fracture resulting in early functional usage of limb and further studies are necessary for the molecular investigation of healing process and proper establishment of commercially available of Platelets rich plasma gel in our country and easyiest way of application.

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Sensor Noise Reduction with RHC and LQR for System with Backlash Nonlinearity

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ABSTRACT: In this paper, two robust optimal control strategies: Discrete Model Predictive Control (DMPC) and Linear Quadratic Regulator (LQR) are proposed to solve the problem of backlash nonlinearity present in two mass system and also reducing the sensor noise present at the output of the system. In past, number of attempts has been made to develop the optimum controls for backlash nonlinear system to compress the oscillations in load speed. The (DMPC) and (LQR) are now one of the most successful robust optimal control strategies for highly uncertain nonlinear systems like specially the one we have in industries. The (DMPC) and (LQR) require online information of all the states of the nonlinear system, so role of estimators becomes very prominent in (DMPC) and (LQR). In this paper, Kalman Filter (KF) has been used for the state estimation assuming that sensor noise is also present at the output of the system, so in that case load speed, which is also output of the nonlinear system contains backlash nonlinearity and random sensor noise, so now both (DMPC) and (LQR) have to deal with two problems simultaneously. In simulations, a comparison has been presented between the two control schemes. From simulations, it is quite clear that (DMPC) performance is much better than (LQR), while suppressing oscillations due to presence of backlash and sensor noise at the output of the system. Comparison between two controllers also reveals that (DMPC) is much faster than (LQR), while achieving tracking.

KEYWORDS: Receding Horizon Control, Linear Quadratic Control, Kalman Filter, Two Mass System, Backlash System.

1 INTRODUCTION

Backlash mechanism can be seen in many mechanical systems because of presence of the gap between teeth of gear, in that situation the driving member (motor) is not directly connected to the driven member (load).T The major difference between RHC and LQR is that, in RHC, horizon window slides along with each sample time [1], so for each sample time new control law is generated and implemented to get desired output during that sample time, and on that measured output, the new control law is again generated. In LQR control, the control law is generated on a fixed horizon window, and that is the key reason why LQR is less robust than RHC.

The paper is organized as follows. The modeling of the two mass system is given in section II. Section III introduces the RHC. The KF design is presented in section IV. The LQR is designed in section V.

2 MODEL

The two mass system model consists of a motor and a load, connected with a shaft, as shown in Fig.1.

The dynamics of a motor [2] can be expressed in (1):

$$J_m \frac{d\omega_m}{dt} + b_m \omega_m + T_{sh} = T_m \tag{1}$$

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Similarly, the load side dynamic has been described in (2):

$$J_l \frac{d\omega_l}{dt} + b_l \omega_l - T_{sh} = -T_d \tag{2}$$

The shaft torque equation is given as [2]:

$$T_{sh} = k_s \theta_{sh} + b_s \omega_{sh} \tag{3}$$

and

$$\begin{aligned} \theta_d &= \theta_m - \theta_l \\ \theta_{sh} &= \theta_d - \theta_b \\ \omega_d &= \omega_m - \omega_l \\ \omega_{sh} &= \omega_d - \omega_b \end{aligned} \tag{4}$$

Where θ_m is the motor position, θ_l is the load position, θ_d is the difference angle, θ_{sh} is the shaft twisting angle. Similarly, corresponding speed variables are defined in (4). Having dynamic equations, the state space model for the linear two mass system can be obtained by putting (3) in (1) and (2), and rearranging. All the controllers and Kalman filter in this paper have been designed on the state space model shown in (5). For the linear system model we assume that $\theta_b = 0$, which is backlash angle.

$$\begin{bmatrix} \dot{\theta}_l \\ \dot{\theta}_m \\ \dot{\omega}_l \\ \dot{\omega}_m \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{K_s}{J_l} & \frac{K_s}{J_l} & -\frac{(b_l+b_s)}{J_l} & \frac{b_s}{J_l} \\ \frac{K_s}{J_m} & -\frac{K_s}{J_m} & \frac{b_s}{J_m} & -\frac{(b_m+b_s)}{J_m} \end{bmatrix} \begin{bmatrix} \theta_l \\ \theta_m \\ \omega_l \\ \omega_m \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{1}{J_m} \end{bmatrix} T_m + \begin{bmatrix} 0 \\ 0 \\ \frac{1}{J_l} \\ 0 \end{bmatrix} T_d \tag{5}$$

$$y = [1\ 0\ 0\ 0] \begin{bmatrix} \theta_l \\ \theta_m \\ \omega_l \\ \omega_m \end{bmatrix}$$

Table 1. Model Parameters

Symbol	Description	Value
k_s	Shaft elasticity	3300 Nm/rad
J_l	Load moment of inertia	1 Kgm^2
J_m	Motor moment of inertia	2 Kgm^2
b_m	Motor damping coefficient	0.1 Nms/rad
b_l	Load damping coefficient	0.1 Nms/rad
b_s	Shaft damping coefficient	1 Nms/rad

The nonlinear model of the two mass system can be obtained by inserting non linearity given in (6) in the shaft torque equation given in (3), from Nordin's exact model [2].

$$\omega_b = \begin{cases} \max\left(0, \omega_d + \dfrac{k_s}{b_s}(\theta_d - \theta_b)\right) \\ \omega_d + \dfrac{k_s}{b_s}(\theta_d - \theta_b) \\ \min\left(0, \omega_d + \dfrac{k_s}{b_s}(\theta_d - \theta_b)\right) \end{cases} \begin{matrix} if \quad \theta_b = -\alpha \\ if \quad |\theta_b| < \alpha \\ if \quad \theta_b = \alpha \end{matrix} \tag{6}$$

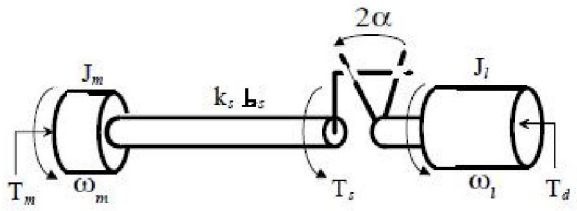

Fig. 1. Two mass system with gear having backlash of size α

Fig. 1, completely describes the two mass system with backlash nonlinearity, where α is the backlash size and is ω_b the backlash speed.

3 DISCRETE MODEL PREDICTIVE CONTROL

DMPC or RHC is an optimum control strategy based on minimization of some cost function [3]. In the standard RHC, the state space model of the two mass system is utilized to have desired output.

In order to design RHC, the augmentation of an integrator with the actual state space model is required [3]. Then the state space model will take the form of (7), which is also acknowledged as the augmented model of the system:

$$\begin{bmatrix} \Delta x_m(k+1) \\ y(k+1) \end{bmatrix} = \begin{pmatrix} A_m & O_m^{\ T} \\ C_m A_m & 1 \end{pmatrix} \begin{bmatrix} \Delta x_m(k) \\ y(k) \end{bmatrix} + \begin{bmatrix} B_m \\ C_m B_m \end{bmatrix} \Delta u(k)$$

$$y(k) = C_m x_m(k) \tag{7}$$

$$y(k) = \begin{bmatrix} o_m \\ 1 \end{bmatrix}^T \left[\Delta x_m(k) y(k)\right]^T$$

Where $A = \begin{pmatrix} A_m & O_m^{\ T} \\ C_m A_m & 1 \end{pmatrix}$ $B = \begin{bmatrix} B_m \\ C_m B_m \end{bmatrix}$ $x(k_i+1) = \begin{bmatrix} \Delta x_m(k+1) \\ y(k+1) \end{bmatrix}$ $x_m(k_i) = \begin{bmatrix} \Delta x_m(k) \\ y(k) \end{bmatrix}$

$O_m = \begin{bmatrix} 0000.....0 \end{bmatrix}_n$ $C_m = \begin{bmatrix} o_m \\ 1 \end{bmatrix}^T$

From the augmented model, the states are predicted using the current information from the system and future control moves [4].

