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Salient Methods of Image Processing: A Fundamental Survey

Mrs. Umamaheswari. D[1] and Dr. E. Karthikeyan[2]
[1]Asst. Professor, U.G. Department of Computer Applications, N.G.M College, Pollachi
[2]Head, Dept of Computer Science, Govt. Arts College, Udumalpet

ABSTRACT: In the field of Information Technology due to the advancement of techniques, the amount of data being gathered is increasing day by day. The technique to analyse these data is known as data mining. Finding out the missing data in the images is really an important problem. Inorder to find out the missing data, the image taken as input should be denoised and enhanced. So that the processed image should be segmented to smaller pieces to find out the meaningful insights about the objects and finally the patterns present in the image are recognised and checked with the matching data sets in order to find out the missing data.

Keywords: Image denoising, Image enhancement, Image segmentation, Pattern matching.

I. INTRODUCTION

Generally the digital images produced through cameras and scanners are definitely affected by noise blur, contrast and low colour balance. The quality of image is examined thoroughly so that the expected result will be obtained. Denoising an image will make the image noise free and clean. After that image enhancement is applied to minimize the degraded effects. The enhanced image will be of good quality and better contrast. The image enhancement process brings out the hidden details and the output image of this process will be more applicable for the expected purposes. Then the image should be segmented and Image segmentation is used to divide the processed image into several pieces which provides essential information. Data analysis tool is used to discover previously unknown, valid patterns. The frequent pattern mining algorithms determine the frequent patterns from an image. So that the patterns are compared and matched in order to find the missing data present in an image.

II. LITERATURE SURVEY

Nowadays remote sensing and medical sensing are the most important image based practical applications. The images play a vital role in medical field, so the concentration is laid on image processing. Mostly the images captured by modern cameras are corrupted by noise. This paper introduces an excellent method based on Generalised Cauchy (GC) distribution. Particle Swam Optimization algorithm selects the filter parameters according to the noise level in order to remove the noise. The proposed algorithm achieves the maximum Peak Signal to Noise Ratio value and it preserves the edge and image details [5]. The main advantage of this method is that it can be implemented easily.

The quality of image and accurate results are the most important effects regarding image processing in the field of biometric identification and authentication systems. In day-to-day life biometric systems are playing an important role in the security. Noise free images provide good quality of the finger prints. Because a fetus fingerprints are fully developed at the age of seven months and it will not change throughout the lifetime. Sometimes the injury, disease or decomposition after death may cause alteration. However the pattern will grow back after the injury heals [11]. Different filtering techniques such as Average filtering, Median filtering and Adaptive Wiener filtering were applied to clear the noise and the performance was compared using a statistical approach called the correlation value.

The image quality is examined thoroughly during the lung disease processes like diagnostic, prognostic and follow-up. Due to heavy death rate, the lung cancer should be identified at an early stage. Each and every image contains noise. Hence removal of noise should be the primary objective in medical image processing. Many minor details are hidden by the noise and outliers present in the medical images. That's why removal of noise in an image plays a significant role in the image analysis. Filters are tools that are used for removing noise from an image. This paper provides the different types of noise that are present in the images and also the methods for obtaining clear images and noise removal methodologies are discussed thoroughly [13].

Definitely noise can affect quality of digital images. Sometimes filtration compromises the level of details.

In order to quantify noise level Signal-to-Noise Ratio (SNR) is checked. The higher the SNR value, better the quality of the filtered image. Noise in medical images manifests itself as single pixels brighter or much darker than the neighbourhood. So that the erroneous pixels

can be considered as local extremes of image intensity. Particular attention is paid to random noise in the author's paper. The various analysis of the received results conclude that the selected number of iterations improve signal-to-noise ratio. The proposed method in the author's paper can be very much useful in the case of noisy medical images presenting different details [2]. It can be applied successfully in all image processing and image enhancement process.

