Novel based Color image segmentation and image de-noising techniques

Dhanalaksmi.L, Dr.H N Suresh

***Abstract*— Image segmentation is an important and challenging problem and a necessary first step in image analysis as well as in high-level image interpretation and understanding such as robot vision, object recognition, and medical imaging. The goal of image segmentation is to partition an image into a set of disjoint regions with uniform and homogeneous attributes such as intensity, colour, tone or texture, etc. Many different segmentation techniques have been developed. In order to solve the problems of image segmentation, many practical means have been advanced. These include fuzzy cluster method, thresholding method, region growing method, neural networks, water snakes, watershed segmentation and rough sets and so on. In order to get good performance of image segmentation there is a need of de noising and image enhancement techniques along with different image segmentation techniques. These includes wavelet and multi wavelet de-noising algorithms.**

KEYWORDS: ***Image segmentation, mixture models, impulse noise Clustering, color image preprocessing***

I ..INTRODUCTION:

Color image preprocessing and segmentation are classical examples of multichannel information processing. The primary challenges faced in the processing of color images are the variety and enormity of the color intensity gamut along with the processing of the spectral characteristics of the different color components therein. To be precise, the task of color image processing involves a vast amount of processing overhead since color intensity information is generally manifested in the form of admixtures of different color components. Moreover, the relative proportions of the component colors and their inter-correlations also exhibit nonlinear characteristics.

The main steps in digital image processing are (i) preprocessing, which is a data preparation step for contrast enhancement, noise reduction or filtering [1, 2], (ii) feature extraction, for retrieving non-redundant and significant information from an image. This operation is targeted at achieving time efficiency at the cost of data reduction [3, 4] followed by object detection, localization and recognition, which determine the position, location and orientation of objects [5]. A plethora of algorithms targeted at the aforementioned objectives, has been evolved from time to time. In general, the characteristics and efficiency of an algorithm is determined by the domain of input data to be processed. Typical input domains comprise pixels, local features, image edges, embedded objects, to name a few. The output domains invariably comprise homogeneous image segments, edges of detected/localized objects, regions/segments, and different objects differing in size, shape, color and textural information.

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Dhanalaksmi.L, Associate Professor,Bangalore Institute of Technology, Research scholor, Dept. Of ECE, Jain University, Bangalore, Karnataka, India. Ph.No;9980335265

Dr .H. N. Suresh, Professor, Bangalore Institute of Technology, Dept.of Instrumentation Technology,VVpuram, Bangalore–04, Karnataka Ph.No: 9980414212.

II. BRIEF LITERATURE SURVEY :

Mario et al. (2004) proposes a new approach to model-based clustering under prior knowledge. The proposed formulation can be interpreted from two different angles: as penalized logistic regression, where the class labels are only indirectly observed (via the probability density of each class); as finite mixture learning under a grouping prior. To estimate the parameters of the proposed model, EM algorithm with a closed-form E-step, in contrast with other recent approaches to semi-supervised probabilistic clustering which require Gibbs sampling or suboptimal shortcuts is proposed. They have introduced an approach to probabilistic semi supervised clustering which is particularly suited for image segmentation. Nikolaos Nasios et al. (2005) presents a variational Bayesian framework for image segmentation using color clustering. A Gaussian mixture model is used to represent color distribution. Variational expectation-maximization (VEM) algorithm takes into account the uncertainty in the parameter estimation ensuring a lower bound on the approximation error. In the variational Bayesian approach the distribution of parameters is integrated. The processing task in this case consists of estimating the hyperparameters of these distributions.