The predicted output vector can be written in (8):

$$Y=\begin{bmatrix} CA \\ CA^2 \\ CA^3 \\ . \\ . \\ . \\ . \\ CA^{N_P} \end{bmatrix} x(k_i)+\begin{pmatrix} CB & 0 & 0.....0 \\ CAB & CB & 0.....0 \\ CA^2B & CAB & CB.....0 \\ . & . & . \\ . & . & . \\ CA^{N_P-1}B & CA^{N_P-2}B & CA^{N_P-3}B.....CA^{N_P-N_C}B \end{pmatrix} \Delta U \quad (8)$$

Let we symbolize theses matrices in (9):

$$Y = Wx(k_i)+\Phi\Delta U \quad (9)$$

Where N_P and N_C are the prediction and control horizon of the predicted output and the control moves respectively [4].

The cost function for RHC can be written in the form of (10):

$$J=(R_S-Wx(k_i))^T(R_S-Wx(k_i))-2\Delta U^T\Phi^T(R_S-Wx(k_i))+\Delta U^T(\Phi^T\Phi+\bar{R})\Delta U \quad (10)$$

Where $\bar{R}$ is the weighting matrix, and $R_S=[111....1]^T_{1xN_P} r(k_i)=\bar{R}_s r(k_i)$

The optimum control law can be obtained by applying optimization condition, which is of cost function minimization.

$$\Delta U=(\Phi^T\Phi+\bar{R})^{-1}\Phi^T(R_S-Wx(k_i))$$

Since in RHC, only first sample is taken to predict states, so the control law becomes:

$$\Delta u(k_i)=[1000....0]^{1XN_C}(\Phi^T\Phi+\bar{R})^{-1}(\Phi^T\bar{R}_S r(k_i)-\Phi^T Wx(k_i))$$

On further simplifying, following control law has been obtained:

$$\Delta u(k_i)=K_y r(k_i)-K_{mpc}x(k_i) \quad (11)$$

Where K_y is the first element of $(\Phi^T\Phi+\bar{R})^{-1}\Phi^T\bar{R}_S$ and K_{mpc} is the first row of $(\Phi^T\Phi+\bar{R})^{-1}\Phi^T W$

Fig. 2 describes the closed loop system with RHC. Where $K_{mpc}=\begin{bmatrix} K_x K_y \end{bmatrix}$ and $r(k)$ are the closed loop gains and set point signal respectively [5, 6].

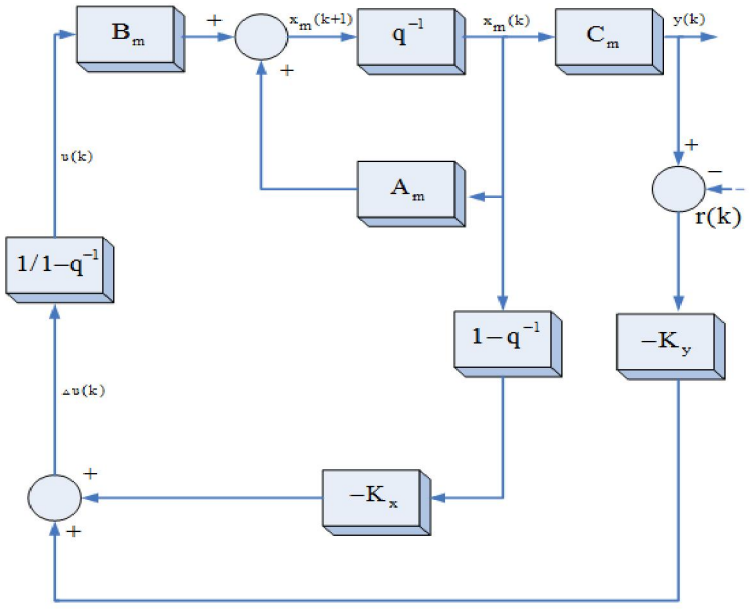

Fig. 2. RHC complete architecture

4 DISCRETE KALMAN FILTER

The Discrete KF is basically an estimator for the states of the LTI system disturbed by white noise, and also taking the measurement corrupted by white noise [7, 8].

In the discrete time KF problem, the discrete time stochastic process is given in (12):

$$x_k = Ax_{k-1} + Bu_{k-1} + w_k \tag{12}$$

And the measurement equation is given in (13):

$$y_k = Cx_k + v_k \tag{13}$$

Where w_k, v_k are the white process and measurement noises respectively.

Let we symbolize the a priori state estimate at time k having the information of process a prior to step k by $\hat{x}_k^-$ and $\hat{x}_k$ be the posteriori state estimate at step *k* having the measurement y_k.

The a priori estimate error covariance is

$$P_K^- = E[e_k^- e_k^{-T}] \tag{14}$$

And a posteriori estimate error covariance is

$$P_k = E[e_k e_k^T]$$

The KF is basically used to discover the a posteriori state estimate as the linear combination of a priori estimate and a weighted difference of the measured and predicted measurement.

$$\hat{x}_k = \hat{x}_k^- + K(z_k - C\hat{x}_k^-)$$

The term $K(z_k - C\hat{x}_k^-)$ in above equation is called the residual. Zero residual means that two are in complete concurrence.

Where K is the gain of KF that minimizes the a posteriori error covariance.

The Kalman gain matrix can be obtained by following equation (15):

$$K = P_k^- H^T (HP_k^- H^T + R)^{-1} \tag{15}$$

From eq (15) , it is clear that as R approaches zero the residual is weighted more by the Kalman gains and vice versa [8, 9]. The KF algorithm composed of two equations, the time update equations and measurement update equations.

The time update and measurement update equations are also known as predictor and corrector equations, both the equations are given below:

Time Update Equations

$$\hat{x}_k^- = A\hat{x}_{k-1}^- + Bu_{k-1}$$

$$P_k^- = AP_{k-1}A^T + Q$$

Measurement Update Equations

$$K = P_k^- H^T (HP_k^- H^T + R)^{-1}$$

$$\hat{x}_k = \hat{x}_k^- + K(z_k - C\hat{x}_k^-)$$

$$P_k = (I - K_k H)P_k^-$$

From the above equations, it is clear that the KF is recursive in nature. After obtaining the posteriori state estimates, they are then used to predict new a priori state estimate.

In the KF algorithm, the matrices Q and R are process and measurement noise covariances and also known as the tuning parameters. After obtaining the state estimates, these states are feedback to the RHC and LQR to get desired output [10].