Ophthalmologists have used several techniques for early detection of disease. Optical Coherence Tomography (OCT) is one such technique that provides high resolution images. But OCT images contain speckle noise. In daily life, OCT technique is widely used by ophthalmologists to diagnose the various diseases like Glaucoma, Macular Edema etc. Speckle noise is also a special type of noise which carries information about the image, acting as a major degrading factor of an image. It is proved that the noise will be an obstacle in biomedical image for diagnosis of different diseases. This paper shows that wavelet denoising filter provides good results on all OCT images. Bilateral filter is considered to be worst and wavelet filter is considered the best for removal of speckle noise [4].

Inorder to obtain accurate structure for random vibration signals, removing the interference factors and noise components from the collected vibration signals are expected. Sometimes in research, the original or true vibration signal is not applied, instead tested signal is applied. But it tends to produce errors and wrong conclusions. By comparing the wavelet, Infinite Impulse Response numeric filter and singular entropy, the SNR value of singular entropy is the highest. The determination of order to denoise by singular spectrum is more reasonable [10]. It is very important to extract the accurate signal feature and reliable analysis.

Image processing is, taking an image as input and providing the processed image as output. The digital images produced through cameras and scanners are definitely affected by noise, blur, contrast and improper colour balance. Automatically the quality of these images will be low. Inorder to minimize the degraded effects, image enhancement is applied. The high frequency content images are produced using Discrete Wavelet Transform techniques. The performance enhancement for very dark images can be retrieved using adaptive DWT based Dynamic Stochastic Resonance (DSR) technique. The result of this technique provides better enhancement for very dark images [18]. Internoise is used to improve the performance and provides less computational complexity.

The main aim of image enhancement is used to provide good image quality for better visualization. Improvement of interpretability or perception of information in images is done by image enhancement. It is used to remove noise, enhance dark image and highlight the edges in an image. So the enhanced image is more suitable for various applications. The image contrast algorithms include gray scale manipulation, filtering and Histogram Equalization (HE) [17]. The image enhancement methods bring out hidden details in an input image and increase the contrast in a low contrast image. The major working of human brain is involved in processing and analysing images.

Image enhancement provides various methods to process the input image and supplies the output image. The output image provided by the image enhancement methods is more applicable than the original image. Image enhancement is applied in various fields where analysed images are used. This paper proposed a genetic algorithm related enhancement method. Contrast enhancement plays an important role in image processing. Histogram Equalization is an important method for image contrast enhancement. But sometimes it produces an un-natural looking images. Inorder to overcome this problem, the author's paper proposes a solution with contrast enhancement method based on genetic algorithm which provides natural looking images [8].

The processing of more useful images and improving the quality of images are done by image enhancement. Based on the original input image, Histogram Equalization helps to display the enhanced output images. HE is mainly used in the field of contrast enhancement. This paper presents an algorithm which focuses on utilization of Histogram Equalization. It also proposes a new binary preserved Histogram Equalization. This proposed algorithm reduces the complexity [20]. It also proves that HE enhances the contrast and preserves the image with proper brightness.

Image enhancement delivers clear image for edge detection, segmentation and other image processing steps. Image fusion provides better results for multi resolution images. Image fusion provides fused images with most of the information from the input images by combining relevant information from the same input images. This paper discusses the implementation of various fusion algorithms by using metric measures such as Average Difference, Normalized Mean Square Error and Peak Signal to Noise Ratio [19]. The image fusion methods provide better results than the other general image enhancement methods. Image segmentation being one of the significant steps that leads to the study of processed image data, this paper presents a study of problems being encountered and the issues regarding segmentation. The aim of image segmentation is domain independent partitioning of an image into a set of disjoint region that are visually not same. The authors investigate and then discuss the different popular segmentation techniques [12]. With this analysis, the author's paper concludes that, which segmentation suits for which application domain. But

no single algorithm serves all types of images and provides good performance.

