Analyzing the Image Quality in Various Applications using Segmentation Algorithms and Image recognition systems

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***Abstract*— Image segmentation is the process of partitioning a digital image into multiple segments. Segmentation is the fundamental step in analyzing and understanding an image. Watershed transform is a region based segmentation technique. It converts the original image into another image, whose catchment basins are the objects to identify. But this algorithm causes over segmentation. Therefore labeling watershed algorithm has been applied called Marker based segmentation method. This method segments an image using internal and external markers, results in high efficiency and produces a closed and connected region. A high quality images obtained are recognized using neural network algorithm in order to reduce the causes and effects at the earlier stage itself.**

***Index Terms*— Image segmentation,Image quality assessments,Marker controlled watershed algorithm.**

I. Introduction

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels)[1].It is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics**.**

The goal of segmentation is to simplify and 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.

Image recognition system is the process of detecting an object or features in a digital image or video. There are two types of image recognition systems. They are Image verification and Image identification which is referred as image recognition task. The identification of the test image is done by locating the image in the database that has the highest similarity with the test image.

A. REASONS FOR IMAGE SEGMENTATION

Image segmentation is to classify or cluster an image into several parts (regions) according to the feature of image, for example, the pixel value or the frequency response. For some applications, such as image recognition or compression, we cannot process the whole image directly for the reason that it is inefficient and unpractical. Therefore, several image segmentation algorithms were proposed to segment an image before recognition or compression.

B. *The following categories are used in Image segmentation*

- Threshold based segmentation
- Edge based segmentation
- Region based segmentation
- Clustering techniques
- Matching.

For various applications, there are suitable segmentation methods that can be applied. If the requirement is that the pixels of each cluster should be linked, then region-based segmentation algorithms. The edge-based segmentation method, especially watershed, has the over-segmentation problem, so the marker tool is used.

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. Each of the pixels in a regions are similar with respect to some characteristic or computed property, such as color, intensity, or texture.

II. Existing Methods

Segmentation methods vary depending on the image modality, application domain, method will be automatic or semi-automatic, and other specific factors.

While some of the methods uses pure intensity-based pattern recognition techniques such as thresholding followed by connected component analysis.some other methods apply explicit vessel models that extracts the vessel contour. Based on the image quality and the image artefact such as noises, some segmentation schemes may require image pre-processing prior to the segmentation algorithm.

On the other hand, some methods apply post-processing to overcome the problems arising from over segmentation.

A. DISADVANTAGES OF EXISTING SYSTEMS

- There is no single segmentation method which can extract vasculature from every image modality.

- Results in over segmentation

III. PROPOSED APPROACH

The algorithm introduced by Luc Vincent and Pierre Soille is based on the concept of "immersion"[2]. Each local minima of a gray-scale image I which can be regarded as a surface has a hole and the surface is immersed out into water. Then, starting from the minima of lowest intensity value, the water will progressively fill up different catchment basins of image (surface) I. Conceptually, the algorithm then builds a dam to avoid a situation that the water coming from two or more different local minima would be merged.

At the end of this immersion process, each local minimum is totally enclosed by dams corresponding to watersheds of image (surface)

The watershed transformation is performed on a gradient image g extracted from the original image However the problem with the conventional intensity gradient is it is not able to detect the interfaces between homogeneously textured image regions. This is because the gradient image highlights the variations within the textures rather than showing the change between textured regions.

A. PROCESS FLOW DIAGRAM

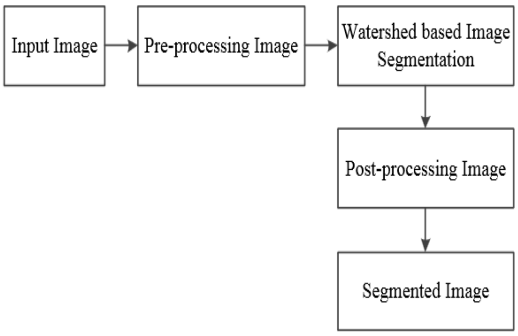

Fig 1.process flow diagram.

B. WATERSHED ALGORITHM

The watershed transform is a tool morphological based for image segmentation. It is proposed by Digabel and Lantuejoul which consider a grey level image as a topographic relief. If one combines the grey level of each point at an altitude. It is then possible to define the watershed transform as the ridge forming the boundary between Two watersheds. This is to compute the watershed of the said relief.

