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A Microcontroller Based Building Automation System for real time Sensing and Control

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ABSTRACT: The research paper discusses a microcontroller based building automation system for real time monitoring and control for a standard three-bedroom unit. Standard buildings designed and built in Nigeria are without any form of automation and with emerging technologies that support automation of certain sections/processes in buildings the intelligent building paradigm can be a realizable objective. This paper thus proposed a microcontroller based design interfaced with appropriate sensors, actuators and voice recognition abilities to develop a building automation system (BAS) that could open/ close two doors, three windows and turn-on a light bulb with the detection of appropriate control signals with the flexibility of leaving room for future improvement increased complexity.

KEYWORDS: BAS, Microcontroller, Sensors, Actuators.

1 INTRODUCTION

An intelligent building according to the European Intelligent building group (EIBG) is one "that incorporates the best available concepts, materials, systems and technologies integrating these to achieve a building which meets or exceeds the performance requirements of building stakeholders which includes the owners, managers and users as well as the local and global community" or the definition by the intelligent building institute (IBI) as one that provides a productive and cost effective environment through optimization of its four basic components – structure, systems, services and management as well as the interrelationships between them.

Buildings since the 1980's have slowly been integrated with technologies and processes that have created a safer, comfortable and more productive facility for its occupants. Intelligent building technology thus refers to the integration of four systems namely a Building Automation System (BAS), a Telecommunication System (TS), an Office Automation System (OAS) and a Computer Aided Facility Management System (CAFMS) where a sophisticated BAS is actually the basis of every intelligent building [10]. The desire to improve comfort inside new, large building after the World War resulted in more complex mechanical systems, better heating and control systems, Pneumatic controls and mounted electrical switches. The period through the 50's, 60's, 80's and the current time saw the emergence of different technologies such a Pneumatic sensor transmission that permitted local indication and remote signaling, electrochemical multiplexing systems which resulted in the reduction of installation cost and maintenance, Automatic control, emergence of user friendly systems, man-machine interface, smart multiplexers, field interface devices (FID's), Microprocessor based distributed direct digital control (DDDC), interoperability and expandability that allowed the linking together of monitoring and control systems and more compatible communication protocols that were suitable for implementation of diverse technology towards achieving the "Intelligent Building" is very wide and almost never ending as changing human wants/needs would require bigger complex building designs that need to be automated to meet future standards.

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2 RELATED WORK

Reference [6] proposed a research methodology that describes an integrated approach to using results of literature search and inputs from expert survey in the field of building automation and thus presented a framework for identifying and classifying key parameters thus, a building automation performance index (API) model. Reference [7] developed a system that can be utilized in assessing a building's energy or operating cost performance where in such case, the building automation system was simply treated as a set of options chosen from a list where automation would be assumed to be at optimum levels whenever an option from the list is selected.

Reference [8] provided a novel survey of prominent international intelligent buildings research efforts with the theme of energy saving and user activity recognition and thus devised new metrics for comparative study, determination of most valuable activities and behaviours with focus on their impact on energy saving potentials for each of the main subsystems that we used as a case studies such as HVAC, light and plug loads. A conclusion with principles and perspectives for energy intelligent buildings based on user activity with clear reference to the most promising and appropriate activity recognition technologies and approaches were discussed. The CASAS Smart home project is a multi-disciplinary research project at the Washington State University focused on the creation of an intelligent home environment. The approach attempts to view the smart home as an intelligent agent that perceives the environment through the use of sensors, and can act upon the environment through the use of actuators [2].

Reference [5] presented SPOT-LIGHT which was a prototype system that can monitor energy consumption by individuals using a proximity sensor. The basic idea is that an occupant carries active RFID tag which is used for detecting proximity between user and each appliance. This proximity information is then used for energy apportionment, reporting the energy consumption profiles in terms of useful/wasteful power of each user with each appliance.

3 METHODS

A structured approach to system analysis as summarized below was used in developing the system.

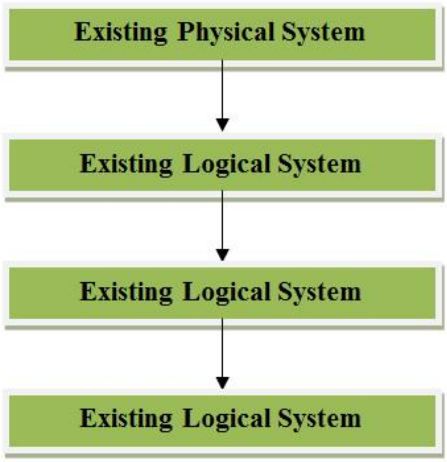

Fig. 1. A Structured approach to System Analysis

Source: Reference [9]

To provide answers to the following questions relating to the problem statement such as:

- What programmable control device can be used to implement the automation required for the three (3) bedroom apartment?
- What sensors and actuators would be required to execute the control action?
- What level of automation is currently being employed and is developed/deployed system flexible for the future?

