

Enhancing Thermal Image Segmentation By The Application Of The Concepts Used In Unsupervised Artificial Neural Network

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ABSTRACT: In image processing an essential step is image segmentation. The aim of segmentation is to simplify and to change the representation of an image into a form easier to analyse. Many image segmentation methods are available but most of these methods are not suitable for thermal image and they need prior knowledge. In order to overcome these obstacles, a new thermal image segmentation method is developed using an unsupervised artificial neural network method called Kohonen's self-organizing map and a threshold technique. Kohonen's self-organizing map is used to organize the pixels according to gray level values of multiple bands into groups then a threshold technique is used to cluster the image into dislocate zone, this mode is TSOM.

KEYWORDS: Image segmentation, Kohonen's self-organizing map, Neural Networks, Unsupervised.

1 INTRODUCTION

SOM are data visualization technique invented by professor TeuvoKohonen which reduce the dimension of data through the use of self –organizing neural network .The problem that data visualization attempts to solve is that humans simply can't visualize high dimensional data as is so techniques are created to help us understand this high dimensional data.

Image Segmentation is the process of image division into regions with similar attributes. Image Segmentation is an important step in the image analysis chain with the application of pattern recognition, object detection and so on.

Neural network [1] base Image Segmentation mostly depends on the supervised segmentation method such as maximum likelihood (ML) with an average efficiency rate of about 85%. Supervised Segmentation method needed to get a successful [2].

Segmentation process and sometimes the required information may not be available and also supervised method is like comparing output with available output information so if any little difference is there in the output it will reject that output this is the main problem in supervised method. So we are going for unsupervised neural network method in this method we don't want any example like supervised method unsupervised method divide the input data into groups of similar points it able to cluster the data in different class.

Thermal images are an important source of information which is used in many types of environmental assessment. I am using FLIR T355 camera. The thermal imaging camera is a type of thermography camera used in fire fighting by rendering infrared radiation as visible light; such camera allows firefighters to see areas of heat through smoke, darkness, heat permeable barriers. Thermal imaging cameras pick up body heat, and they are usually used in cases where persons are trapped where rescuers cannot catch them.

A known research uses SOM incrementally to segment a land sat image by first extracting feature and then SOM is trained to segment their type of images this method was attempted on one type of satellite images and for this method to provide accurate result a field survey must be conducted .The correct sample is provided to the SOM network for further

training for further training in a supervised manner. for segmenting the satellite images base paper they used unsupervised method[3] . The proposed method used both SOM and a developed technique known as T-Cluster .

In this paper we are using thermal image as an input image. The first time we are using SOM and proposed T-clustering method for thermal image. There are many image processing segmentation methods are available. There are many image processing methods are available and also many neural network methods are also available but in image processing segmentation method take more time to execute, The efficiency of output is low and more human power is needed but in neural network the segmentation method take less time, The output accuracy is much higher that the image segmentation and it need less man power and, if we are comparing supervised and unsupervised neural network method in supervised neural network method human expert or operation chooser training images and manually segment them into K sub regions method segment the image and labels the regions according to the training data[4] .In unsupervised method automatically segments the image into K sub region then the algorithm is assigns label to the k sub region.

The paper is structured as follows. In section 2.Flir Camera, 3. An overview of SOM and it is implemented as part of the new segmentation method. In section4.threshold clustering technique (T-cluster) is presented 5. TSOM segmentation method is explained. 6. Experimental result gives the conclusions.

2 FLIR CAMERA

For taking a thermal image I used FLIR T325 camera. This camera is very newly invented one the cost of this camera is around to lack of Indian money. Thermal imaging cameras work based on a principle called Forward Looking Infrared (FLIR). This technology is very similar to the expertise used in non- contact (infrared) thermometers. Infrared thermometers and warm imaging cameras both work on the principle that any object with a temperature above absolute zero (zero degrees Kelvin, (-273.16 C, or -459.69 F) radiate infrared energy. The warm within an thing causes molecular vibrations. These oscillations in turn induce the electron vibrations which leads to the electromagnetic coupling that causes the infrared energy to be emitted.Because of the mechanics involved in this method, the wavelengths of the resulting infrared energy vary according to temperature. The infrared energy that is released from an object is a kind of electromagnetic radiation, and has several of the same features as light. The energy is transferred at the speed of light, and streams indeterminately in all directions.