5 LINEAR QUADRATIC REGULATOR

The LQR is the second optimum control strategy, that has been adopted to solve the problem of backlash nonlinearity and presence of sensor noise. The LQR gives closed-loop gains based on some minimization criterion [11]. The cost function for the LQR design is described in (16):

$$J = \int_0^\infty (x(t)^T Q x(t) + u(t)^T R u(t)) dt \tag{16}$$

Where matrices R and Q are the weighting matrices of the states and input respectively [12], giving the compromise between the state transient energy and control input energy.

The cost function shown in (16) is of a fixed infinite horizon, while that of RHC, it was receding horizon, so that is why the RHC is more robust to the backlash nonlinearity as compared to LQR.

For the state space model in (5), the control law can be written in (17):

$$u(t) = r(t) - K_{LQR} x(t) \tag{17}$$

Where K_{LQR} is the closed-loop gain matrix [13]: $K_{LQR} = -R^{-1} B^T P$

Where P is the solution of the following algebraic Riccati equation (18):

$$A^T P + PA - PBR^{-1} B^T P + Q = 0 \tag{18}$$

6 SIMULATION RESULTS

For the simulations, the proposed controllers and Kalman Filter designed for linear state space model of the two mass system, are now applied to the actual two mass system with backlash nonlinearity.

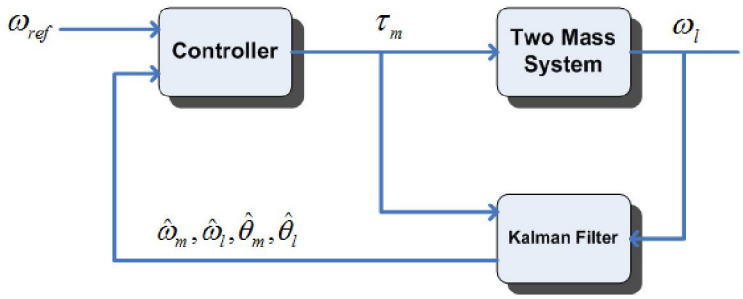

Fig. 3. Closed loop system for load speed control

The model parameters used in the simulations are given in table 1. In Fig. 3, the closed loop system for the load speed control with KF is shown. Where's τ_m, ω_l, $\hat{\omega}_m, \hat{\omega}_l, \hat{\theta}_m, \hat{\theta}_l$ and ω_{ref} are the motor torque , load speed, estimated motor speed, estimated load speed, estimated motor position, estimated load position and reference load speed respectively. In case of the load speed control, the load speed ω_l corrupted by white noise is measured to have the state estimates. In order to have the desired load speed, the controller generates control law after utilizing the state estimates from KF.

In simulations, the problems of oscillations and noise in the load speed have been considered by applying the two optimum controllers, RHC and LQR. Fig. 4 and Fig. 5 show the results for the control of the load speed of the two mass system with backlash nonlinearity and white noise disturbance with RHC and LQR, using KF. It is evident from the results that

the performance of the RHC is better than LQR, while suppressing oscillations due to backlash nonlinearity and also minimizing the affect of sensor noise. It is also observed from the plots that the RHC has less settling time as compared to LQR. In Fig. 6 and Fig. 7, the reference to the control system is now rectangular wave having frequency slightly less than that of the systems cutoff frequency, for that case similar results can be deduced as that of the step input. The sine wave as a input, is now given to the control system in Fig. 8 and Fig. 9, and due to the slowness of the LQR controller, there is more delay in the tracking signal as compared to that of RHC and the noise cancellation in the RHC control is still better than LQR.

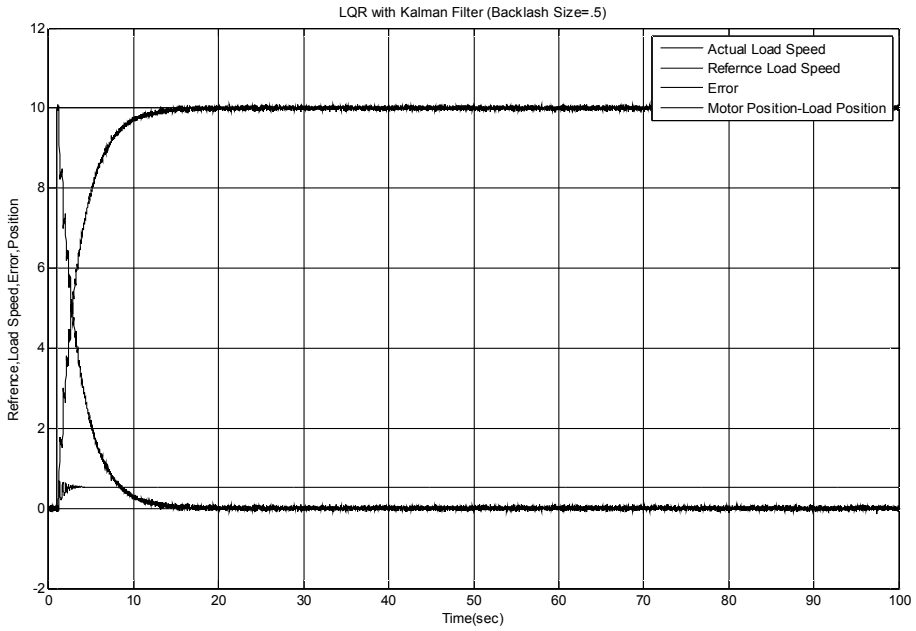

Fig. 4. Speed control of system with reference step, Load speed is regulated with LQR and Kalman Filter.

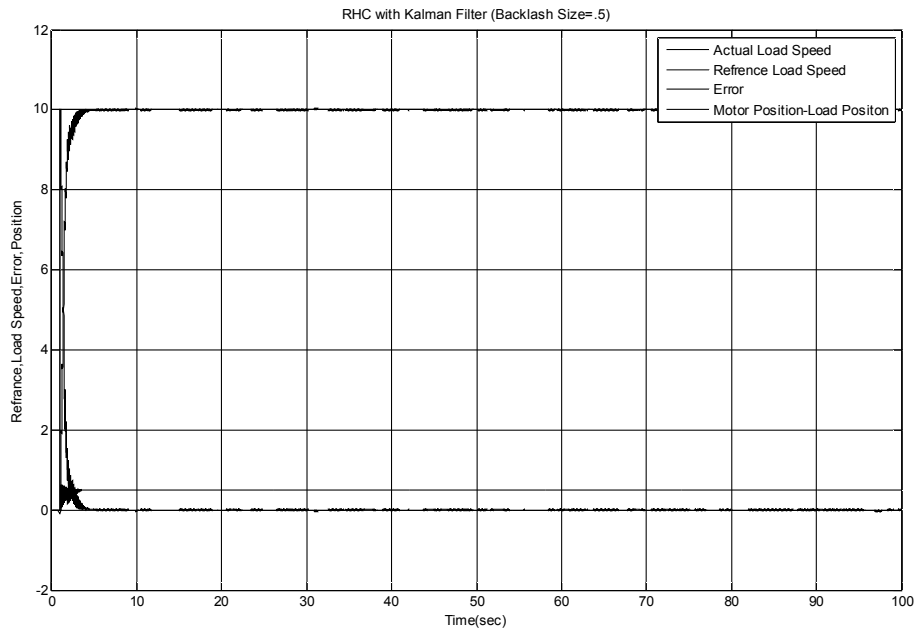

Fig. 5. Speed control of system with reference step, load speed is regulated with RHC and Kalman Filter