Watersheds thus obtained correspond to regions of the image. Watershed represents the boundaries between adjacent catchments. The minimum can be interpreted as markers of watershed regions and the watershed can be interpreted as contours, figure 1.

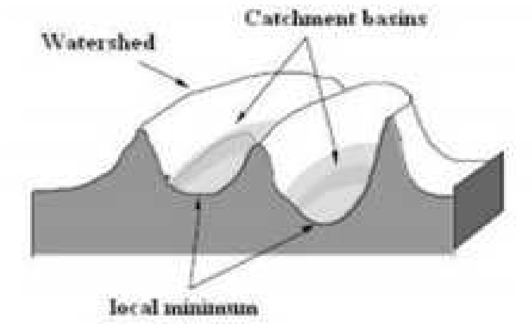

Fig 2.Process flow diagram

Many pre-processing techniques are proposed by the different researchers (filters, morphological operators) were then designed to reduce the number of regions not significant. Nevertheless, the work of Beucher demonstrated the limitations of these methods namely the over-segmentation.

C. MARKER CONTROLLED APPROACH

Direct application of watershed transform to a gradient image can result in over segmentation due to noise[3].Over segmentation means a large number of segmented regions. An approach used to control over segmentation is based on the concept of markers. A marker is a connected component belonging to an image. Markers are used to modify the gradient image.

Markers are of two types internal and external, internal for object and external for boundary. The marker-controlled watershed segmentation has been shown to be a robust and flexible method for segmentation of objects with closed contours, where the boundaries are expressed as ridges. Markers are placed inside an object of interest; internal markers associate with objects of interest, and external markers associate with the background[3].After segmentation, the boundaries of the watershed regions are arranged on the desired ridges, thus separating each object from its neighbors.

D. ADVANTAGES OF PROPOSED SYSTEM

The resulting boundaries form closed and connected regions. Traditional edge based techniques most often form disconnected boundaries that need post-processing to produce closed regions.

The boundaries of the resulting regions always correspond to contours which appear in the image as obvious contours of objects.

This is in contrast to split and merge methods where the first splitting is often a simple regular sectioning of the image leading sometimes to unstable results. The union of all the regions forms the entire image region

IV. System Architecture

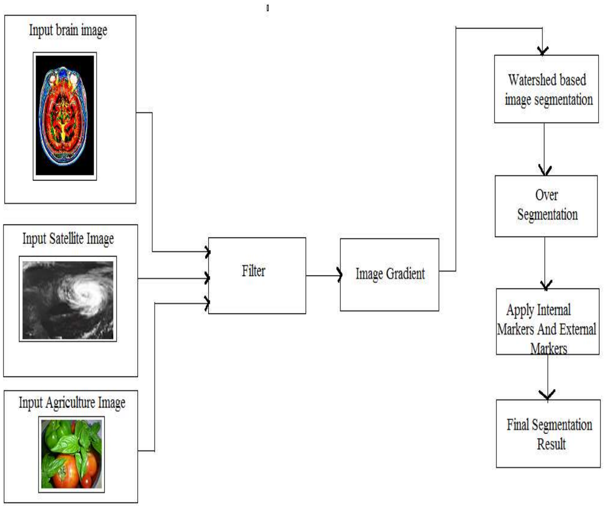

Fig 3. Implementation of marker controlled algorithm.

A. IMPLEMENTATIONS

The input unit consists of medical image, which is fed into the filter to reduce noise and distortion in an image. It is referred to be as pre-processing stage. There are various types of noises present in an image like salt and pepper noise, they are reduced by the pre-processing step by means of median filter.

The input units consists of RGB color image, it is converted into gray scale image and further changed to a gradient image An image gradient is a directional change in the intensity or color in an image.

B. WATERSHED METHOD AND MARKERS COMPUTATION

A watershed algorithm is applied to the gradient image. consider a grey level image as a topographic relief. A landscape is filled with water from the minimum point. Watersheds thus obtained correspond to regions of the image. Watershed represents the boundaries between adjacent catchments. thus the watershed segmentation leads to over segmentation[3](i.e.) they are divided into more number of regions.

Markers are of two types internal and external, internal for object and external for boundary. An internal marker is used to identify the internal objects in the image and external marker is to extract the boundaries. Markers are placed inside an object of interest; internal markers associate with objects of interest, and external markers associate with the background.Then,both the markers are computed together, A Final segmented image is obtained with high quality.