Fig1: FLIR T325 Thermal Camera

An infrared thermometer contains a sensor called a thermopile. When the thermometer is sharpened at an object, a lens centres the infrared radiation emanating from that thing onto the thermopile. The thermopile produces a small volume of electricity, which differs depending on the amount of infrared energy that has been received. A simple processor within the thermometer measures this voltage and computes the object's temperature based on the thermometer's inner calibration tables.What makes a thermal imaging camera different from an infrared thermometer is that the thermopile holds multiple sensors. These sensors are organised in both horizontal and vertical rows. The amount of rows fixes the camera's resolution. For model, the thermal imaging camera that Modern Stage Paranormal uses has a resolution of 320 x 200. This fund that the camera's thermopile has 200 rows, each of which contains 320 sensors.

A thermal imaging camera determines temperatures independently for each sensor. The temperature data are then sent to a video processor that is responsible for forming a picture based on the warm data. Typically, the video processor will allot the colorblack to the coldest warm that was detected, and will allot white to the warmest detected temperature. Gradient shades of grayscale are applied to the remaining temperatures comparative to their proximity to the upper and lower temperature limits.

The thermal imaging camera will refresh its warm data several periods of second. One of the things that create thermal imaging cameras so costly is that they require a fast microprocessor that can keep up with the constant movement of new data, and that can allotcolor codes to the most recently detected temperatures on a actual time basis. For model, a thermal imaging camera with a resolution of 320 x 200 takes 64,000 warm readings at a time. If the camera is designed to display ten frames per second (which is the bare minimum for a flicker unrestricted display), then the microprocessor must be able to dependably process 640,000 data points per second.

3 AN OVERVIEW OF SOM AND ITS IMPLEMENTATION

Kohonen Self Organizing I shall be referring to them from on, are fascinating beasts. They were invented by a man named TeuvoKohonen, a lecturer of the academy of Finland, and they deliver a way of demonstrating multidimensional data in much lower dimensional spaces-usually one or two dimensions. This process of decreasing the dimensionality of vectorsis fundamentallya data compression method known as Vector Quantisation. We are using unsupervised SOM neural network method[5]. A SOM covert pattern of arbitrary dimensionality into the responses of two dimensional array of neurons Feature map preservesneighborhood relations of the most important.

SOM is a type of artificial neural network that is trained using unsupervised training to produce a low dimensional discretized representation of the input space of the training samples called a map. It is little differ from the other artificial neural network in the sense that they use a neighborhood function to preserve the topological properties of input space

A typical SOM structure is given in figure 2. This consists of two layers, An input layer and An output layer. The sum of input neurons isequivalent to the dimension of the input data[6]. The output neurons are arranged in a two dimensional array and each and every SOM maps node directly connected with the input node.

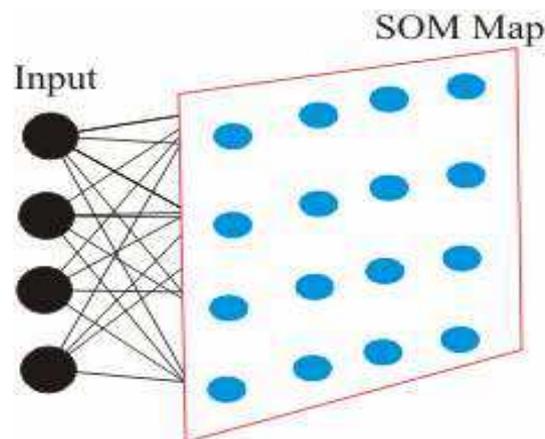


Fig2: Self Organizing Map

Colors are more importantfeatures considered in the biological virtual system, since it is used to separate object and patterns, even in condition of equal luminance. SOM is used to map patterns in three-dimensional color space to a double dimensional space. In SOM, the input signals are n-tuples and there is a set of m cluster units. Each input is finally connected to all units. In SOM initial weights are random and small, and their contribution to the final state decreases with the decrease of the number of samples.

Each input is fully connected to all units. The initial weights are random and small, and their contribution to the final state decrease the decrease of an orthogonal grid of cluster units, each is associated with three internal weights for the three layers of the satellite image. At each step in the training phase, the cluster unit with weights that best match the input pattern is elected as the winner usually by using minimum Euclidean distance as in equation 1

$$D(j)=\sum(w_{ij}-x_i)^2 \quad (1)$$

$i=1$ to n and $j=1$ to m ;

When $D(j)$ is minimum.

For all units J , with the specified neighborhood of J , and for all I , update the weights.

$$W_{ij(new)} = W_{ij(old)} + \alpha [X_i - W_{ij(old)}] \tag{2}$$

A is the initial learning rate and it is equal to 0.1. The learning rate is updated every iteration (old), initially can be half the length of the network or the maximum of the either the width or length of the image divided by two. As the learning proceeds, the size of the neighborhood should be diminished until it encompasses only a single unit.