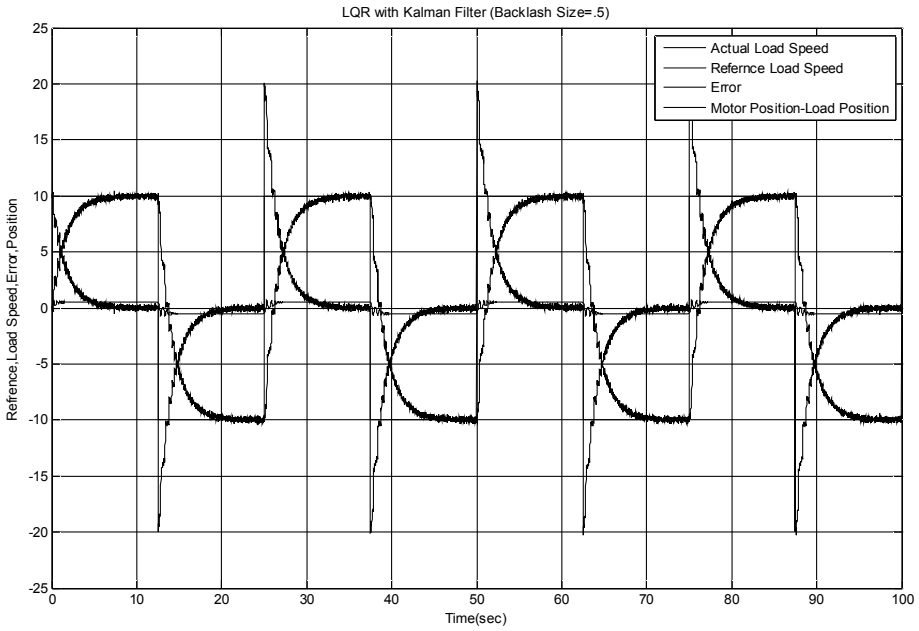

Fig. 6. Speed control of system with reference square wave, load speed speed is regulated with LQR and Kalman Filter

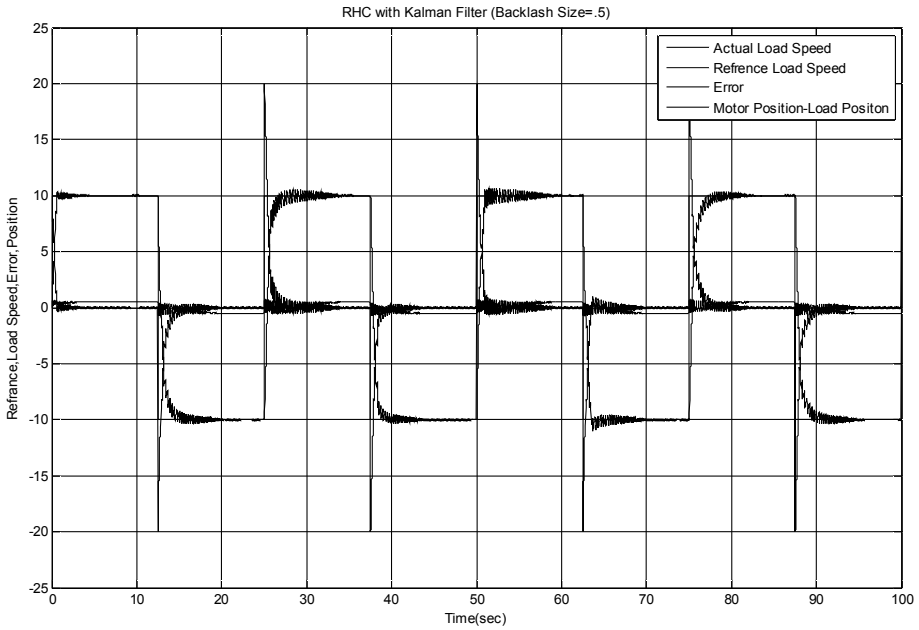

Fig. 7. Speed control of system with reference square wave, load is regulated with RHC and Kalman Filter

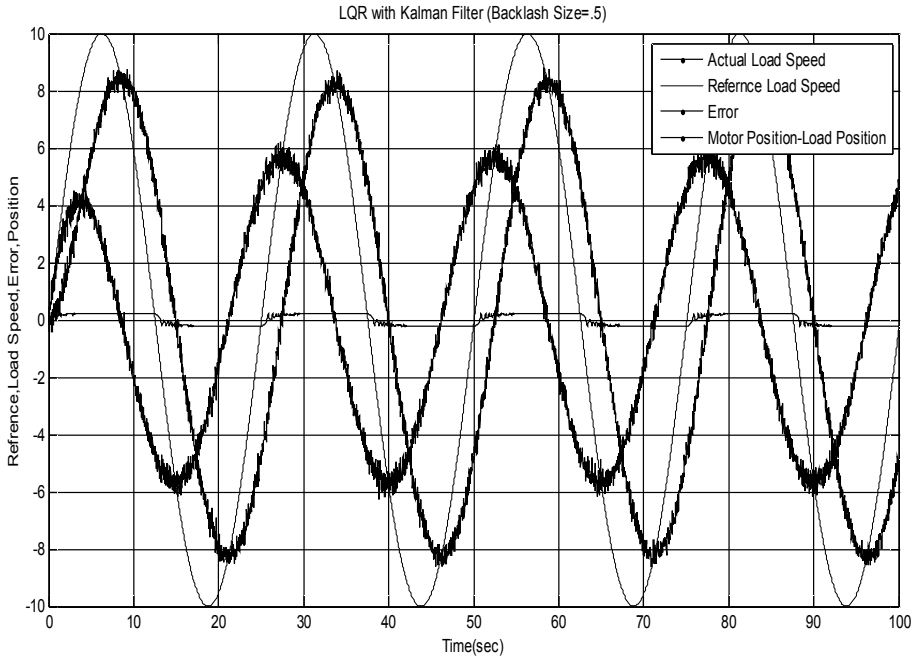

Fig. 8. Speed control of system with reference sine wave, load speed is regulated with RHC and Kalman Filter

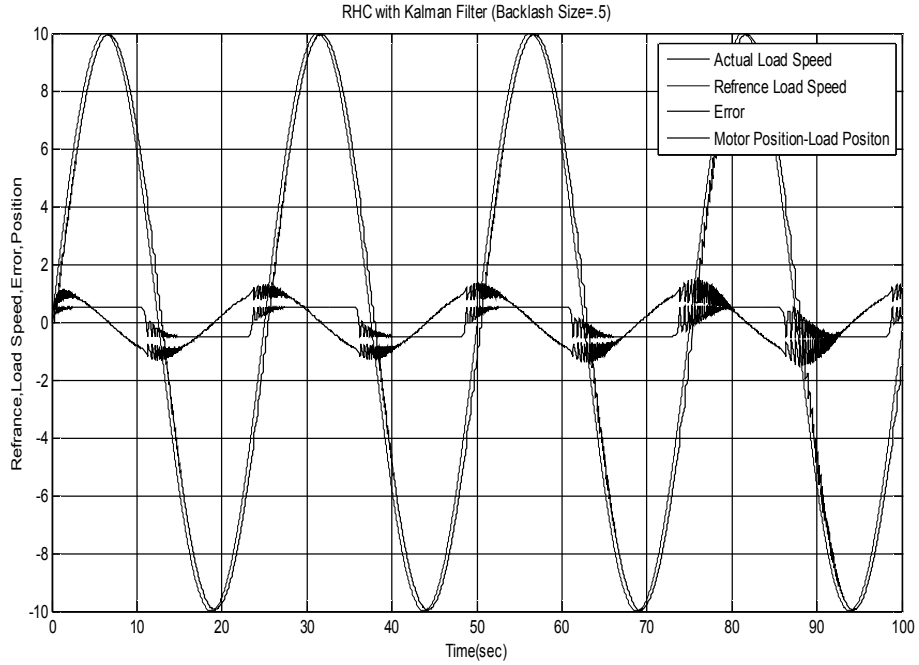

Fig. 9. Speed control of system with reference sine wave, load speed is regulated with LQR and Kalman Filter