Segmenting an entire image into several pieces which is more meaningful and rejoined will cover the entire image. This paper delivers an outline on most common segmentation techniques and exposes thresholding as the simplest technique for segmentation. The threshold value is retrieved from the edge detected image. So the edge detections are accurate, then automatically, the threshold too. Whenever the gradient is high, the gray level points are then added to threshold surface for segmentation. Hence because of this drawback, this technique is not applied to complex images. The authors summarize the various segmentation techniques and comparing to other methods, found that thresholding is the simplest one and computationally fast [21].

Image segmentation is an important step which provides essential information such as relative size, shape and orientation of blood vessels. This paper projects the increasing number of attempts at venipuncture due to the difficulty in vein localization. The authors proposed an algorithm to emphasize the features of contextually related regions including vessel size and shape. The number of local extrema is decreased and single global minimum for each vessel is obtained by the Conditional Rule Generation (CRG) method [23]. Also this CRG algorithm will be a potential method to extract vessel information for automated venipuncture systems.

By classifying image patches at different resolutions and pooling multi-channel feature information at segments, hierarchical cascade of information propagation is generated. This paper proposes a fully automated bottom-up approach for pancreas segmentation in abdominal Computed Tomography (CT) scans [1]. By using efficient supervised edge learning techniques, the strength of semantic object level boundary curves may be utilized artificially and low image boundary contrast issue in super pixel generation present in medical imaging could be solved.

This paper presents polar dynamic programming to outline complex shapes [6]. The size of the object for correct boundary delineation need not be constrained with the introduction of polar variance image. The already available implementation of polar dynamic programming cannot accomplish this task. The algorithm presented by the authors' segment high curvature objects along with low-gradient objects.

The deep Convolutional Neural Networks (CNN) based depth estimation methods are used in this paper and expose the performance of object detection and semantic segmentation can be improved by adding an explicit depth estimation process. The authors combined the task of depth estimation with object detection and semantic segmentation and propose two ways of exploiting depth information [22]. The depths from RGB image are separately estimated and adding them as a cue for detection improves the performation of the segmentation. It is proved that the performance can be improved by exploiting related data which does not share the same set of labels.

Information retrieval is the process of extracting required data from the database based on the input from the user. The algorithm which is used for this purpose is known as pattern matching algorithm. The main aim of this paper is information retrieval from desktop using string matching algorithm. Various pattern inputs such as single word, multiple word or file are used to check the accuracy of this algorithm. The authors conclude that the enhanced Knuth-Morris-Pratt (KMP) algorithm gives better accuracy than the already existing algorithms based on performance measures [9].

The main rule of data mining is to retrieve meaningful pattern from huge volume of data. In order to achieve this, finding out frequent patterns from a database is very essential. The main aim of this paper is to compare the performance of many such algorithms and evaluate them. The authors have improved the already existing Apriori algorithm with effective hash-based algorithm for the candidate item set generation which is more effective than Apriori algorithm [16].

Upon using various inputs such as noisy/denoised samples, the pattern matching algorithm performs much better than the training based in a significant manner. A comparative study of three different categories of recognition algorithms, the bootstrap aggregating tree classifiers and median filtering for high intensity noise gives the high performance. The main difference between holes filling and missing data is that the depth values are available for hole whereas they are not available for missing data [14]. Missing data generally occurs with 3D imaging system because of the reasons like self-occlusion which appears after post correction, large depth variation or imaging device inaccuracy.

Various problems arising due to more complicated patterns like trees, regular expressions, graphs, arrays and point sets use the algorithm of combinatorial pattern matching. A pattern algorithm plays an important role in finding the appropriate content in minimum time. The best algorithm can be found by applying various algorithms in various applications. This paper concludes that the KMP algorithm has less time complexity and Boyer Moore (BM) algorithm and Boyer Moore Horspool (BMH) algorithm has less processing time complexity [15]. A comparative study of the string matching algorithm has been done based on the execution time of the algorithms. In this paper, the authors researched about the efficiency of different matching algorithms. This paper concludes that, the fastest and easy to implement algorithm is BMH algorithm whereas Rabin Karp (RK) algorithm is the slowest when increasing pattern length

and pattern placement [7]. Whenever pattern is placed at the end of the target, KMP algorithm can be applied. One of the most important applications in Bioinformatics is Deoxyribo Nucleic Acid (DNA) sequence detection. The mechanism which helps to find out the exact location of a specified pattern is pattern matching. To get the expected result at the cost of sufficient time, well established pattern matching algorithm is needed.