After the SOM neural network converges to balance state, the original image is mapped from a high color space to a smaller color in this space. The number of colours is equal to the number of neurons of SOM network. The final weight vectors in the map as the new sample space. This new data set is used for clustering, and allows determining a set of cluster centers.

4 THRESHOLD TECHNIQUE (T-CLUSTER)

In order to eliminate small clusters and to reduce over segmentation problem the following technique is implemented. This technique consists of several steps as follows:

1. After obtaining cluster center's by SOM the process of clustering starts by calculating the distance between the values of the cluster centers representing the sum of the three bands.
2. Two clusters are combined if the distance between their centers is less than a predefined threshold T.
3. If step two is correct, the minimum number of pixels is considered in the combination procedure. where the cluster with smaller number of pixels is merged with the large one. Figure 3 shows more details of the merging procedure and the equation 3 explains the procedure of distance calculation.

$$d(V(p_i), V(p_j)) \leq T \tag{3}$$

where T is a predefined threshold and $V(P_i)$ is the value of the three bands of the cluster centers P_i which is the sum of the result 3 weights obtained from the running SOM each weight is multiplied by 255. $V(P_j)$ is the value of the three bands of another cluster center P_j , these two clusters centers are combined together if the distance value is less than a predefined threshold T. The value of the final cluster is the cluster with higher number of pixels.

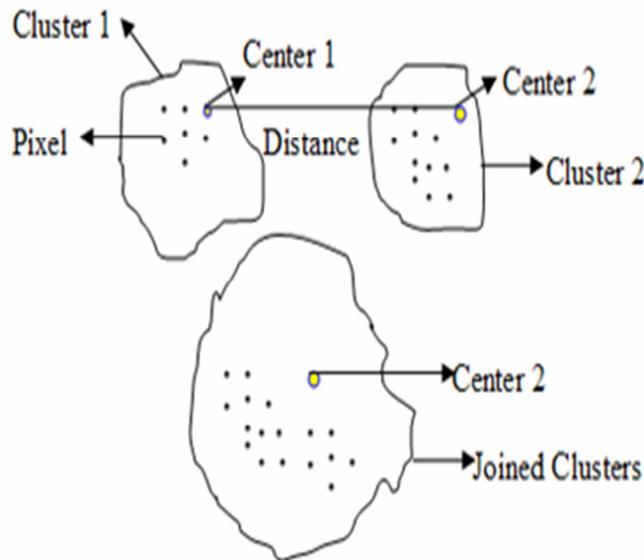


Fig 3. The merging process according to the distance between the clusters.

TSOM segmentation method

SOM and the threshold technique(t-cluster) work sequentially in order to complete the segmentation process. In order to complete the segmentation process. In other words, working separately cannot complete the job correctly as shown fig (below).

SOM use thermal image features to organize pixels in group.The highest peaks of the histogram are used as cluster centers and are provided to T-cluster to deliver the final solution in the image segmentation.

This method starts by reading the thermal image than it is provided to SOM to organize the pixels in the group. The organize pixels are used by T-cluster to obtain the final number of cluster centers .TSOM fixes the problem of under and over segmentation which are caused by using SOM separately.