7 CONCLUSIONS

This paper reveals that, the RHC is more suitable control strategy than LQR while dealing with the backlash nonlinearity and also measurement noise present in the load speed of the two mass system. From simulations, it is clear that the RHC suppresses oscillations due to backlash nonlinearity and sensor noise in load speed much better than LQR, and this is because of the fact that, RHC changes its horizon after each sample time, also RHC is faster than LQR, while achieving tracking.

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A New Approach for Software Cost Estimation with Hybrid Genetic Algorithm and Ant Colony Optimization

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ABSTRACT: One of the most important effective factors the software companies face is the Software Cost Estimation (SCE) in software development process time. SCE is one of the subjects which have been considered in late decades in many researches. The real estimation in software development needs effort and cost factors which are done by use of the algorithmic and Artificial Intelligence (AI) models. Boehm used the COCOMO model which is an algorithmic model in 1981 for SCE. The low accuracy and non-reliable structures of the algorithmic models led to high risks of software projects. So, it is needed to estimate the cost of the project annually and compare it to the other techniques. The Meta-Heuristic algorithms have been developed well lately in software fields and SCE. Meta-heuristic and Genetic Algorithms (GA) and Ant Colony Optimization (ACO) solve the problems according to the optimization of the problems and are very efficient in optimizing the algorithmic models and the effective factors in cost estimation. In this paper we have proposed a hybrid model based on GA and ACO for optimization of the effective factors' weight in NASA dataset software projects. The results of the experiments show that the proposed model is more efficient than COCOMO model in software projects cost estimation and holds less Magnitude of Relative Error (MRE) in comparison to COCOMO model.

KEYWORDS: Software Cost Estimation, COCOMO, Artificial Intelligence, Meta-Heuristic Algorithms, Genetic Algorithm, Ant Colony Optimization.

1 INTRODUCTION

One of the most effective and important factors in development of the software projects, is SCE. In development of the software projects, there are many effective factors value and limits of which must be identified using the accurate estimation. The highest costs of software projects and totally the vast value of the costs are related to the work forces. So, the most important problem in software engineering is the cost estimation and the needed effort for development of the software projects.

The accurate estimation of the costs of software projects causes the projects be done in format of the identified time and costs [1]. With no suitable estimation about the costs for development of the software projects, the project manager would not be able to diagnose the how much time or cost is needed for the project and if there any mistake happens, the project would be defeated or face risks [2]. The accurate cost estimation and the reliable one especially at the beginning of the project, is an important factor for the success of the project. The accuracy of the software cost estimation causes project manager makes powerful decisions in the lifecycle of the software. Also the project manager, analyzer, designer, programmer and all other work forces of the software development must know that how much effort and cost are needed for production of software. SCE is one of the most critical tasks in managing software projects. Development costs tend to increase with project complexity, and hence accurate cost estimates are highly desired during the early stages of

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development. An important objective of the software engineering community has been to develop useful models that constructively explain the software development life-cycle and accurately estimate the cost of software development. So, the time estimation would be effective when it is enough for the software development needs. The software needs are being changed day by day, but the effect of the time changes which are identified via the accurate estimation will lead to the reduction of the time needed for software projects development.

Algorithmic models were presented in the early times of the software development. COCOMO model was first introduced by Boehm in 1981 [3]. COCOMO II is a model of estimation of time and costs in software projects. COCOMO II model is used for decision making in different software projects [4]. COCOMO II model works better for software projects estimation and is innovated for the projects in which different factors are effective. In COCOMO II, the parameters value is achieved by the experience of the previous projects like COCOMO 81.

Now the meta-heuristic algorithms are used vastly in hybrid optimization problems. One of the basic applications of these algorithms is to contribute the optimization and efficiency of the optimized solutions [5]-[6]-[7]-[8]-[9] and [10]. Meta-heuristic algorithms are the algorithms which search the near optimized answers in the problems spaces indecisively. These algorithms are very efficient in solving the hard and complex problems. A usual procedure which can be used in estimation of the software projects is to use a favored function with algorithmic methods for finding the values of the cost estimation which lead to the upmost favor. When dimensions of the problem go high by the increase of the numbers of the factors and the variables of the problem, the algorithmic methods will be unable to achieve the real answers. So, in this paper we have used the combination of the GA and ACO to present a new model for estimation of the software projects.

We have organized the paper as follows: in Section 2, we have introduce the related works; in Section 3, the COCOMO model is introduced; in Section 4, we have introduced the meta-heuristic algorithms; in Section 5, the proposed algorithm is described; in Section 6, the evaluation and the results of the proposed algorithm are presented and at finally in Section 7, we have presented the conclusion and future works to be done.

2 RELATED WORKS

Lately many researches have taken place in cost estimation field for the software projects using the AI techniques. But it is not possible to say that AI is 100% percent to estimate the costs accurately. But according to the studies, we have resulted that the AI techniques have been more efficient in comparison to the algorithmic techniques. COCOMO is a model for cost and time estimation of the software projects among the algorithmic methods.

In [11] has used the Artificial Neural Networks (ANNs) for estimation of the software projects estimation. In this research, 11 projects of 60 projects of NASA dataset [12] have been tested using ANNs. And they were compared to COCOMO model and it is shown that COCOMO model error is more than ANNS in many cases. The results show that in more than 90 % of the cases, ANNs has presented better estimation than COCOMO model. So, it is possible to conclude that the methods based on AI are as complements and good replacement for the algorithmic methods. For accurate study of cost estimation in software projects, KEMERE [13] has studied the FP, COCOMO, SLIM and ESTIMACS patterns. According to the results of his paper a high error percent is seen in all four models. So it is possible to say that the estimation models are very effective in accuracy of effort and costs and the ending of the project in a defined time. In [14], it has utilized the GA for the optimized value of the COCOMO model parameters. One of the problems of COCOMO model is identifying the optimized value for the parameters. In this research, the projects of NASA dataset are used for presenting the better efficiency of the proposed model. Also, the two DLOC and ME factors which are very effective in estimation of costs, are studied on 18 projects. According to the results it is possible to say that using GA, it is possible to achieve better estimation. Researchers in [15] have studied the SCE using ANNs. Studying the results shows that ANNs are very good in estimation of the costs of software projects. Some other researches [16] have studied the three methods based on Machine Learning (ML) like ANNs, Case-Based Reasoning (CBR) and Rule Induction (RI). They have studied the cost estimation of the software projects using 77 projects. The results of this study show that ANNs are more accurate than other methods.

