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DIGITAL IMAGE PROCESSING TECHNIQUES – A SURVEY

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ABSTRACT

Digital Image Processing (DIP) is the process of digital images using various computer algorithms. This digital image processing has been employed in number of areas such as pattern recognition, remote sensing, image-sharpening, colour and video processing and medical. This paper presents a brief overview and literature review of digital image processing techniques such as image pre-processing, image compression, edge detection and segmentation.

KEYWORDS :Digital image processing, Compression, Edge detection, Segmentation.

1. INTRODUCTION

The image processing is an analyzed and manipulation of a digitalized image, especially in order to improve the quality of image processing. DIP technique can be applied in variety of different fields such as Diagnostic image analysis, Surgical planning, Object detection and Matching, Background subtraction in video, Localization of tumours, Measuring tissue volumes, Locate objects in satellite images (roads, forests, etc.) ,Traffic control systems, Locating objects in face recognition, iris recognition, agricultural imaging, and medical imaging.DIP addresses challenges and issues like that loss of image quality, to enhance degraded image. In this paper the review of literature related to DIP is discussed. The major DIP techniques are pre-processing, image compression, edge detection and segmentation are discussed.

2. PRE-PROCESSING

Pre-processing of images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing or enhancing data images prior to computational processing.

Eapen, et al. [1] have proposed a method to enhance the edges and reduce the noise level in the input images before dealing with segmentation process. In the pre-processing module they included image resizing, histogram equalization, ROI selection (Image cropping) and median filtering. In this method, a global histogram equalization was used which was a perfect technique for contrast and texture enhancement of medical images.

In [2] Sivappriya, et al. proposed medical image edge detection. Medical images pre-processing is an important step in medical image segmentation and 3D reconstruction. Salt and pepper noise were more prevalent in medical images the conventional methods were not effective in filtering salt and pepper noise. Morphological erosion is the best filter for removing salt and pepper noise. The experimental results were more effective for medical image de-noising.

Puri, et al. presented a pre-processing technique to group pixels into “super pixels”. They would like to work with “super pixels” which were local, coherent, and which preserve most of the structure necessary for segmentation at the scale of interest. They applied the normalized cut algorithm to produce the super pixel map. Both contour and texture cues were used [3] in the method.

3. IMAGE COMPRESSION

Image compression is an application of data compression that encodes the original image with few bits. The objective of image compression is to reduce the redundancy of the image and to store or transmit data in an efficient form. The main goal is to reduce the storage quantity as much as possible, and the decoded image displayed in the monitor can be similar to the original image as much as can be.

Afifi et al. [4] proposed a system to maintain the quality of image after the image compression process using Wavelet Algorithm. In their work, JPEG and PNG image was used. It was noted that for JPEG image, the size is reduced almost half of original image by using Haar wavelet algorithm, because, JPEG image used lossy compression type, it still maintain the quality and information of the image.

Raju, et al. [5] proposed a solution that enhances the image quality. The enhanced image was then segmented using a modified watershed algorithm that uses mean-shift clustering. The enhancement technique proposed a hybrid version that combined wavelets, improved anisotropic diffusion and CLAHE to improve the input satellite image. Three algorithms were used during segmentation. They were conventional mean-shift algorithm, clustering based k-means algorithm and modified watershed algorithm. Various experiments proved that modified watershed algorithm produced better segmentation results when compared with other two algorithms. The proposed watershed algorithm, taken care of the over segmentation process efficiently, but the under segmentation process was not considered.

In medical, image compression using integer multi wavelets transform for telemedicine applications Praveenkumar, et al. [25] have suggested an efficient compression and encoding performance based on Integer multi wavelet transform of medical application. The proposed algorithm resulted in better quality images. The work focused on the implementation of lossless image data. They proposed multiwavelet based compression for this problem, which had been shown to have much better coding efficiency and less computational complexity than existing approaches. The success of high PSNR was due to improvement of the compression ratio.

Sukanya, et al. [6] discussed about compression methods such as JPEG 2000, Embedded Zero

Tree (EZW), Set Partition in Hierarchical Trees (SPIHT) and Highly Scalable SPIHT (HS-SPIHT) on the basis of processing time, error comparison, mean square error, peak signal to noise ratio and compression ratio. But to scale the image more so as to get better compression they were using the line-based Wavelet transform because it requires lower memory without affecting the result of Wavelet transform. The author's proposed a highly scalable image compression scheme based on the Set Partitioning in Hierarchical Trees (SPIHT) algorithm called HS_SPIHT. They proposed HS-SPIHT algorithm which gives us better scalability and reduced bit stream i.e. size of image is reduced well and it also gives better compression ratio. Finally they got reduced bit stream and better scalability.