A top-down design approach was used where the overall system was broken down into smaller modules to handle different areas of the study. AutoCAD was used to draw the design of a standard three bedroom apartment, A microcontroller, sliding motor (Actuator), Infrared sensor and voice recognition device with appropriate electronic circuitry was used to develop the building automation system (BAS) such that the infrared sensor is used to detect human presence at the main door "A" which in turn causes the microcontroller to trigger the sliding motor enabling the door to open and close.

The microcontroller on detecting the presence of an individual in the house would switch on the main bulb in the room and trigger the actuators to open the windows “B”. The system remains in this state till a preprogrammed voice signal tells it to open door “C” then the microcontroller triggers door “C” to open.

Module One: AutoCAD is used to draw the design of the three bedroom apartment.
Module Two: A microcontroller based design that can automate the apartment as required was developed.
Module Three: The developed system is interfaced with the original building design to effect the control action.

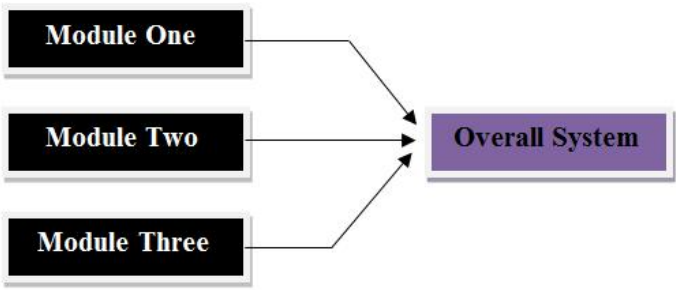

Fig. 2. Modular Framework of System

Source: Reference [3].

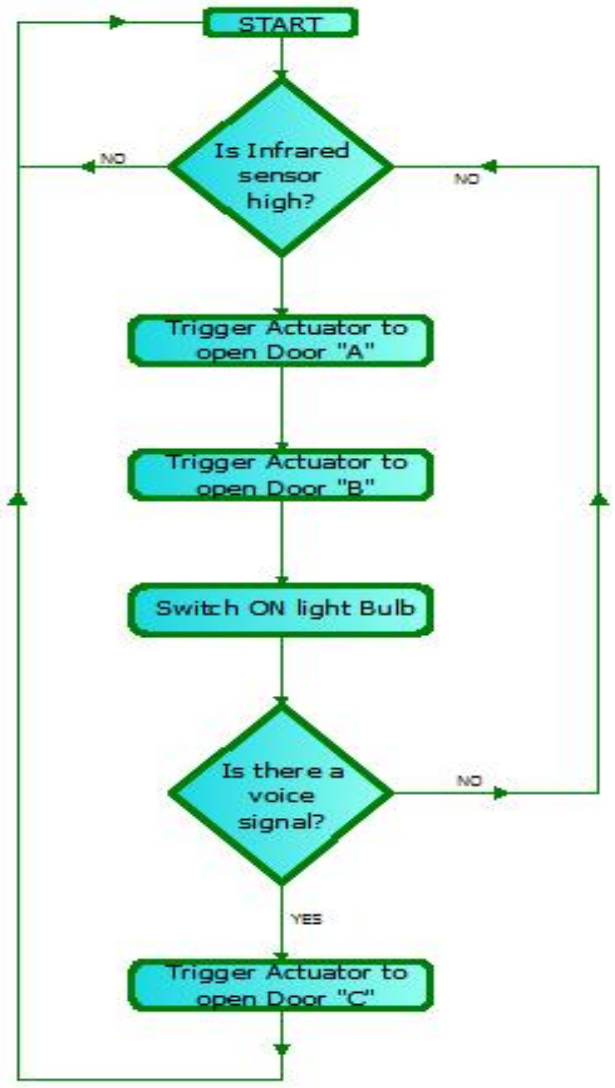

Fig. 3. Flow diagram showing the operation of the microcontroller

The combination of the three modules whose mode of operation is based on the system flow diagram is shown clearly below.

