An Approach to Extract Salient Regions by Segmenting Color Images using Soft Computing Techniques

Prasanna Palsodkar
Yeshwantrao Chavan College of Engineering
Wanadongri, Hingna Road
Nagpur

Prachi Palsodkar
Yeshwantrao Chavan College of Engineering
Wanadongri, Hingna Road
Nagpur

Aniket Gokhale
Yeshwantrao Chavan College of Engineering
Wanadongri, Hingna Road
Nagpur

ABSTRACT
Due to the advent of computer technology image-processing techniques have become increasingly important in a wide variety of applications. This is particularly true for medical imaging such as Computer Tomography (CT), magnetic resonance image (MRI), and nuclear medicine, which can be used to assist doctors in diagnosis, treatment, and research. In this paper, hybrid algorithm for segmentation of color images is presented. The segments in images are found automatically based on adaptive multilevel threshold approach and FCM algorithm. Neural network with multisigmoid function tries to label the objects with its original color even after segmentation. One of the advantages of this system is that it does not require a past knowledge about the number of objects in the image. This Fuzzy-Neuro system is tested on Berkley standard image database and also attempts have been made to compare the performance of the proposed algorithm with other currently available algorithms. From experimental results, the performance of the proposed technique is found out to yields better extraction of salient regions with high resolution as nearly same as the original image and better than the existing techniques. It can be used as a primary tool to segment unknown color images. Experimental results show that its performance is robust to different types of color images**.**

General Terms
Image Processing, Color Image, Image Segmentation.

Keywords
Neural Networks & Fuzzy Logic Systems, Object Extraction, fuzzy-neuro system, Salient Regions.

1. INTRODUCTION
Due to the advent of computer technology image-processing techniques have become increasingly important in a wide variety of applications. This is particularly true for medical imaging such as Computer Tomography (CT), magnetic resonance image (MRI), and nuclear medicine, which can be used to assist doctors in diagnosis, treatment, and research. Color image segmentation is attracting greater attention. The color perceived by human eye as a combination of tri-stimuli such as red (R), green (G), and blue (B) are usually called the primary colors. It has long been recognized that the human eye can detect only in the neighborhood of one or two dozen intensity levels at any one point in a complex image due to brightness adaptation, but can discern thousands of color shades and intensities. Compared to monochrome image, a color image provides in addition to intensity the additional information (hue and saturation) in the image [1-2].

In this paper, authors have proposed a novel fuzzy-neuro technique for color image segmentation which yields better extraction of salient regions with resolution as nearly same as the original image. The paper is organized into six sections. Section two describes image segmentation and existing methods of extraction of salient regions. Section three introduces the methodology for the proposed work. Section four narrates the architecture. Section five & six shows simulation results with conclusion.

2. IMAGE SEGMENTATION
Image segmentation is the process of partitioning the pixels of a digital image into multiple homogeneous regions or clusters (sets of pixels) so that items in the same class are as similar as possible and items in different classes are as dissimilar as possible.

2.1 Types of Image Segmentation

Image segmentation methods fall into five categories:

- Pixel based segmentation
- Region based segmentation
- Edge based segmentation
- Edge and region Hybrid segmentation
- Clustering based segmentation

The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image [3]. All of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture.

Figure 1 shows the example of image segmentation. The figure depicts how an color image can be segmented and how the region of interest can be extracted from the image.