4. EDGE DETECTION

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities.

In [7] Saif, et al. presented two techniques of segmentation algorithms such as Canny edge detection and Otsu thresholding. The effectiveness of the proposed algorithms was evaluated for medical and non medical images. For non medical images two algorithms returned in good segmented images. Canny segmentation is more suitable than Otsu to the tested endoscopic images because there is no clear distinction of the objects from the backgrounds and for MRI grey scale image.

Image segmentation based on watershed and edge detection techniques, Salman, et al.[8] have proposed a combination of K-means, watershed segmentation method, and Difference In Strength (DIS) map to perform image segmentation and edge detection tasks. They have used two techniques; in the first watershed technique with new merging procedures based on mean intensity value is used to segment the image regions and to detect their boundaries. The second technique was the edge strength technique to obtain accurate edge maps of our images without using watershed method. They solved the problem of undesirable over segmentation results produced by the watershed algorithm, when used directly with raw data images. Also, the edge maps they obtained have no broken lines on entire image and the final edge detection result was one closed boundary per actual region in the image.

Karantzalos, et al. [9] brought together two advanced nonlinear scale space representations, anisotropic diffusion filtering and morphological levellings, forming a processing scheme by their combination. The proposed scheme was applied to edge detection and watershed segmentation tasks. Experimental results on automatic olive tree extraction and watershed segmentation showed its effectiveness as a pre-processing tool for edge detection and segmentation from remote sensing images. Their interest has focused on panchromatic high spatial resolution satellite sensor data processing but the developed scheme can also be applied to color and multidimensional image data by processing each channel separately.

Alamri, et al.[10] presented methods for edge segmentation of satellite images, they used seven techniques for this category, Sobel operator technique, Prewitt technique, Kiresh technique, Laplacian technique, Canny technique, Roberts technique and Edge Maximization Technique (EMT) and they were compared with one another so as to choose the best technique. Experiments are carried out for different techniques Kiresh, EMT and Perwitt techniques respectively and are the best techniques for edge detection.

In Enhanced Watershed Image Processing Segmentation Shahzad, et al. proposed a system to enhance the watershed method. The image was converted into grayscale then canny edge detector was applied and after some enhancement processing finally watershed was applied. The evaluation of the segmentation was done by comparing the each object in true segmentation with the object in

marker-controlled watershed segmentation or proposed method. The proposed method enhances the result of marker-controlled watershed [11].

Ramadevi, et al. [12] discussed interaction between image segmentation (using different edge detection methods) and object recognition. Edge detection methods such as Sobel, Prewitt, Roberts, Canny, Laplacian of Guassian (LoG) are used for segmenting the image. Expectation-Maximization (EM) algorithm, OTSU thresholding and Genetic algorithms were used to demonstrate the synergy between the segmented images and object recognition. Expectation-Maximization algorithm and OTSU algorithm exhibited stable segmentation effect.

In [13] Nagabhushana Rao, et al. discussed number of image segmentation techniques that can be applied to the security systems. Edge detection is the most common approach for detecting meaningful discontinuities in gray level. The comparative analysis of various image edge detection techniques was presented on finger print images. Evaluation of the images showed that Prewitt, Sobel and Laplacian exhibits better performance, respectively.

Quality Evaluation for Edge Detection of Choromosome G-band Images for Segmentation method was proposed by Wayalun, et al. [14] in which an edge detection of chromosome in G-band type image. It is an important preprocessing step in segmentation. A chromosome type G-band image has very noise and poor image quality. A lot of edge caused by chromosome can easily mislead the edge detection algorithm. This paper presented analysis of evaluation chromosome G-band image edge detection. It has been appeared 4 different techniques, i.e. Canny, Laplacain, Robert's, and Sobel, on chromosome image type G-band. The results of their study indicate that the Robert's method obtains the highest accuracy and compared with the other three algorithms.