In [17] has tested SEE using GA. In this method, it is cited that COCOMO model is not good in effort estimation in comparison to the other models. So, it is tried to make better the value of the parameters in proposed model and make effort estimation more accurate. In this research, the NASA dataset software projects are used for the results of the experiments. According to the results, the proposed model has achieve better estimation and has made Mean Magnitude of Relative Error (MMRE) value to 0.2298% in comparison to COCOMO model. Researchers in [18] have tested the software projects cost estimation using the soft computing techniques. They have used Fuzzy Logic (FL) in their paper and also the Particle Swarm Optimization algorithm for better cost estimation. They have used 30 projects of NASA dataset for their results of experiments. According to the results, the suggested model has reached better estimation and has made MMRE up

to 7.512% in comparison to the other models. Researchers [19] have used FL for estimation of the software projects. They have introduced SCE as one of the challenges and the important activities in software development. Their proposed method shows that using FL is a model in software development. They have used 14 projects of KEMERE projects set. According to their results it is possible to say that Mean Absolute Relative Error (MARE) and PRED (N) are better in proposed model than algorithmic methods. Cost function has many parameters in software projects. Some of the factors of software process which are directly effective on cost estimation are: Line of code (LOC) and Kilo Line of Code (KLOC). Researchers [20] have used Multi-Objective Particle Swarm Optimization (MOPSO) algorithm for SCE. They have minimized MARE using MOPSO algorithm for optimization of the parameters of COCOMO model. For more studying of the results, the proposed model was tested on small and large projects. According to the experiments, MARE is 16.1306% in small projects in COCOMO model and 9.0143% in proposed model, and 18.1548% in large projects in COCOMO model and 20.9717% in proposed model. The results of experiments show that proposed model is better in estimation. Researchers [21] have used data mining techniques and algorithmic models to study and evaluate the SCE. One of the most critical subjects in software development is the right estimation of the software costs. They have studied COCOMO model using the data mining techniques. SCE using four data mining techniques are Linear Regression (LR), ANNs, Support Vector Regression (SVR) and K-Nearest Neighbors (KNN). Using LR model it is possible to identify the dependency of the effective adjectives in SCE. LR model finds the relationship between independent and dependent factors among the data. ANNs try to train and test the data to make more accurate cost estimation. SVR model is used for optimization of the effective factors in SCE. KNN is a technique in data mining which is used for classification of the data in a set of them which were classified before and hold specified characteristics. Using KNN, the weight of the effective adjectives in SCE is identified. The results of the experiments show that SVR model holds less MRE than others. Researchers [22] have proposed a new model based on regression for cost and effort of software development. The efficiency of the proposed model is evaluated on NASA projects. The results of the experiments show that regression model has lower MRE and is more effective in calibration of the COCOMO model. Researchers [23] have studied data mining techniques in the SCE. They have studied ANNS, LR, Multiple LR (MLR), Bayesian Networks (BN), Fuzzy Decision Trees (FDTs), FL and Neuro Fuzzy (NF). Any input factor is weighted using ANNs and is calculated by the hidden layers and in output layer the optimized value is reached, in MLR and BN models, the estimation takes place using analyzing the dependent variables. In FDTs, FL and NF models, any estimation factor is considered a fuzzy member.

SCE has developed using the AI models and it is possible to say firmly that the AI methods are more accurate than the algorithmic models. AI models are repeated continuously and train the data repeatedly and are able to optimize the effective factors in estimation and minimize the cost and effort of the software projects.

3 COCOMO MODEL

COCOMO is a model of cost and time estimation in software projects. It is an experienced model which is achieved by gathering the data from many software projects [3]. Base COCOMO model is not suitable in cost estimation because of many changes in software development projects and so the intermediate COCOMO was presented for improving the base COCOMO model. In intermediate COCOMO the cost estimation calculation for the software projects is identified by the equation (1) [24, 12].

$$PM = a * (Size)^b * \prod_{i=1}^{15} EM_i \quad (1)$$

In equation (1), a and b are the constant parameters the value of which depend on the data of the dataset. Parameter Size is the size of the project in Thousands of Source Lines of Codes (KSLOC). Parameter EM which is named Effort Multipliers (EM) is a coefficient which causes increasing or reducing the effort rate in person/month [12]. In intermediate COCOMO parameters a and b are initialized according to Table (1).

Table 1. a and b Values in Different Classes

Class of Projects	a	b
Organic	3.2	1.05
Semidetached	3.0	1.12
Embedded	2.8	1.20

Organic class includes relative small projects which are done by the high experienced teams. Usually if the projects sizes are 100 KSLOC, they fall in organic class. Semidetached class includes medium projects which are not complex or simple and

if the size of the projects is 100 to 300 KSLOC, fall in semidetached group. Embedded class includes projects the size of which is more than 300 KSLOC. This class is used when the hardware and operations are defined before and there is no need for any changes.

4 META-HEURISTIC ALGORITHMS

Nowadays the use of the meta-heuristic algorithms in optimizing the problems and achieving an accurate solution has grown very much. Because of the increase of the complexity of the optimization problems and disability of the algorithmic methods in optimized solution, the meta-heuristic algorithms are a suitable method for optimization problems. GA and ACO are the algorithms which solve the optimization problems according to the population. These algorithms hold searching and evaluation specification and try to repeat the problem many times until reaches the optimized answer. In this section, we will study the GA and ACO.

4.1 GENETIC ALGORITHM

GA is one of the meta-heuristic algorithms which were first by John Holland in 1975 for the first time [25]. GA is an optimization algorithm which takes into consideration a set of the points of answer space in any calculation repetition effectively and searches different areas of answer space. Execution of this algorithm starts with creation of the initial population. Any individual of the population which is called a chromosome is considered as an answer for optimization problem and any element of the chromosomes which is called gene shows the value of the optimization problem. The new generation takes into consideration the suitability of the chromosomes function and is created by using the GA operators (crossover and mutation) and the suitability function of the individuals is improved in any repetition. GA execution includes the following stages:

- **Initial Population**: In primary state, a population of the chromosomes is created randomly. In production of the initial population, the limits of the problem must be considered. Any chromosome is a solution for optimization problems.
- **Evaluation:** This operator uses an evaluation function for identification of suitability of any chromosome in relation to the other chromosomes. In fact this operator shows the suitability of the chromosome for solving the problems.
- **Selection:** This operator is the most suitable chromosome from the population for the next generation. If a chromosome does not meet the limits of a problem, will not be selected.
- **Crossover:** Production of the new chromosomes from the selected chromosomes takes place by the crossover operator.
- **Mutation:** This operator changes the random genes from the random chromosomes. The probability of its incidence on the population is low and the goal of it is to maintain the genetic diversity of the population in convergence to the optimized solution.

GA is a meta-heuristic algorithm which takes into consideration a set of the solution space points in each calculation repetition effectively ad searches the different solution spaces. In GA, select, crossover and mutation operators cause new points of the solution space to be searched in each calculation repetition. GA operators ban the solutions to be locally convergent and also cause searching ability increase and finding optimized points of the searching space and finally leads increase of the searching ability of the algorithm.