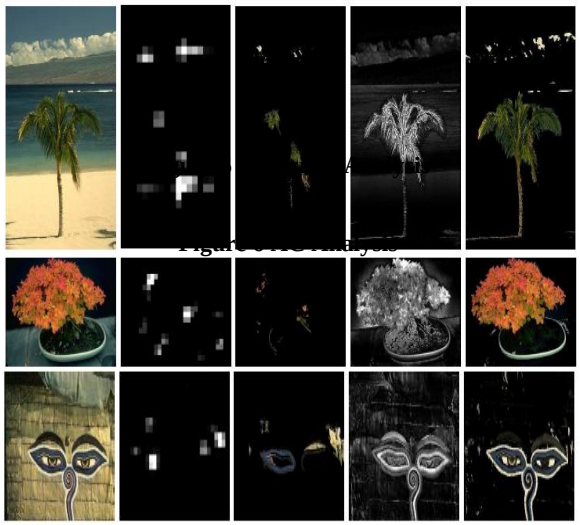

Figure 1. Example of Image Segmentation

2.2 Extraction of Salient Regions

Salient regions as those regions of an image that is visually more attentive with respect to conspicuous by virtue of their content with surrounding regions. Salient regions extraction plays an important role in image analysis and processing, and it is widely used in image compression, coding, content-based image retrieve and so on [4]. The approaches for determining saliency can be based on biological models or purely computational ones. Some approaches consider saliency over several scales while others operate on a single scale. In general, all methods use some means of determining local contrast of image regions with their surroundings using one or more of the features of color, intensity, and orientation [5]. Usually separate feature maps are created for each of the features used and then combined to obtain the final saliency map.

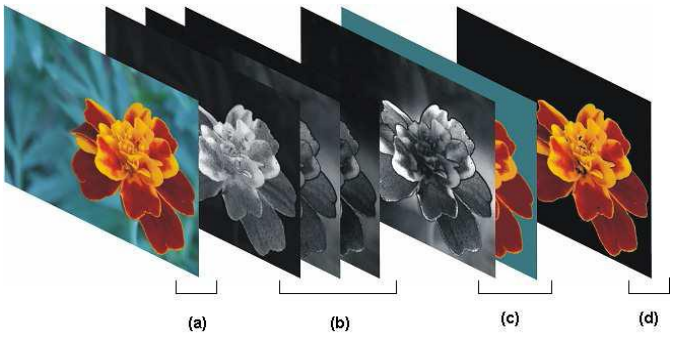

Figure 2. Overview of the process of finding salient regions. (a) Input image. (b) Saliency maps at different scales are computed, added pixel-wise, and normalized to get the final saliency map. (c) The final saliency map and the segmented image. (d) The output image containing the salient object.

The approaches for determining low-level saliency can be based on biological models or purely computational ones. Some approaches consider saliency over several scales while others operate on a single scale. In general, all methods use some means of determining local contrast of image regions with their surroundings using one or more of the features of color, intensity, and orientation.

Usually, separate feature maps are created for each of the features used and then combined to obtain the final saliency map. A complete survey of all saliency detection and segmentation research is beyond the scope of this paper, here we discuss those approaches in saliency detection and saliency-based segmentation that are most relevant to our work.

Ma and Zhang propose a local contrast-based method for generating saliency maps that operates at a single scale and is not based on any biological model. The saliency map is obtained from summing up differences of image pixels with their respective surrounding pixels in a small neighborhood. This framework maps, and cellular neural networks extracts the points and regions of attention [6]. The saliency maps produced by Itti's approach have been used by other researchers for applications like adapting images on small devices and unsupervised object segmentation [7]. Francisco Estrada et al, on the other hand, use a Support Vector Machine trained on the features of image segments to select the salient regions of interest from the image, which are then clustered to extract the salient objects [8]. .Mingxin Zhang et al. create saliency maps by threshold the color, intensity, and orientation maps using histogram entropy threshold analysis instead of a scale space approach [9]. V. Boskovitz et al used integral images in visual object detection with computational attention system (VOCUS) to speed up the computation of center-surround differences for finding salient regions using separate feature maps of color, intensity and orientation. But they resize the feature saliency maps to lower scale which looses the resolution of the extracted salient regions [10].

3. METHODOLOGY

The work already did by researchers for extraction of salient regions from the color images deals with computing the saliency maps and then extracting regions of interest from the maps. But most of them have resized the saliency maps, which ultimately leads to low resolution salient regions of the images.