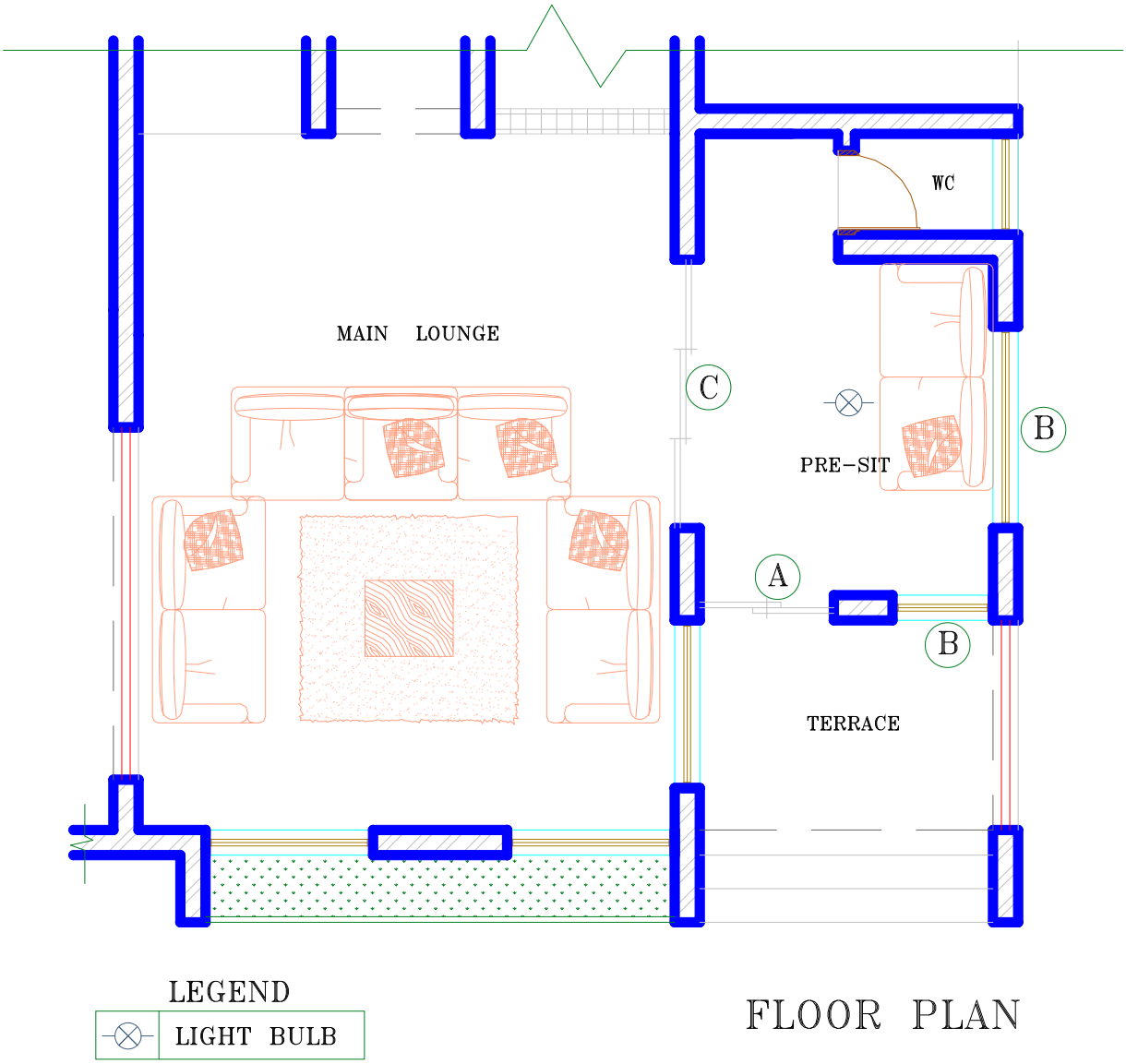

Fig. 4. Floor plan of the proposed building

Source: Authors research design

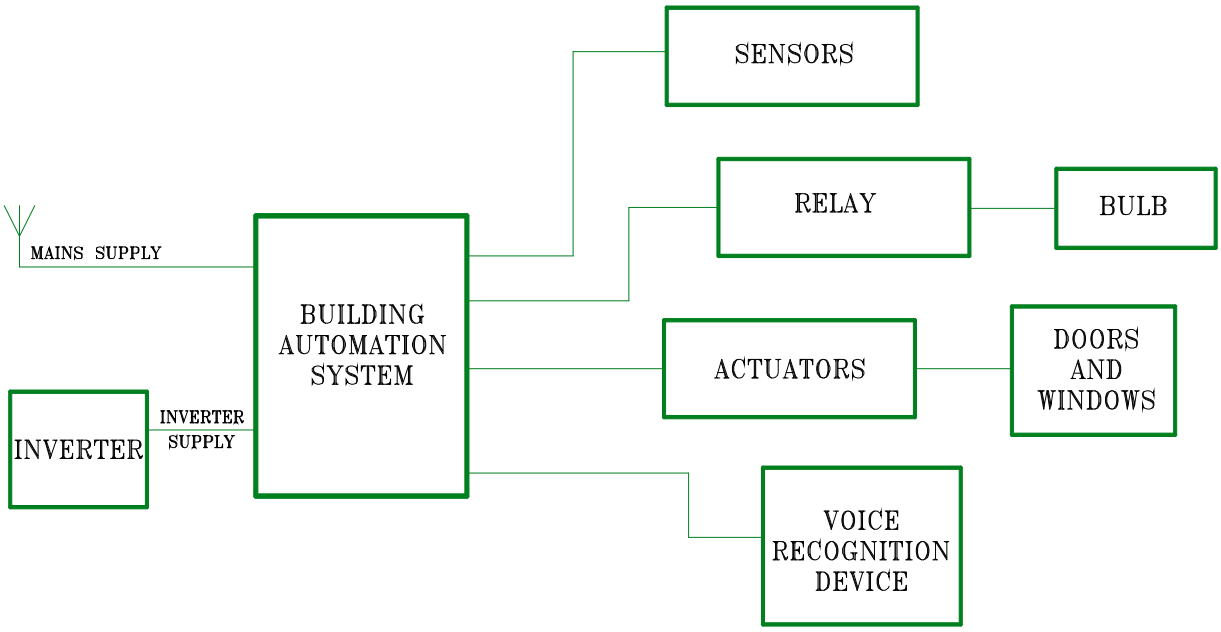

Fig. 5. Total system overview

Source: Authors research design

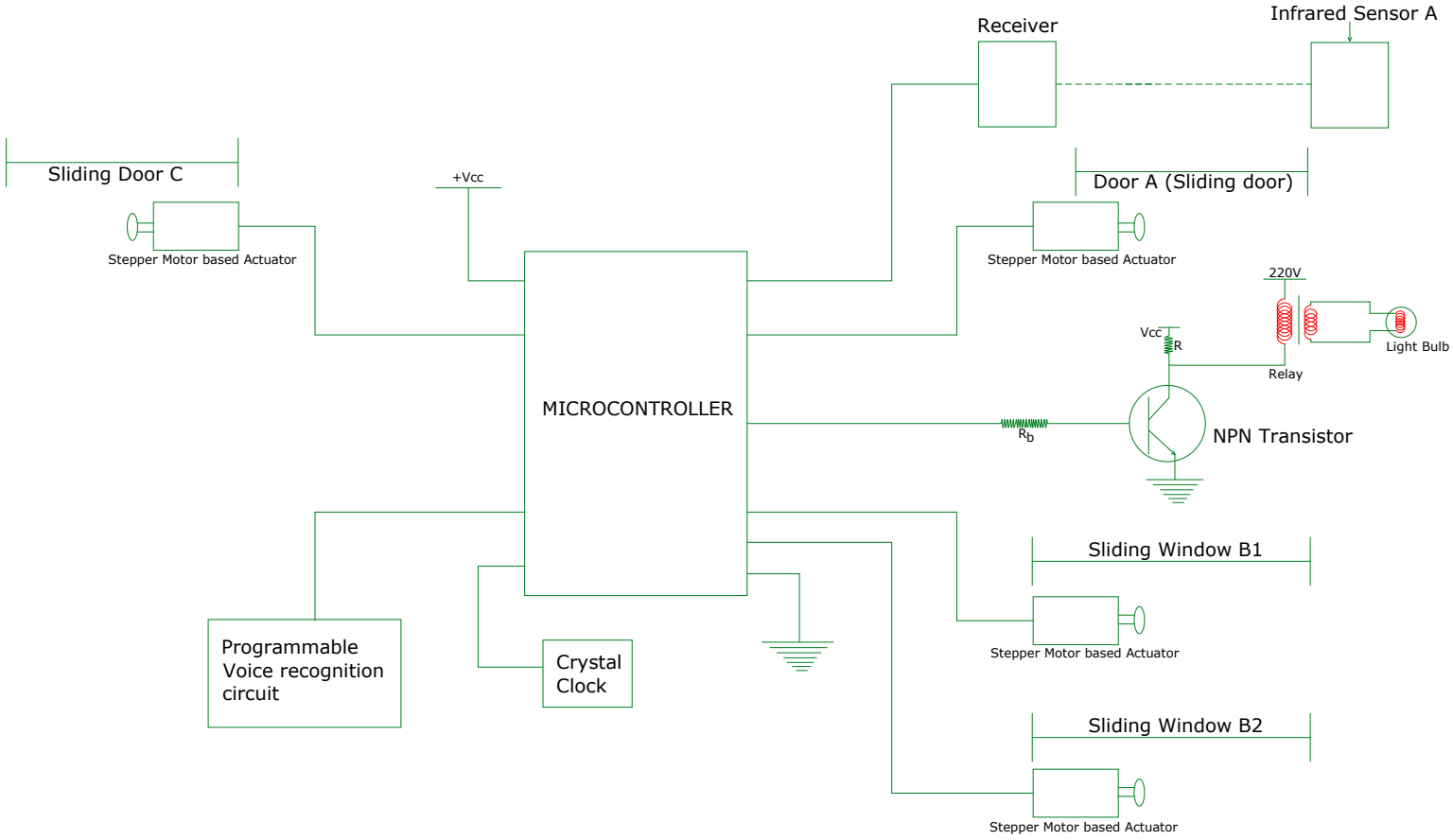

Fig. 6. A Microcontroller base BAS design

Source: Authors research design

4 RESULTS AND DISCUSSIONS

The system operates by the microcontroller sensing a disruption at the receiver end of the infrared sensor which indicates the presence of a human, thus prompting the system to trigger the actuators connected to open door A and windows "B" to slide them open as well as switching ON the light by turning the pin connected to the VPN transistor ON or Logic 1 in order to bring the transistor to saturation thus energizing the relay which turns ON the light.

A voice recognition device is also interfaced with the microcontroller so in the event, the keyword has stored in memory observed the controller triggers the appropriate actuator to open door "C".

The microcontroller can be coded using assembly language or suitable high level programming language like C, in order to provide 24-hour service especially in a country like Nigeria which experiences incessant power outages an appropriate inverter could be employed to provide a back-up power solution.