Zhuowen Tu et al. (2005) proposed a Bayesian framework for parsing images into their constituent visual patterns. The parsing algorithm optimizes the posterior probability and outputs a scene representation in a “parsing graph”, in a spirit similar to parsing sentences in speech and natural language. The algorithm constructs the parsing graph and reconfigures it dynamically using a set of reversible Markov chain jumps. This computational framework integrates two popular inference approaches – generative (top-down) methods and discriminative (bottom-up) methods. Mahinda P. Pathegama et al. (2005) shows that extraction of edge-end pixels is an important step for the edge linking process to achieve edge-based image segmentation. This paper presents an algorithm to extract edge-end pixels together with their directional sensitivities as an augmentation to the currently available mathematical models. The algorithm is implemented in the Java environment because of its inherent compatibility with web interfaces since its main use is envisaged to be for remote image analysis on a virtual instrumentation platform. A.NAKIB et al. (2007) proposed a microscopic image segmentation method with two-dimensional (2D) exponential entropy based on hybrid micro canonical annealing. The 2D maximum exponential entropy does not consider only the distribution of the gray level information but also takes advantage of the spatial information using the 2D-histogram. In this paper, they proposed a new approach to find optimal thresholds, based on hybrid micro canonical optimization. In the first phase the two dimensional histogram was constructed using spatial information, local average gray value, to choose optimal thresholds. In the second phase, a new extension of the one-dimensional exponential entropy to the two dimensional case and its generalization to multilevel segmentation were developed. In the third phase, micro canonical annealing (MA) is introduced to remove the stochastic feature of the solution. This approach allows for good microscopic image segmentation by using exponential two-dimensional entropy.

Tang et al. [15] proposed a multichannel edge enhancing filter (MEEF) based on the vector median for enhancing degraded edges in color images. In the proposed approach, an input multichannel signal is filtered with three sub-filters. The final output is determined by comparing the outputs of the sub-filters and their vector median. Plataniotis et al. [16] proposed an adaptive nearest neighbor multichannel filter to deal with the problem of noise attenuation for multichannel data. The filter utilizes adaptively determined data-dependent coefficients based on a novel distance measure involving both vector directional filtering with vector magnitude filtering. Other applications of multichannel filters for processing of color images can be found in the literature [17].

A completely different framework for chromatic filtering of color images was introduced by Lucchese et al. [18]. The approach is centered on encoding the chromatic and achromatic contents of a color image in different ways. The chromatic content is encoded in the CIE chromaticity coordinates. The achromatic content is encoded as a CIE tristimulus value. The colors in the chromatic part are added according to the well-known center of gravity law of additive color mixtures and filtered accordingly. The achromatic content is processed with traditional linear or nonlinear filtering schemes. A plethora of chromatic filters designed for the processing of noisy and noise-free color images exist in the literature [19, 20].But most of these approaches suffer from the need of an a priori knowledge regarding the noise distribution in the input images.

As regards to the segmentation of color images, Makrogiannis et al. [21, proposed a multiresolution image segmentation scheme based on a graph-theoretic approach. The technique employs a feature-based, inter-region dissimilarity relation between the adjacent regions of the images under consideration. Finally, the regions are grouped to achieve the desired segmented outputs. The grouping strategy however, is dependent on the chosen inter-region dissimilarity relation. Grady and Schwartz [23] treated image segmentation as a linear problem instead of the eigenvector approach to a graph-partitioning problem [24]. They achieved segmentation out of spectral partitions with a small isoperimetric constant. The choice of an isoperimetric indicator function obviates the requirements of any coordinate information about the graph. Hence, it results in partitions with optimal cardinalities. Comaniciu and Meer [25] employed the mean shift analysis (MS) algorithm in searching for the exact estimation of the color cluster centers in color space. Wenbing et al. [26] developed a robust real-time approach for color image segmentation using the MS segmentation and the normalized cut (Ncut) [24] partitioning methods. The method resorts to the Ncut method to optimize the images clustered by the MS algorithm. These methods however, suffer from the shortcomings in the heuristic choice of a threshold eigen value for attaining stable segments. Luo and Khoshgoftaar [27] applied the MS clustering method for designing an unsupervised multi scale color image segmentation algorithm. The resultant over segmented images are then merged based upon a minimum description length criterion.

Markov random field (MRF) models have often been used for modeling and analysis of the spatial dependencies between multispectral image data [28, 29] supported by the Expectation Maximization (EM) algorithm [30]. However, the computational complexity of these methods prevents their use in real-time applications. Several alternatives to the MRF models have been proposed to cut down the time complexity. Several statistical mixture models have been proposed to suitably estimate the structural distributions of image data. Examples include the Gaussian mixture and the Dirichlet mixture models .