The current paper proposed a novel approach to extract the salient regions by segmenting color images using Fuzzy-Neuro approach. The image to be segmented to extract the salient region is converted from the RGB color space to YCbCr color space. It is more convenient to work with the image in YCbCr color space.

YCbCr is a scaled and offset version of the YUV color space. Individual components of YCbCr color space are Luma (Y), chroma (Cb) and chroma (Cr). Chroma (Cb) corresponds to the U compoent and Chroma (Cr) corresponds to V component of the general YUV color space.

The proposed system is capable of performing adaptive multilevel color image segmentation based on threshold and Fuzzy c-means (FCM) clustering techniques. The main advantage of this method is that it does not require prior information to segment the color

image. Threshold values are determined by applying FCM algorithm. After detecting threshold values, labels for the object are decided. The information about the labels is employed to construct network's activation function.

Fuzzy c-means (FCM) algorithm is used to decide the threshold values for a pixel to be included in a particular cluster. Fuzzy c-means is appropriate tool for this classification of pixels in an image because color intensity has lots of variation and it is not suitable to define crisp boundaries to them, otherwise the segmentation results will not be satisfactory.

These cluster values are used to train the neural network. Neurons use a multi-level sigmoid function as an activation function. This function takes care of threshold & labelling the pixels during recursive training process. A back propagation algorithm is used for training. At every training epoch, error is calculated by taking the difference between the actual output and the desired output of neuron. As the training progresses, a pixel gets the colour depending upon its surrounding pixel colours. Thus the network tries to label a cluster with an even colour spread. Thus, the colour image segmentation is achieved.

4. FUZZY-NEURO ARCHITECTURE

Presently, the fuzzy-neuro approach is becoming one of the major areas of interest because it gets the benefits of neural networks as well as of fuzzy logic systems and it removes the individual disadvantages by combining them on the common features. Neural networks and Fuzzy logic have some common features such as distributed representation of knowledge, model-free estimation, ability to handle data with uncertainty and imprecision etc. Fuzzy logic has tolerance for imprecision of data, while neural networks have tolerance for noisy data (Medsker, 1995). A neural network's learning capability provides a good way to adjust expert's knowledge and it automatically generates additional fuzzy rules and membership functions to meet certain specifications. This reduces the design time and cost. On the other hand, the fuzzy logic approach possibly enhances the generalization capability of a neural network by providing more reliable output when extrapolation is needed beyond the limits of the training data.

The fuzzy-neuro system consists of the components of a conventional fuzzy system except that computations at each stage is performed by a layer of hidden neurons and the neural network's learning capacity is provided to enhance the system knowledge.

In a fuzzification layer each neuron represents an input membership function of the antecedent of a fuzzy rule. In a fuzzy inference layer fuzzy rules are fired and the value at the end of each rule represents the initial weight of the rule, and will be adjusted to its appropriate level at the end of training. In the defuzzification layer each neuron represents a consequent proposition and its membership function can be implemented by combining one or two sigmoid functions and linear functions.

The weight of each output link here represents the centre of gravity of each output membership function of the consequent and is trainable. After getting the corresponding output the adjustment is made in the connection weights and the membership functions in order to compensate the error and produce a new control signal.

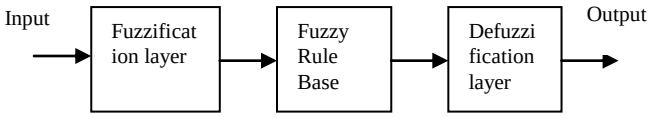

Figure 3: Fuzzy Architecture

One possible architecture of a fuzzy-neuro hybrid system is shown in Figure 3. The system contains the following three different layers:

- Fuzzification layer
- Fuzzy rule layer
- Defuzzification layer

A survey on image processing with neural networks reported several types of neural networks that have been applied to the task of image segmentation, among them multilayer perceptrons, self-organizing and cellular neural network [11]. The generalization capability is the biggest strength of neural network and are useful for learning and adaptation [9]. In neural network performance is less affected by noisy condition. Developing algorithm for salient region detection using neural network has following advantages :

- ✓ Resistance to noise,
- ✓ Tolerance to distorted patterns/Images.
- ✓ Superior Ability to recognize overlapping pattern classes or classes with Highly Nonlinear Boundaries or partially occluded or degraded Images.