V. Image Quality Assessments

A. CONTRAST

Contrast can be simply explained as the difference between maximum and minimum pixel intensity in an image.

$$\sum_{i,j} (i,j)^\wedge 2p(i,j)$$

Where i and j are the maximum and minimum pixel values respectively.

B. CORRELATION

Correlation is an method that employs tracking and image registration techniques for accurate 2D and 3D measurements of changes in images.

$$\frac{\sum_{ij} (i-\mu i)(j-\mu j)p(i,j)}{\sigma i \sigma j}$$

(i-µi)- i value minus the mean of x
(i-µj)- j value minus the mean of y

C. ENERGY

Energy is defined that would capture the solution we desire and perform gradient descent to compute its lowest value, resulting in a solution for the image segmentation.

$$\sum_{i,j} p(i,j)^\wedge 2$$

P(i,j) is the vectors of i and j respectively.

D. HOMOGENEITY

A real-time segmentation of images requires features which are fast to calculate and a segmentation procedure which can classify pixels or regions with respect to the feature are referred to as homogeneity.

$$\sum_{i,j} \frac{p(i,j)}{1+(i+j)}$$

$\sum$ is the sigma(sum of elements)
i is the smallest element in the region,
j is the largest element in the region.
MSE (MEAN SQUARE ERROR)

An estimator measures the average of the squares of the errors. MSE is equivalent to minimizing the variance.

$$\frac{1}{MN}\sum_{y=1}^{M}\sum_{x=1}^{N}[I(x,y)-I'(x,y)]^\wedge 2$$

VI. Experimental Results

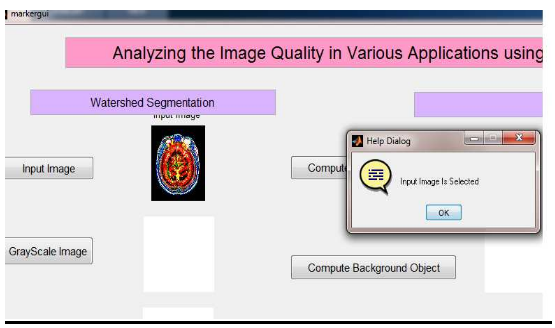

Fig 4. selection of an input image.

An input image(Medical image) is selected for pre-processing stages such as,filteration,conversion of RGB color image to gray scale image and image gradient.

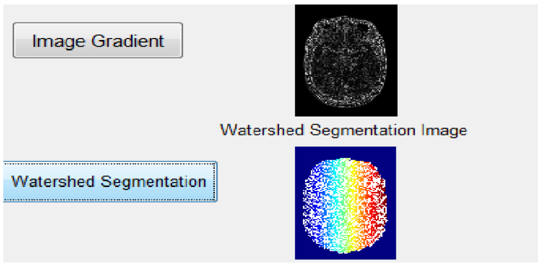

Fig 5 Implementation of watershed algorithm.

A Watershed algorithm is applied to the image gradient. thus, results in over segmentation.(i.e.) the objects being segmented from the background are themselves segmented or fractured into sub components).

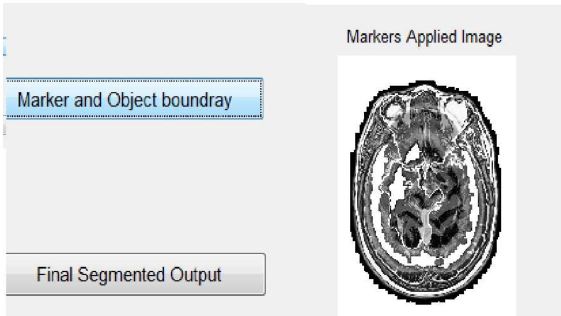

Fig 6. Markers computation.

An image is computed by internal and external markers. thus the image obtained after applying the markers gives the segmented image

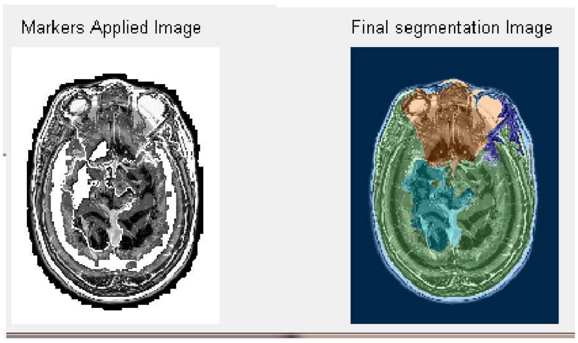

Fig 7. Resultant image.