III. DIFFERENT APPROACHES TO COLOR IMAGE PREPROCESSING AND SEGMENTATION:

On the contrary, other approaches, which include neuro-fuzzy-genetic and wavelet based approaches, operate on the underlying data regardless of the distributions and operating parameters. This section provides a bird's eye view on these types of approaches.

A. FUZZY CLUSTER METHOD

Fuzzy clustering is a process of assigning them membership levels and then using these levels to assign data elements to one or more clusters or classes in the image/data set. In fuzzy clustering data elements can belong to more than one cluster with a degree of some membership values.Area of applications of fuzzy cluster analysis includes data analysis, pattern recognition and image segmentation.Fuzzy clustering is often suited for classification of data in decision oriented applications. One of the most difficult tasks in image analysis and computer vision applications is to classify correctly the pixel values as there are no crisp boundaries between object in an image. For this difficult task fuzzy clustering techniques proving to be good research area.

The method of image segmentation using fuzzy clustering technique provides a mean to classify pixel values with a great extent of accuracy.The objective function based on fuzzy clustering algorithms includes fuzzy C-means (FCM), Gustafson-Kessel (GK), Gaussian Mixture Decomposition (GMD), Fuzzy C-Varieties (FCV) and so on. FCM is the most accepted means of image segmentation since it has robust characteristics for ambiguity and can preserve much more information than hard clustering approach.[1].On noisy images FCM does not incorporate special information which makes it sensitive to noise and other image artifacts.FCM cluster segment method is based on exclusively on the distribution of pixel intensity that makes it sensitive to intensity variation.To overcome the above drawbacks other methods based on FCM are implemented. [10]

B. THRESHOLDING METHOD

Threshold segmentation [9][12] is a parallel segmentation method, which tests regions directly to utilize intensity features of images.The method is used to the image composed of objects and backgrounds with peaks of intensity. The intensity of adjacent pixels is extremely related within an object or a background, while they are very different between object and background.The intensity value of an image is supposed to come from 0 to L. Some threshold values are supposed with $0= t_0<t_1<t_2\ldots\ldots<t_k=L$, which are compared with the intensity of all pixels of the image. The intervals are given with $\{(0,t_1),(t_1,t_2),\ldots\ldots(t_{k-1},L)$.Those pixels are put together if their intensity are values are in the same interval and those pixels are alternative if their intensity values are equal to the value of interval boundary. So the image is divided into several regions. For this the threshold is the key, so we must search some good thresholding algorithm.The algorithms are adaptive thresholding [13], thresholding for wavelets [17] and so on.

C.REGION GROWING

This approach is to examine neighboring pixels of initial seed points and determines whether the pixel neighbors should be added to the region. Region growing method can correctly separate the regions that have the same properties. The regions are grown from the seed points to adjacent points depending on a region membership criterion. A suitable threshold value for the region membership criterion is important, which affects the quality of segmentation.Region growing [19] is sensitive to noise which may result in holes or over segmentation and difficulty of manual threshold selection.

D.NEURAL NETWORKS

Image processing with neural networks generally falls into one of the following two categories; Image reconstruction and image restoration. The Hop field neural network is one of the most used neural networks for image reconstruction. The major advantage of using Hop field neural network is that image reconstruction can be taken as optimization problem, which is easily solved by letting the network converge to a stable state while minimizing the energy function. In the most basic image restoration approach, noise is removed from an image by filtering. Suzuki et al. developed neural network based filters (NFs) for this problem.The feed forward neural network is the most used neural network for image segmentation. Compared with the traditional maximum likelihood classifier (MLC) based image segmentation method, it has been observed that the feed forward neural networks based segmented images appear less noisy and is also less sensitive to the selection of the training sets than the MLC. These neural networks have a very slow convergence rate and require a priori learning parameters.