Here we are using back propagation algorithm to train the network. The back propagation algorithm is generalization of the least mean squared algorithm that modifies network weights to minimize the mean squared error between the desired & actual outputs of the network. Back propagation uses the supervised learning in which the network is trained using the data for which inputs as well as desired outputs are known. Once trained, the network weights are frozen & can be used to compute output values for new input samples [12].

5. SIMULATION RESULT

The Neuro fuzzy system for extraction of salient region by segmenting color images is simulated in the MATLAB. The standard database has been used for various set of images. The images used are from the Berkley standard image database. The results of the simulation show that the extracted salient regions are the most visually attentive portion of the images.

The algorithm used for extraction has following steps:

Step 1: Acquire image from the database

Step 2: Resize the acquired image

Step 3: Convert the resized image into YCbCr color space

Step 4: Compute the threshold values by fuzzification.

Step 5: Form a feed forward neural network with n1 hidden layer neurons all with logistic neurons

Step 6: Sets the number of training epochs

Step 7: Train the network with the training data

Step 8: Test the network at the test data

Figure 4 (a & b) shows the original images and the extracted salient regions by using proposed fuzzy-neuro approach

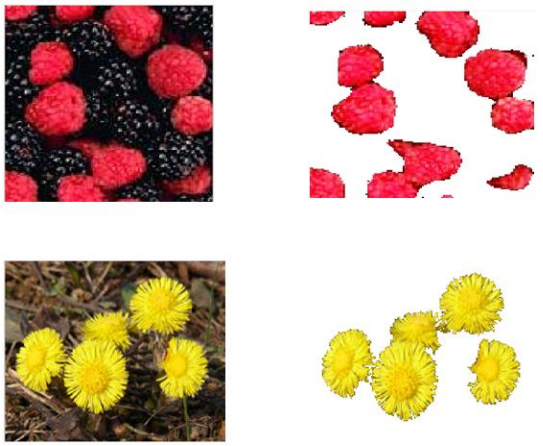

Figure 4 (a & b): Original Image and the extracted salient region

Figure 4 (a) shows the image of red berries. In this red color of the berries dominates the background color. Hence the region of interest is to extract the red berries only.

Figure 4 (b) shows the flower image in which the yellow colored flowers are more prominent then the background color. Hence yellow colored flower are extracted from the image

Figure 4(c) shows the flower with red and yellow color. In this red is more attentive than the yellow color. Hence the extracted salient region shows the red petals of the flower

Figure 4 (d) shows a bag containing grains. The color of the bag is not so significant as compared to the color of the grains. Hence grain color has been extracted from this image.

Figure 4 (c & d): Original Image and the extracted salient region

6. CONCLUSION

In this paper, hybrid algorithm for segmentation of color images is presented. The segments in images are found automatically based on adaptive multilevel threshold approach and FCM algorithm. Neural network with multisigmoid function tries to label the objects with its original color even after segmentation. One of the advantages of this system is that it does not require a past knowledge about the number of objects in the image. This Fuzzy-Neuro system is tested on Berkley standard image database and also attempts also have been made to compare the performance of the proposed algorithm with other currently available algorithms. From experimental results, the performance of the proposed technique is found out to yield better results as compared to other existing segmentation algorithm. It can be used as a primary tool to segment unknown color images. Experimental results show that its performance is robust to different types of color images.

7. REFERENCES

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