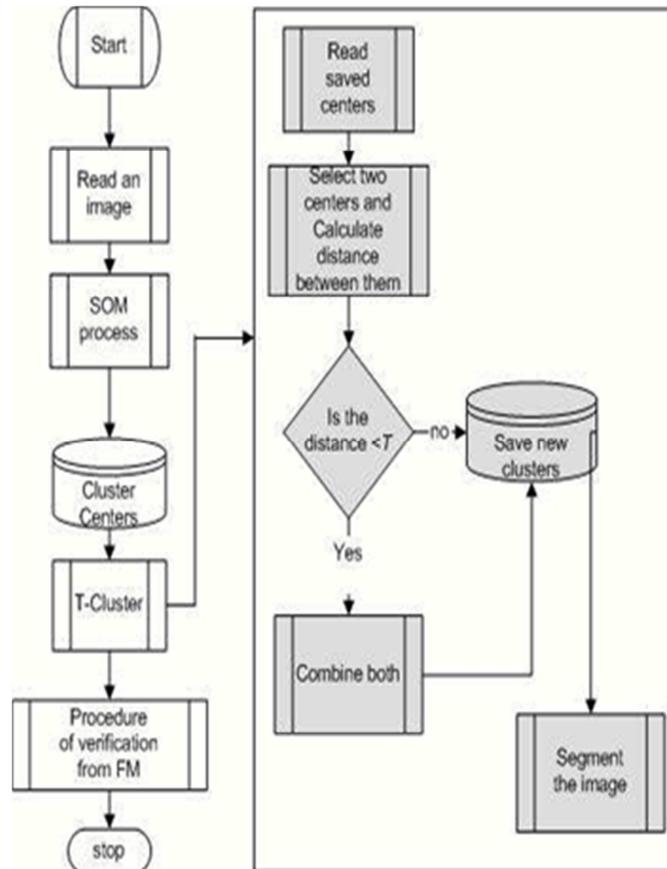


Fig 4: SOM and T cluster sequential process

Reading the image from the input then we are giving that image to the SOM processor for segmenting the image by using SOM algorithm then we are finding the cluster centers then we are using T-cluster to avoid the over segmentation problem in T-clustering the SOM process output is given as a input then we selecting two cluster centers and then we are calculating the distance between them then the T value is more than the distance between 2 clusters then it automatically save the new clusters then new image segmentation is saved before that the 2 cluster will combine if the cluster size is small.

5 EXPERIMENTAL RESULTS

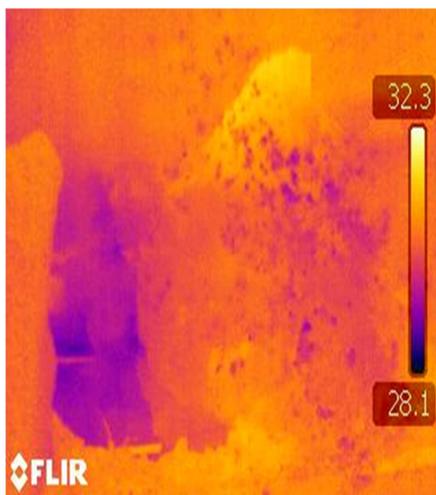


Fig 5: Input Thermal Image

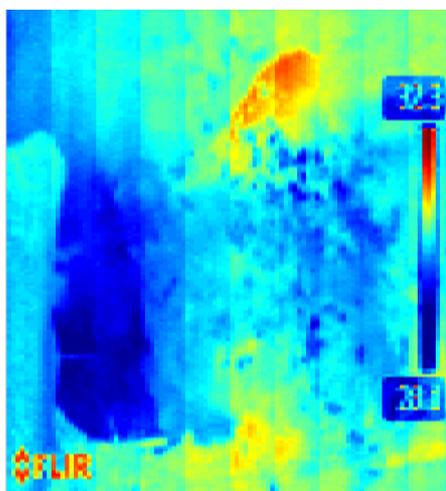


Fig 6: Output Thermal Image

The proposed image segmentation method is implemented using MATLAB .In figure 5 a) is input image and b) is output image .The result obtained by TSOM segmentation process with threshold value equal to the 75 and iteration number equal to 1000 .To increase the confidence in the obtained results, the segmented image is converted into vector format. There are many raster to vector conversion method such as the one by Suzuki and by Zenzo etc. These methods are available in many commercial software such as Arc Info. In this research the conversion process is done using the vector module. The vector layer elements are labelled according to each cluster number. TSOM took almost 25 seconds to segment the image.

6 CONCLUSION AND FUTURE WORK

Thus this project is based on how to segment the thermal image to find the defected area. Segmentation is an important step's in an image processing lot of the methods therefor segmenting the thermal images but let us implement a sequential method for thermal image segmentation using SOM and threshold technique we called it TSOM.

The efficiency of this new method depends on the selected number of iterations and threshold value. However, these values can be determined easily for type of thermal image, and they can be permanently in segmenting these images. TSOM is compared to ISODATA (Iterative Self Organizing data) method which has some similarities, especially in the need for determining the number of iteration and threshold value. In addition to this we are using a new type camera called FLIR335 camera and the temperature range of the image also we are calculating.

TSOM is almost two times faster if compare to the extreme case of running ISODATA.

Compare to the TSOM method new method they introduced is called Generalized SOM (GenSOM) was proposed to handle distance measurement of mixed-type data via distance hierarchy. Whereas the GenSOM constrains projection result in a predetermined fixed-size map, making the resultant map unable to reflect data distribution in accordance with the nature of data clusters. In this paper, we propose a Growing Mixed-type SOM (GMixSOM) which extends GenSOM with a dynamic structure, to handle mixed-type data and tackle the problem of the fixed map structure of GenSOM. Experimental results show the proposed method can reveal the topological relationship between mixed data and overcome the drawback of map structure constraint arisen in GenSOM.

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