E. WATERSHED SEGMENTATION

The watershed algorithm is a classical and effective segmentation by which one pixel wide continuous edge can be extracted. The watershed transform can be classified as a reason based segmentation approach. The intuitive idea underlining this method comes from geography: It is that of a landscape or topographic relief which is flooded by water, Watersheds being the divide lines of the domain of attraction of rain falling over the region[2]. An alternative approach is to imagine the landscape being immersed in a lake, with holes pierced in local minima. Basins are catchment will fill up with water starting at these local minima, and at points where water crossing from different basins would meet, dams are built. When the water level has reached highest peak in the landscape the process is stopped. As a result, the landscape partitioned into regions or basins separated by dams called watershed lines or simply watersheds.[4][13].In image processing terms, the catchment basins are the image partitions that we target, while watersheds are the boundaries of the partitions.Advantage of the above method includes high segmentation, precision and accurate positioning and it is a fast, simple and intuitive method. Apart from this watershed transform can solve the problem of noise caused by various images.

Even though we have the above advantages which should be addressed. They include some drawbacks like over segmentation and noise in the edges of the images.Water snakes algorithms [7] are a method of minimal energy and which improves the accuracy and continuity of edge detection.

F. ROUGH SET THEORY

Rough set theory [3] proposed by Z. Pawlak in 1982, is an important tool to deal with uncertainty, imprecise and fuzzy information and has many successful applications in machine learning, data mining, artificial intelligence and other areas. The main idea of it is to get the decision rule from the attribute reduct and knowledge reduct without loss of knowledge. In rough set theory [18], knowledge is thought of as an ability to classify the objects. The classical theory is based on indiscernibility relation, and gets the ability in the set calculus by the lower approximation operator and upper one, which is also called the algebraic method of rough sets. Traditional rough set theory is defined in view of algebraic method, the universe is to be thought of set, and knowledge is the ability to create partition of the set.It is possible to improve the performance of image segmentation by introducing rough set along with different algorithms [3].

G. WAVELET AND MULTI-WAVELET TRANSFORM

Wavelet transform based on small waves, called wavelets of varying frequency and limited duration. There are two types of wavelet transform: Discrete wavelets transform (DWT) and continuous wavelet transform.Discrete wavelet transform: If the function being expanded in a sequence of numbers, like samples of continuous function f(x), the resulting co-efficient are called the discrete wavelet transform of f(x).Continuous wavelet transform: The natural extension of the discrete wavelet transforms is the continuous wavelet transform, which transforms a continuous function into a highly redundant function of two continuous variables.

Multi wavelet transform: It iterates on the low frequency components generated by first decomposition. After scalar decomposition the low frequency components have only one sub band, but after multi wavelet decomposition, the low frequency components have four small sub bands. Multi wavelet can satisfy both symmetry and asymmetry, it is very important characteristic for Digital Signal Processing (DSP).It produces a non-redundant image representation which provides better special and spectral localization of image information.

Recently, wavelets have become popular tools in various applications for data analysis and image processing. Applications of wavelets for de-noising of images as produced a large number of algorithms. Multi scale products thresholding which uses adjacent wavelet sub-bands to detach the edges from noise. Complex de-noising of images using wavelets, this produces better SNR compared to the above de-noising. Bilateral filtering in wavelet domain to preserve the edges efficiently.3-D extension of wavelet transform based on bilateral filtering for noise removal [8].DWT multiply ever scale by a weight factor and then reconstruct an image using the inverse DWT. But DWT is not translation invariant, meaning that a shift in the image origin leads to results inherently different to the transform applied to the original image. New methods for image de-noising and enhancement using the wavelet transform [3][24] which combines noise equalization, wavelet shrinkage and scale space constraints. But this gives poor quality with low PSNR. Multi wavelet [17] approach is flexible enough to allow the user to select the desired image enhancement and scale of analysis, it does not require the user to adjust any parameter for image de-noising.

IV. DIFFERENT TYPES OF NOISES:

A. IMPULSE NOISE FOR COLOUR IMAGE:

Impulse noise is a category of acoustic noise which includes unwanted, almost instantaneous sharp sounds. Noises of the kind are usually caused by electromagnetic interference, scratches on the recording disks, and ill synchronization in digital recording and communication. High levels of such a noise (200 + Decibels) may damage internal organs, while 180 Decibels are enough to destroy or damage human ears. An impulse noise filter can be used to enhance the quality of noisy signals, in order to achieve robustness in pattern recognition and adaptive control systems.