4.2 ANT COLONY OPTIMIZATION

ACO is one of the most known meta-heuristic algorithms. ACO algorithm was first presented by Dorigo in 1996 [26]. ACO algorithm is inspired from the natural life of the ants. Ants leave an odorous stuff on the path named pheromone. This stuff evaporates but is left in short time as the ant trace on the earth. The ants are able to produce pheromone to find the nearest path to the food. The ants selecting the nearest path create more pheromone than the ones selecting the longer paths. As the more pheromone attracts more ants, the more and the more ants will select the shorter path and then all ants will find the shorter path and move on it. To study the subject more, we assume that there are two paths on the way to the food which are different in length. The ants select both paths by the same probability. The ants which have been on the shorter path will produce the most pheromone before the others. So the other ants will select this path and will improve the pheromone of this path. At last all ants will find the shortest path to the food.

4.2.1 THE RULE OF TRANSITION PROBABILITY

The probability of movement from city *i* to city *j* for ant *k* in time *t* is calculated according to the equation (2). In equation (2), η_{ij} is the visibility which is $1/d_{ij}$ (the nearer cities will be selected with higher probability).

$$p_{ij}^{k}(t)=\begin{cases}\dfrac{\left[\tau_{ij}(t)\right]^{\alpha}\cdot\left[\eta_{ij}\right]^{\beta}}{\sum_{j\in allowed_k}\left[\tau_{ij}(t)\right]^{\alpha}\cdot\left[\eta_{ij}\right]^{\beta}} & \text{if } k\in allowed_k \\ 0 & otherwise\end{cases} \quad (2)$$

In equation (2), τ_{ij} is the pheromone volume poured on any mane and α and β are the poured pheromone effect on mane and the scope of that mane, respectively. And $allowed_k$ is the set of the cities ant *k* has not moved to till now.

4.2.2 RULES OF PHEROMONE UPDATE

To pay attention to the other ants like the best ant, and to be able to use the valuable information of them, the local updating method is used for updating pheromone rule. In this method the search space is gone fast and on fact the risk of losing the suitable paths and getting into local minimum trap are gone less. The updating law of pheromone on the manes takes place according to the equation (3).

$$\tau_{ij}(t+n)=(1-\rho)\times\tau_{ij}(t)+\Delta\tau_{ij} \quad (3)$$

In equation (3), (1-ρ) is the evaporation rate of the pheromone in t distance to (t + n). To avoid the increase of the pheromone on one mane, the 0<ρ<1 limit is used for ρ. The more ρ, the more will be the evaporation speed.

$$\Delta\tau_{ij}=\sum_{k=1}^{m}\Delta\tau_{ij}^{k} \quad (4)$$

$\Delta\tau_{ij}$ Is the pheromone volume the ant *k* leaves on (i, j) path in time *t* to t + n which is identified as follows.

$$\Delta\tau_{ij}^{k}=\begin{cases}Q/L_k & \text{if k ant uses edge (i,j) at time (t,t + n)} \\ 0 & otherwise\end{cases} \quad (5)$$

In equation (5), parameter Q is the increasing volume of pheromone in Local Updating and L_k is the path length the ant *k* moves.

5 PROPOSED MODEL

By the software development, there are high risks of error in software projects cost estimation using the COCOMO algorithmic models and so this process is very hard. In algorithmic models, the cost estimation constant values are not defined values and are considered as the mean values and so it is not easy to find reliable answers. The relations of the factors of estimation in software projects are very effective in software projects success. For software projects it is possible to balance the estimation factors and estimate the most accurate cost for the software projects. For software projects it is possible to use different algorithms. In this paper we have tried to hybrid the meta-heuristic algorithms for estimation of the software projects. The software projects cost estimation using meta-heuristic algorithms cause software upgrade, software project control and software quality. The problem of software projects development is the numeral estimations like costs and the effort needed for the projects. At first stage of the development of software projects, there is no accurate information accessible about the system operation, limits and the responsibilities of the projects. Using the GA and ACO it is possible to hybrid the different factors like hardware, software and human forces for development of the software projects development.

In estimation of the software projects costs, some of the project factors are varying. For example the programming factor in software projects is a team activity and there is no total process for it. Some of the programmers use the techniques in programming which need les codes and some others use the techniques of more codes and spend more time on

programming. So, the attention to the programming bases leads to the reduction of development time and increase of utilization of the software projects. By reducing the codes costs, the produced software will be more efficient from cost point of view. In the proposed model we test the costs of estimation [12] using the GA and using the ACO, the training operation is done for making the parameters more optimized. In estimation accuracy the EM factors value are very important [12]. In proposed model, we use the GA and test the suitable value of these factors according to the projects' size and then use the ACO to train more optimized factors. In GA, the longer the gene length in chromosomes, the mower the estimation error and the more accurate results will be accessible for the cost estimation. In Fig. 1 the flowchart of the proposed model is shown.

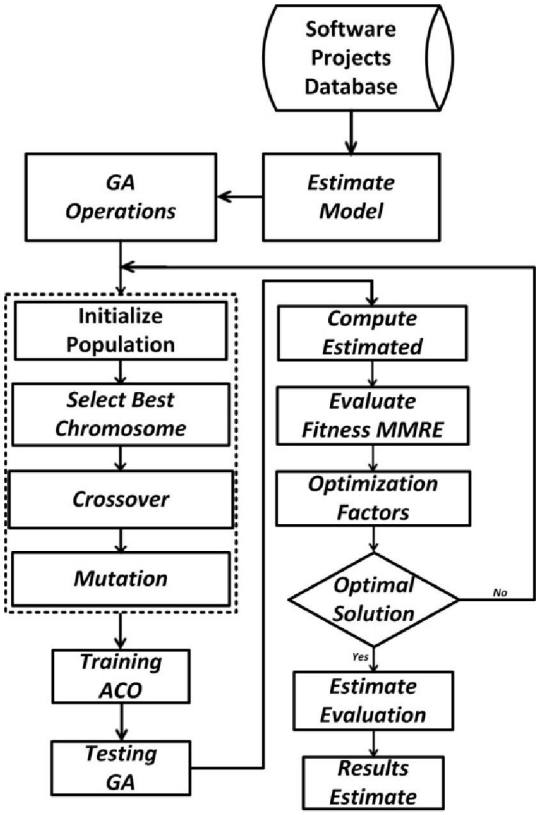

Fig. 1. Flowchart of the Proposed Model

In Fig. 2, the quasi code of the proposed model is shown.

1. Initialize Parameters
2. Do
Initialize population
Select best chromosome
Crossover
Mutation
3. Training ACO
4. Testing GA
5. Compute Estimate
6. Evaluate Fitness
MRE=|Estimate – Actual| / Actual;
MMRE=∑ (MRE) / N;
7. While (not terminate condition)
8. Estimate Evaluation
9. Results Estimate

Fig. 2. Quasi Code of Proposed Model

In the proposed model, MMRE is set as the fitness function. The suitability function fitness is to minimize the MMRE in comparison to the COCOMO algorithmic model in proposed model and the algorithm is repeated till the MMRE is reduced down to the favored rate and then the best chromosome and gene value of it is selected. MMRE is defined according to the equation (7) [27].

$$MRE_i = \frac{|Actual_i - Estimate_i|}{Actual_i} \times 100 \quad (6)$$

$$MMRE = \frac{1}{N}\sum_{i=1}^{N} MRE_i \quad (7)$$

Using the equation (7), it is possible to compare the error sum of the different models of estimation. The SCE using the combination of GA and ACO is implemented in C#.NET 2008 programming environment. In Fig. 3, the scheme of the program is shown.