5. WATERSHED SEGMENTATION

A watershed transformation algorithm presented by Belaid, et al. [24] presented in which a new method was proposed for image segmentation using mathematical morphology. The approach was based on the watershed transformation. In order to avoid an over segmentation, they proposed to adapt the topological gradient method. The watershed transformation combined with a fast algorithm based on the topological gradient approach gives good results.

Robust Watershed Segmentation of Noisy Image using Wavelet was addressed by Dey, et al. [23] in which a very effective technique called wavelet thresholding for de-noising. The soft thresholding method was used to analyze the methods of the de-noising system for different levels of DWT decomposition because of its better performance than other de-noising methods. This paper shows that using soft threshold wavelet on the region based Watershed Segmentation on noisy image gives a very effective result.

Thenmozhi, et al. [22] proposed fast watershed transform that detects salient objects in an image. This transformation was entirely different from traditional watershed as it didn't depend on mathematical morphology. It started with sorting image pixel according to their intensity levels and stores them in their corresponding FIFO structure. This method was implemented using chain code algorithm. In addition it was faster than any other watershed algorithm. Integrating this fast watershed with energy based segmentation leads to a new segmentation method called fast water snakes. It reduced the over segmentation and under segmentation due to thick watershed lines, without the need of markers.

Acharjya, et al. [19] proposed a very useful image segmentation method for finger prints segmentation by taking the idea from friction ridges of human finger and also with an effective storage capacity for the segmented images. Watershed algorithm depends on ridges to perform a proper

segmentation, a property that is often fulfilled in contour detection where the boundaries of the objects were expressed as ridges. The concept of watershed algorithm was used for segmentation purpose. The sizes of the databases were a major concerned issue. Thereby, they had stored the segmented images of fingerprints instead of the original images to reduce the size of the databases.

Siddiqui, et al. [21] proposed an algorithm based on merging morphological watershed result with enhanced edge detection result. As a post processing step, to each of the segmented regions obtained, color histogram algorithm was applied, enhanced the overall performance of the watershed algorithm. The proposed method enhanced the result of marker-controlled watershed for degraded images.

Acharjya, et al. [20] discussed a new approach of watershed algorithm using distance transform was applied to image segmentation. After applying watershed algorithm they got an over-segmented image. The watershed algorithm with Laplacian of Gaussian (LoG) edge detector was used to detect the edges of the image and produce an image which was less over-segmented.

Tulsani, et al. [18] presented an approach for counting different blood cells during blood smear test. The approach presented was based on segmentation using morphological watershed transformation. Morphological operations were used for creating masks and marker-based watershed transform was used for segmentation of cells. The masks for each type of cell can be efficiently obtained using color conversion and morphological operators. Marker based segmentation solved the problem of over segmentation associated with watershed transform.

Acharjya, et al. [15] presented an effective approach of digital image segmentation with watershed algorithm for reducing over segmentation problem. A gaussian 7x7 mask was used for the smoothing purpose. Watershed algorithm has applied to generate the final segmented image. It can be observed from the final resultant or segmented images that the technique of reducing the over segmentation has been accomplished.

Vijayran, et al. [16] presented a hybrid approach to perform the image segmentation. The approaches covered were morphological operators, watershed algorithm and the adaptive threshold approach. The basic segmentation approaches were defined as well as a new hybrid was presented to perform the effective segmentation. The focus was on one of important image feature called thinning. The thinning process is about to identify the internal image processing and the feature extraction at the lower level. The approaches included in this work were median filter for the pre-processing, watershed and morphological operators for the edge detection and region identification, region selection and distance measure for the feature point identification and the threshold for the area exclusion. The obtained results showed the effectiveness of the segmented area over the image.

Acharjya, et al. [17] presented a new approach of image segmentation and edge detection. The watershed algorithm was used with twelve new and proposed arbitrary structuring elements and morphological smoothing operation to reduce the over segmentation problem. The basic philosophy of using the structuring element in mathematical morphological operation lies in the fact that it serve as a seed or needle to collect the image information. The statistical analysis were shown and as per visual perception analysis the segmented images with proposed approach yields better accuracy in detection of edges and the over segmentation problem also reduced.

CONCLUSION

Digital image processing deals with manipulation of digital images through a digital computer. In this paper various types of DIP technique presented in the literature are discussed and analyzed. The DIP technique using image compression, edge detection and segmentation provides better

compression ratio and accuracy of an image.

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