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Radial Basis Function Neural Networks (RBFNN) For Fire Image Segmentation

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Abstract— ***A novel method of fire color image segmentation using RBF Neural Networks is proposed. In Radial Basis Function Network (RBFN), Clusters are found automatically using k-means algorithm. Radial basis function is used in hidden layer to find output which depends on the distance of the input from a stored vector. RBF Neural network is used to train input layer to target vector. The experimental results of segmentation process using Radial Basis Function neural network is good when compared with traditional k-means clustering segmentation algorithm***

***Index Terms*—: Image Segmentation, RBFN, Neural networks, K-Means clustering.**

I. Introduction

Image processing is any form of information processing for which both the input and output are images, such as photographs or frames of video. Image segmentation is one of the most important precursors for image processing based applications and has a crucial impact on the overall performance of the developed systems. The area of color image analysis is one of the most active topics of research and a large number of color-driven image segmentation techniques have been proposed. The techniques that are used to find the objects of interest are usually referred to as segmentation techniques. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments [9]. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

Fire detection based on image or video plays a key role in surveillance and monitoring technology in many areas such as fire detection, metallurgical industry and other fields. With the powerful computer of the information processing capability, image-based flame detection technology as a new and effective detection technology will play a more important role and have broad application prospects [2]

RGB color model is chosen for image segmentation due to its simplicity and the fast processing speed .In color images each pixel is represented by a triplet containing red, green, blue. For color images this ratio must be reasonably constant over the connected regions . As the RGB color ratio does not have smoothly varying values when the pixel intensity is low, the color image segmentation based on color ratio requires that the intensity of the image must be above a threshold value. The requirements of good image segmentation are as follows: A single region in a segmented image should not contain significantly different colors and a connected region containing same color should not have more than one label. All significant pixels should belong to the same labeled region. The intensity of a region should be reasonably uniform

Without a good segmentation algorithm, an object may never be recognizable. The problems of image segmentation become more uncertain and severe when it comes to color image segmentation . This is due to the diversity in the color gamut. Real images exhibit a wide range of heterogeneity in the color content. This diversity of color information induces varying degrees of uncertainty in the information content. The vagueness in image information arising out of the admixtures of the color components has often been dealt with the soft computing paradigm[8].

RBFN is becoming an increasingly popular neural network with diverse applications and is probably the main rival to the multi-layered perceptron . Much of the inspiration for RBF networks has come from traditional statistical pattern classification techniques. [1]

II. SEGMENTATION USING K-MEANS CLUSTERING

The K-Means is a non hierarchical clustering technique that follows a simple procedure to classify a given data set through a certain number of K clusters that are known a priori. More importantly this algorithm does not produce meaningful results when applied to noisy data or to tasks such as the segmentation of complex textured images or images affected by uneven illumination. Each cluster is associated with a centroid .Each point is assigned to the cluster with the closest centroid. The experimental results are shown in Fig.3 column b.

III. FIRE IMAGE SEGMENTATION USING RBFN

A. *RBFN*

A RBFN is an artificial neural network that uses radial basis functions as activation functions. It is a linear combination of radial basis functions. The Basic architecture for a RBF is a 3-layers network, The input layer is simply fan-out layer and does no processing .The second or hidden layer performs a non-linear mapping from the input space into a higher dimensional space in which the patterns become linearly separable. The final layer performs a simple weighted sum with a linear output. RBFs, networks where the activation of hidden units is based on the distance between the input vector and a prototype vector

B. *RBFN Architecture*

The traditional radial basis function network consists of n components of the input vector x feeds forward to m basis functions whose outputs are linear combined with weights wj(j=1..m) into the network output f(x). RBF neural networks are conceptually similar to K-Nearest Neighbor (k-NN) models. The basic idea is that a predicted target value of an item is likely to be about the same as other items that have close values of the predictor variables. The traditional radial basis function network is shown in Fig. 1