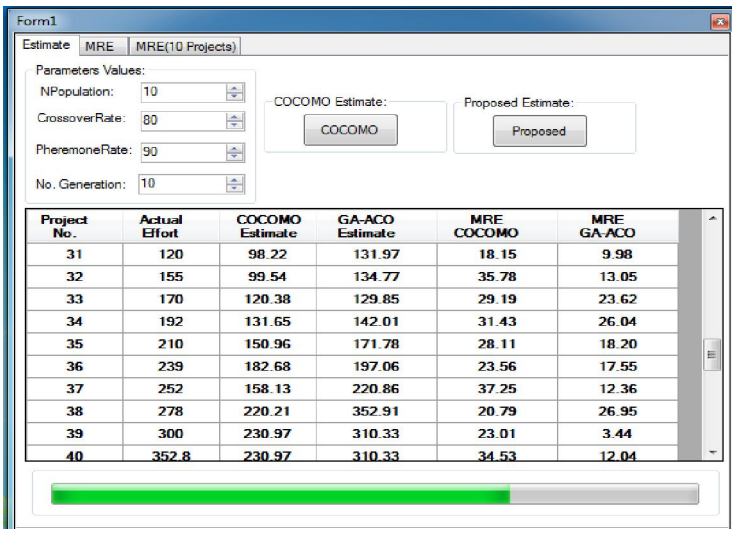

Fig. 3. The Program of the Proposed Model for SCE

6 EVALUATION AND RESULTS

In this section, the results of proposed model and COCOMO model are evaluated. In meta-heuristic algorithms, it is important to identify the primary parameters for evaluation of the results. So, meta-heuristic algorithms are very delicate in their parameters and setting the parameters is very effective in their operation. So, setting the parameters leads more flexibility and efficiency of the proposed model. The population selection is very important in meta-heuristic algorithms. If the number of the population is low, the problem will be soon convergent and will not achieve the favored and near global optimum solution and if the population number is high, long time will be spent for the algorithm to be convergent. So, the number of the population must be suitable and in harmony to the problem to reach the optimized solution. In Table (2), the parameters affecting the operation of the proposed model are shown.

Table 2. Parameters Value

Parameters	Value
No. Population	10
Crossover	0.6
Mutation	Randomized
Pheromone Rate	0.9
Population Rang	0.9-1.4
No. Generation	10
Fitness Function	MMRE

To show the efficiency better in Table (3), 10 projects of the NASA dataset software projects are evaluated. The results of the experiments in Table (4) show that the proposed model holds lower MRE than COCOMO model. So, proposed model is suitable for estimation and has less estimation error than COCOMO model.

Table 3. MRE Comparison of the Proposed Model and COCOMO Model on 10 Projects

No	Project No.	MRE using COCOMO	MRE using Proposed
1	9	28.08	16.60
2	11	26.99	10.56
3	13	46.02	33.88
4	16	25.15	8.67
5	28	34.14	19.32
6	37	37.25	12.36
7	43	37.64	15.30
8	47	44.43	31.93
9	57	28.79	23.16
10	60	25.57	27.50

In Fig. 4 the MRE comparison of the proposed model to the intermediate COCOMO model on 10 projects of the NASA dataset software projects is shown. As it is clear, the suggested model holds less estimation error than COCOMO model.

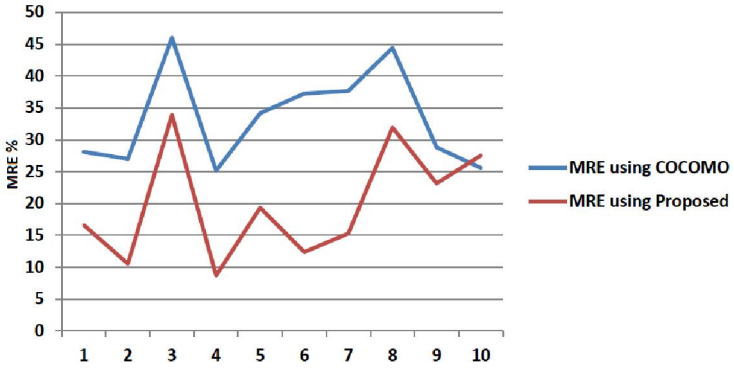

Fig. 4. MRE Comparison of the Proposed Model and COCOMO Model on 10 Projects

Fig. 5 shows the comparison diagram of MRE of proposed model with effect of the number of the different generations to minimize the error.

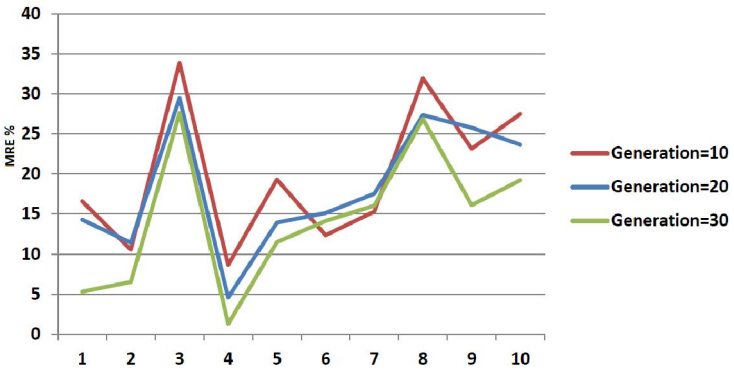

Fig. 5. MRE Comparison of the Proposed Model Affected by the Number of the generations on 10 Projects

As it is clear in Fig. 5, the proposed algorithm holds more ability in increasing the number of the generations in minimizing the MRE. In Fig. 6 the diagram of comparing the MMRE of the proposed model and intermediate COCOMO model for 60 projects of the NASA dataset software projects [12] is shown.

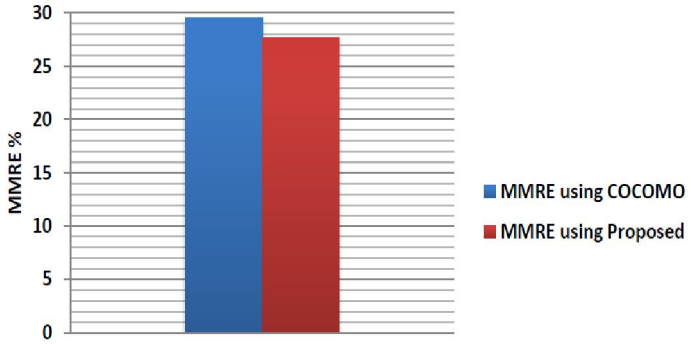

Fig. 6. The Comparison Diagram of Proposed and Intermediate COCOMO Model

7 CONCLUSION AND FUTURE WORKS

The accuracy of SCE causes the managers to schedule the projects of software development in a known format. In this paper, we have presented a new model for estimation of the costs of the software projects using a combination of GA and ACO for NASA software projects. In the proposed model, the effective factors in estimation are using the GA the test and using the ACO the training and better results are achieved in comparison to COCOMO model. By this paper, we hope in future will present better models for estimation of the SCE of implementation and designing with more accurate estimation by combining other meta-heuristic algorithms.

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