Maximum usage of sequence information is applied in Bioinformatics analysis. The algorithm specified in this paper looks for the specified pattern in a DNA sequence and produces the expected result [3].

III. COMPARISON OF VARIOUS IMAGE PROCESSING TECHNIQUES

Table 1: Comparison of Various Image Processing Techniques.

Image Processing Methods	Author and Year	Technique / Algorithm	Applications / Advantages
Image Denoising	Azam Karami (2017)	Denoising algorithm	Achieves the maximum PSNR and preserves the edges.
	K.Kanagalakshmi (2011)	Comparative evaluation of Adaptive Filtering, Median Filtering and Adaptive Wiener Filtering	Median filtering is the best with less computational time.
	Madhura.J (2017)	Noise removal methodologies	Median filter is used for reducing impulse noise.
	Anna Fabijanska (2007)	Noise reduction algorithm	Useful in case of noisy images presenting different details
	Asim Altaf shah (2016)	PSNR and MSE	Wavelet denoising filter performed well on OCT images
	Jianwei Zhang (2010)	Singular entropy technique	Essential to extract the accurate signal feature.
Image Enhancement	Rajlaxmi Chouhan (2012)	Adaptive DWT technique	Provide better enhancement for very dark images.
	Sukhjinder Singh (2012)	Image contrast algorithms	Brings out the hidden details in an input image.
	Hashem.S (2010)	Contrast enhancement based on Genetic Algorithm	Provides natural looking images.
	Yeong-Taeg Kim (1997)	Histogram Equalization	Enhances the contrast and preserves the image with proper brightness.
	Swati Khidse (2014)	Image fusion methods and DWT Technique	DWT based fusion techniques provide good quality fused images.
Image Segmentation	Karthick.S (2014)	Region merging algorithm	This algorithm is very constant with respect to noise.
	Yogamangalam.R (2013)	Markov Random Field	MRF is the strongest method of noise cancellation and thresholding is the simplest technique for segmentation.
	Yuhe Li (2017)	Vessel segmentation and Vein localization	The CRG model decreases the number of local extrema and obtains a single global minimum for each vessel.
	Amal Farag (2016)	Pancreas segmentation in abdominal computed tomography	Enhances the strength of semantic object level boundary in 2D or surfaces in 3D.
	Christos G.Bampis (2016)	Polar dynamic programming	Segments high curvature objects.
	Yuanzhouhan Cao (2016)	Object detection and semantic segmentation	Improves the performance by exploiting the related data.
Pattern Recognition and Matching	Janani.R (2016)	Enhanced KMP algorithm	Gives better accuracy.
	Paresh Tanna (2013)	Pattern mining algorithms	Efficient for two phase transaction database pruning.
	Mhryar Emambaksh (2015)	Recognition algorithms	Significantly outperform the training-based methods.
	Nimisha Singla (2012)	String matching algorithms	KMP algorithm has less time complexity.
	DU Vidanagama (2015)	String matching algorithms	KMP algorithm serves faster.
	Ashish Prosad Gope (2014)	Novel pattern matching algorithm	DNA sequence detection.

IV. CONCLUSION

In the survey of the various methods applied and compared with input images, wavelet filter serves its purpose and clears the noise. Also the methods applied in image enhancement, Histogram Equalization helps the image in adapting medical purposes. CRG algorithm used in image segmentation helps the images to localize the search. In pattern matching, KMP algorithm fine tunes the process and provides the best result. After applying all these methods in images, the missing data in images will be found accurately.

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