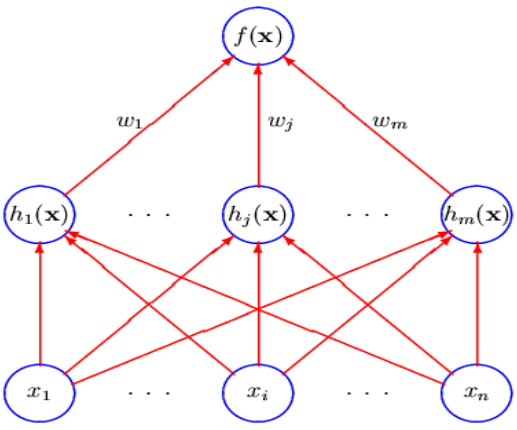

Figure 1 : The traditional Radial Basis Function Network

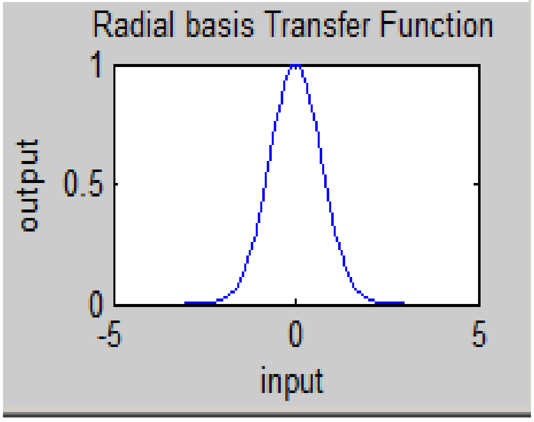

Figure 2 : Radial Basis Transfer function

The unique feature of the RBF network is the process performed in the hidden layer. The idea is that the patterns in the input space form clusters. If the centres of these clusters are known, then the distance from the cluster centre can be measured. The most commonly used radial-basis function is a Gaussian function. In a RBF network, r is the distance from the cluster centre. The equation represents a Gaussian bell-shaped curve, as shown in Fig 2. The distance measured from the cluster centre is the Euclidean distance. For each neuron in the hidden layer, the weights represent the co-ordinates of the centre of the cluster. Therefore, when that neuron receives an input pattern, X, the distance is found using the following equation

$$r_j = \sqrt{\sum_{i=1}^{n} (x_i - w_{ij})^2} \qquad (1)$$

C. *Training hidden layer*

The hidden layer in a RBF network has units which have weights that correspond to the vector representation of the centre of a cluster. These weights are found using a traditional k-means clustering. The training is unsupervised but the number of clusters(k) is set in advance. Radial Basis Function neural network is used to train input layer to target vector. The RBFN finds centroids of clusters using k-means clustering algorithm and make them as stored vector. Hidden-to-output weight vectors are determined so as to minimize the sum-squared error between the RBF outputs and the desired targets Radial basis function is used in hidden layer to find output which depends on the distance of the input from a stored vector.

Algorithm

1. *Initially k points in the pattern space are randomly set.*
2. *Then for each item of data in the training set, the distances are found from all of the k centres.*

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3. *Initial classification : The closest centre is chosen for each item of data - all items of data will be assigned a class from 1 to k.*
4. *for i= 1 to k*
5. *begin*
6. *All data which has been found to be class i, the average or mean values are found for each of co-ordinates. These become the new values for the centre corresponding to class i.*
7. *end*
8. *Process of measuring the distance between the centres and each item of data and re-classifying the data is repeated until there is no further change – i.e. the sum of the distances monitored and training halts when the total distance no longer falls.*

IV EXPERIMENTAL RESULTS

(a) (b) (c)

Figure 3 : The Experimental Results arranged in 3 columns namely a , b and c . (a) Fire images (b) Resultant images of after K-Means clustering applied (c) Resultant images of after RBFN applied

Table 1: **The** SSE **values for the Data**

Neurons	**SSE**
0	512.784
25	269.006
50	127.09
75	85.2805
100	40.9492
125	19.7122
150	8.18635
175	3.96028
200	2.0704
225	0.438761
250	3.80431e-013

V CONCLUSION

A new method for segmentation of fire images using RBFN was introduced in this paper. The unique feature of the RBF network is the process performed in the hidden layer. RBF neural networks are conceptually similar to K-Nearest Neighbor (k-NN) models. Training algorithms for RBF are significantly faster. The hidden layer is easier to interpret than the hidden layer in an multi-layered perceptron. However there are some disadvantages of this method. It need manually select the number of clusters .Furthermore the flicker nature of the fire will be considered as a future work

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