A Final segmented image is obtained, which results in higher resolution with closed and connected boundaries.

TABLE 1:PERFORMANCE COMPARISON OF THRESHOLD APPROACH AND MARKER CONTROLLED METHOD

PARAMETERS	CONVENTIONAL APPROACH	PROPOSED APPROACH
CONTRAST	0.7234	0.1601
CORRELATION	0.9962	0.4287
ENERGY	0.2977	0.3601
HOMOGENEITY	0.8677	0.9906
MSE	1.6422	0.2461

VII. IMAGE RECOGNITION SYSTEM

A quality of a medical image is improved with various parameters which is highly useful for image compression, image recognition systems etc. The image obtained with higher resolution are further implemented with neural network algorithm in order to classify the types of tumors in Medical image and various types of diseases involved in agriculture image.

A. REASONS FOR NEURAL NETWOK ALGORITHM

- Inductive Reasoning. Given input and output data (training examples), we construct the rules.
- Computation is collective, asynchronous, and parallel.
- Memory is distributed, internalized, short term and content addressable.
- Fault tolerant, redundancy, and sharing of responsibilities.
- Applicable if rules are unknown or complicated, or if data are noisy or partial.

VIII. SYSTEM ARCHITECTURE

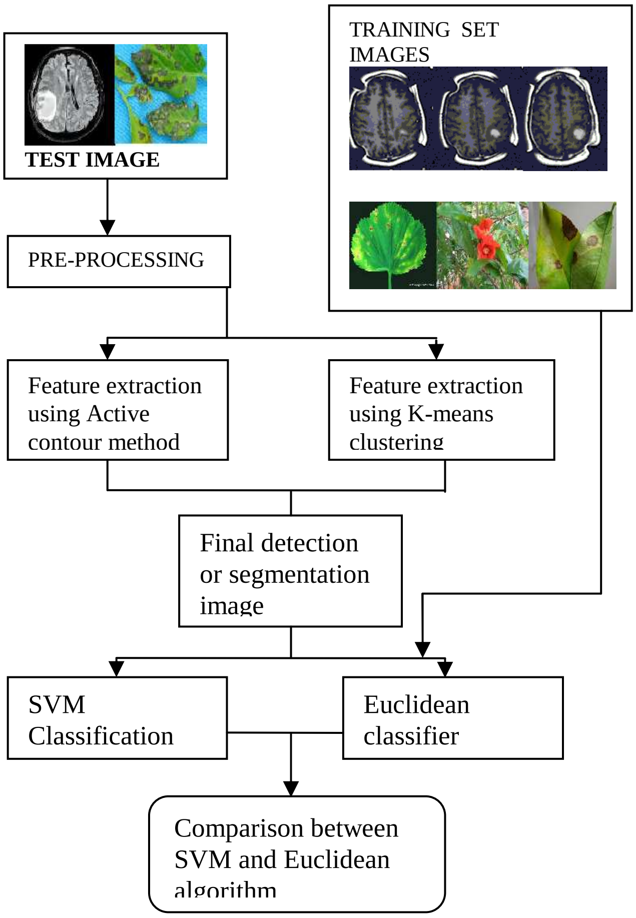

Fig 8.Image recognition using SVM and Euclidean classifiers

A. TEST IMAGE

An input image is fed into the preprocessing step called as Test image. Test images are brain tumor image and leaf image which is attacked by diseases. This test image is processed and classified by comparing with training set.

B. PRE-PROCESSING

An RGB color image, which is a brain tumor image is converted into grayscale image. Incase of agricultural applications, an input test image is enhanced for further feature extraction.

C. FEATURE EXTRACTION

1) Medical image analysis

The features of brain tumor image are extracted using ACM(Active contour model). Our goal is to recognize the tumor region on the brain image with proper description of their exact shape.

By having ACM the mostly likely boundary of extracted exudates region will be obtained. Detecting and locating curves corresponding to object boundaries in an image is vital in segmentation and using these boundary detectors to iteratively move towards their final solution is the underlying principle of Active Contours.