5 CONCLUSION

The research paper proposed a microcontroller based building automation system for real time sensing and control in a typical three bedroom apartment design where an attempt was made to control two doors, two windows and a lighting bulb. The control for the first door was based on physical sensing while the second door was based on voice recognition.

The research endeavor to develop an intelligent building based on user activity and as current situation has shown that building control is mainly done manually from switching lights and appliances to controlling heating systems. We have clearly shown that using appropriate technology the "Intelligent Building" concept can be applied using cheap off the shelf components applied to small residential homes.

6 FUTURE WORK

The researchers intend to carry out further research on the subject topic by incorporating security features that ensure authorized entry, complete automation of the building that incorporates remote monitoring and control functions using smart objects and internet-of-things as well as entire coverage of the entire building plan to achieve the "Intelligent Building".

REFERENCES

[1] Bellas-Vellidis I, Argiriou A, Balaras C.A, Kontoyannidis S. (1998), "Predicting Energy Demand of Single Solar Houses Using Artificial Neural Networks". Proceedings of the 6th European Congress on Intelligent Techniques and Soft Computing, Aachen Germany, Pp. 873-877.

[2] CASAS Project (2011), Website http://ailab.wsu.edu/casas/

[3] Hawsyszkiewyez, I.T. (1989), "Introduction to system analysis and design". New Delhi: Prentice hall of India.

[4] Intelligent Buildings Project (2011), Website: http://www.bth.se/com/disl.nsf/pages/intelligent-buildings

[5] Kim, Y., Charbiwala, Z., Singhania, A., Schmid, T., & Srivastava, M.B. (2008), SPORTLIGHT: Personal Natural Resource Consumption Profiler, HotEmNets 2008.

[6] Makarechi, S. & Kangari, R. (2011), "Research methodology for building automation performance index". International Journal of facility management, Vol. 2, No 1.

[7] Markus, T.A. (1967). The Role of Building Performance, Measurement and Appraisal In Design Method, Architects Journal, 146, 1567 – 1573.

[8] Nguyen, T. A. & Marco A. (2013) "Energy Intelligent Buildings Based on User Activity: A Survey". Energy and Buildings, 56 (2013) Pp. 244-257. www.elsevier.com/locate/enbuild

[9] Rajaraman, V. (1991). "Analysis and Design of Information System. New Delhi: Prentice hall of India.

[10] Stavrakakis, G., Kolokotsa, D., & Nikolau, T. (2002), "Introduction to Intelligent Buildings". (35) Pp. 1-25.