We are using the RGB color-space, the color of the image pixel at position is denoted as the vector which comprises its red (R), green (G), and blue (B) component, so . Let us consider the use of a sliding filter window of size , with and , which should be centered at the pixel under processing, denoted as . For a 3* 3 window, we will denote the neighboring pixels as to (i.e., from left to right and upper to lower corner). The color pixel under processing is always represented by First, we compute the absolute value differences between the central pixel and each color neighbor as follows: where and denote the value difference with the color at position in the R, G, and B component, respectively. Now, we want to check if these differences can be considered as small. Since small is a linguistic term, it can be represented as a fuzzy set . Fuzzy sets, in turn, can be represented by a membership function. In order to compute the membership degree in the fuzzy set small we have to know the desired behavior, i.e., if the difference is relatively small then we want to have a large membership degree (the membership degree should decrease slowly), but after a certain point, we want to decrease the membership degree faster for each larger difference. Therefore, we have chosen the 1-S membership Function over other possible functions.

B. GAUSSIAN NOISE:

A probability distribution describing random fluctuations in a continuous physical process; named after Karl Friedrich Gauss, an 18th century German physicist. The distribution describes such stochastic processes as the random voltage variations in a carbon resistor due to thermal motion, or the so-called Brown procession motion discovered by Robert Brown, the English botanist who in 1827 first studied the rapid and apparently random motions of minute particles in a gas as seen through a microscope. The formula for the distribution implies that large deviations from the mean become less probable according to exp(-x). It is also known as a de moiré or normal distribution. When an electrical variation obeys a Gaussian distribution, such as in the case of thermal motion cited above, it is called Gaussian noise, or random noise. Other examples occur with some types of radio tubes or semi-conductors where the noise may be amplified to produce a noise generator. Note that in all of these cases, it is only the signal's amplitude fluctuating randomly that results in its being classified as Gaussian noise. Its spectrum is not necessarily similar to that of white noise.

V. PROPOSED METHODOLOGY

In this work, with a view to the preprocessing, we propose a watershed segmentation algorithm in combination with the rough set algorithm [4] to solve the problem like high noise, over segmentation, under segmentation of low contrast images etc.

VI. CONCLUSION

A review of some of the popular algorithms for preprocessing/segmentation of color images is presented. Classical methods suitable for color image processing, ranging from filtering techniques to statistical models, are discussed. Recent techniques, which mainly use neural networks, fuzzy logic, genetic algorithms and wavelet decomposition procedures, are revisited. Representative examples of these approaches are highlighted. The review suggests that the performance of these methods depend among various factors on the data distribution, operating parameters and the operating environment. The article concludes with a note on the role of color quantization and thresholding in segmentation.

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First Author Dhanalaksmi.L : At present She is working as a Assistant Professor in the Dept. of ECE, Bangalore Institute of Technology, Bangalore Affiliated to Visveswaraya Technical University. She is good exposure in the field of signal processing, ,Image processing, etc. She got more 25 years of Teaching experience in various field. She is a member of IEEE, ISTE,IMAPS

Dr. H.N. Suresh received his BE (E&C) from P.E.S College of Engineering, Mysore University, Karnataka, India, in the year 1989 and completed his M.Tech (Bio Medical Instrumentation) from SJCE Mysore affiliated to University of Mysore., in the year of 1996 and since then he is actively involved in teaching and research and has Twenty six years of experience in teaching. He obtained his PhD (ECE) from Anna university of Technology.He worked at various capacities in affiliated University Engineering Colleges. For Visveswaraya Technical University and Bangalore University he worked as a Chairman for Board of Examiners, and member of Board of Studies etc. At present he is working as Professor in Bangalore Institute of Technology, Bangalore Affiliated to Visveswaraya Technical University. He has good exposure in the field of signal processing, Wavelet Transforms, Neural Networks,Pattern recognition,Bio Medical Signal Processing, Netwoking and Adaptive Neural network systems. He has published more 25 research papers in the refereed international journals and presented contributed research papers in refereed international and national conferences. He is a member of IEEE, Bio Medical Society of India, ISTE,IMAPS & Fellow member of IETE.