2) Agriculture image analysis

Plant diseases are one of the major factors which affect the quality and productivity of agricultural system. This degrades the life of plant. Agricultural production has a great influence on economy of farmers as well as whole country. Early diagnosis of the disease can lead to the proper treatment

In the process of disease management, detection of plant disease and its severity is challenging task. It depends on the image features selection and the accuracy with which diseased portion is segmented**.** K-means clustering is used to segment the diseased portion of the leaf.

IX. CLASSIFIERS

A. SVM

The Support Vector Machine (SVM) was first proposed by Vapnik and has since attracted a high degree of interest in the machine learning research community. Several recent studies have reported that the SVM, generally are capable of delivering higher performance in terms of classification accuracy than other data classification algorithms. SVM is a binary classifier based on supervised learning which gives better performance than other classifiers.

The support vector machine operates on two mathematical operations: (1) Nonlinear mapping of an input vector into a high-dimensional feature space that is hidden from both the input and output. (2) Construction of an optimal hyperplane for separating the features discovered.

SVM classifies between two classes by constructing a hyper plane in high-dimensional feature space which can be used for classification. Hyperplane can be represented by equation-

$$w.x+b=0$$

w is weight vector and normal to hyperplane. b is bias or threshold.

SVM has proven its efficiency over neural networks and RBF classifiers. Unlike neural networks, this model builds does not need hypothesizing number of neurons in the middle layer or defining the centre of Gaussian functions in RBF. SVM uses an optimum linear separating hyperplane to separate two set of data in a feature space. This optimum hyperplane is produced by maximizing minimum margin between the two sets. Therefore the resulting hyperplane will only be depended on border training patterns called support vectors.

B. EUCLIDEAN CLASSIFIER

Euclidian distance classifier is used for the binaryzation of the image to get the region of interest (ROI).Extracts most dissimilar components from expected ROI using maximum Euclidian distance with pre-defined threshold value. Based on the distance between two points, the affected region is identified with inaccuracy.

In the field of computer vision, the most commonly used distance is Euclidean distance, which converts images into vectors according to gray levels of each pixel, and then compares intensity differences pixel by pixel. Since Euclidean distance discards image structures, it cannot properly represent the real distance between images. If a small variation occurs in similar images, a large Euclidean distance between the images could arise.

An image with fixed size $M \times N$ can be written as a vector $x=\{x1,x2,...x\ MN\}$ according to gray levels of each pixel. The traditional Euclidean distance $dE(x1,\ x2)$ between vectorized images $x1$ and $x2$ is defined as,

$$d2E(x1, x2) = MN\ \_k=1(xk1 - xk2)2=(x1 - x2)T(x1 - x2)$$

For traditional Euclidean distance, the assumption that different dimensions xi and xj are perpendicular is made, and the relationship between pixels is discarded. As a result, Euclidean distance cannot reflect th real distance between images.

The image Euclidean distance (IMED) considers the spatial relationship between the pixels of different images and can easily be embedded in existing image recognition algorithms that are based on Euclidean distance. IMED uses the prior knowledge that pixels located near one another have little variance in gray scale values, and defines a metric matrix according to the spatial distance between pixels.

X. EXPERIMENTAL RESULTS

On comparing the SVM classifier to Euclidean classifier, SVM(Support vector machine) is more efficient and accurate which is highly useful for image recognition systems. The main advantages of SVM are,

- It works well with clear margin of separation
- It is effective in high dimensional spaces.
- It is effective in cases where number of dimensions is greater than the number of samples.

- It uses a subset of training points in the decision function (called support vectors), so it is also memory efficient.

TABLE-2 COMPARISON BETWEEN SVM AND EUCLIDEAN DISTANCE

Parameters	SVM	EUCLIDEAN CLASSIFIER
Accuracy	94%	85%
Efficiency	97.5%	93.7%

XI. CONCLUSION

The Marker Controlled Watershed algorithm has been implemented. Thus the resultant image obtained with high enhanced features is achieved through the parameters such as contrast, homogeneity, correlation, energy and mean square error.

This approach for segmentation of medical images, can help in the proper detection of the region of interest and also can be very helpful for doctor's diagnoses, medical teaching, learning and researches.

The image obtained with higher resolution are classified in the image recognition systems using SVM classifier which results in the high accuracy rate, The types of tumor in medical image and types of disease in agricultural image are classified accurately, helps in reducing the causes and effects in the earlier stages itself.

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