A Review on the Application of DigitalImage Processing in Various Fields

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Abstract – **Digital Image Processing (DIP) is used in many areas and the recent development and needs in technology should be supported by providing new and advanced techniques in digital image processing. Feature extraction and pattern extraction are major areas in digital image processing. Apart from this, there is also the need for processing images in fields such as medical and forensic analysis. Recognition of characters is also an important feature of the digital image processing. This paper provides an overview of digital image processing and a review on various fields where digital image processing is used. Many digital image processing features are discussed along with the techniques used for implementing them in various research fields in recent times. The review will help the reader to identify the purpose and use of digital image processing in various fields that are discussed in this paper.**

Keywords – Digital Image processing, Forensic using Images, Image Processing, Medical Image Processing, Security in Image Processing

I. INTRODUCTION

The concept of imaging has been developed in recent time after advancement in the field of technology. The images are converted into digital format for them to be stored in memory such as the hard disk or CDs. The representation of an image in 2D format that is composed for a number of digital elements called as the pixels is named as a Digital image. The process of digitization of an image is done by using a camera or a scanner. In recent time this is also available in mobile phone where the camera is embedded. After the digitization, the images can be converted to any image formats such as the TIF, JPEG, PNG, etc depending on the needs. The image can be processed only if it is available in digital format. The two main purposes of digital image processing are:

- Enhancing the digital image to make it look better and make it easy for the human eye to understand the
  details and features within the image.
- Processing the image to reduce its storage space by keeping its quality and for transformation of images from one system to other and with good security.

Based on these two purposes, different applications of digital image processing are considered in this paper and a review was made on each of the techniques or methods used in each of the fields. The concept of digital image processing and the various techniques used within are explained first before moving to the

applications of them. The various fields considered in this paper for review are as below:

- Distributed Image Processing
- Security in Image Processing
- Image processing in Document Forensic
- Medical Image Processing using Neural Networks

II. STATE OF ART REVIEW

A. Digital Image Processing

Digital image processing is the process of implementing image processing technique such as formatting and correction of data pixels. The visual interpretation of the image is enhanced by using digital enhancement techniques in images. Many different techniques are available for digital image processing such as:

- Preprocessing
- Image Enhancement
- Image Transformation
- Image Classification and Analysis

Image Enhancement

The process of changing one or more components within the image to enhance the clarity and the details of the image is called as image enhancement. Many image enhancement techniques are available that are used to enhance the image quality without affecting or damaging the image. Some of these include the following as given in [1]:

- Contrast enhancement
- Hue, Intensity, and Saturation transformations
- Edge enhancement
- Gray level slicing

The main objective of image enhancement is to enhance certain portions of the image to make it more understandable for the required needs. Some example of this includes the stretching of contrast of the image to differentiate between the various parts of the images such as the spatial patterns as explained in [1]. The various image enhancement techniques are discussed below.

Contrast enhancement is a ratio that is used to resolve the digital images. The power and capability of the image depends on its contrast. Methods used to enhance the contrast of a

digital image are the most popular in image processing. The brightness of the computer screen or the screen where the image is displayed is used for enhancing the image more suitable for that screen using the contrast ratio between the image and the screen [2].

An image has predefined primary colors that include a combination of Red, Green and Blue called as the RGB. Apart from this the other color parameters such as the Hue, intensity, and saturation are used to present the image in a realistic way as seen by the human eye [3].

Edge enhancement deals with the changes in the brightness levels of the edges that include features such as linear features. Apart from this there are also other edge related features that can be implemented using various MATLAB functions [4].

The Gray level slicing technique enhances the gray tone of the image into specific digital ranges. This method highlights the variations in gray-scale intensity that cannot be seen by normal human eye [2].

Digital image enhancement techniques provide many methods to enhance the quality and visual clarity of the images [2]. These techniques use a lot of means to alter the given image to make it visually enhanced. The selection of these techniques depends on the contents of the image and the features of the person who are the observers [3].

Image Transformation

Unlike image enhancement techniques that are applied to only one channel of the image, the Image transformations are applied to multiple bands of the images. Arithmetic operations are used to combine existing bands within the image to generate new images. These images will have better quality and features. Some of the techniques used for image transformations are spectral reasoning and Principle Component Analysis (PCA) that are mostly used for multi-channel images [1].

Image Classification

Image classification and analysis techniques are used to classify the various pixel data in the image. This is done often in multichannel images. Here based on the statistical features of the image such as brightness level of the pixels, they are classified into many classes [1]. It is categorized into two as supervised and unsupervised classification.

Feature Extraction

Apart from these there exists another special image processing technique called as the feature extraction or also called dimensionality reduction. Feature extraction is defined as the technique that is used to transform the input data into a set of some other features as in [5]. In such case the input data is the digital image itself and if it's too large then this should be transformed into simplified form of other feature such as pixels or data points. The image is reduced before processing instead of using the full input image [6] and the final result is obtained.

The important thing to be considered when implementing image processing in complex systems is the size of the input data and the storage space required for the process. Also many complex variables are involved in image processing and so an adequate and efficient algorithm has to be used. A combination of many variables can be combined to reduce data storage [6] when using feature extraction. Feature extraction is mostly applied in of Optical Character Recognition (OCR) and it has several techniques within and they are explained below.

Edge detection is the process of identifying and locating the various sharp discontinuities in the given image as said in [7]. These discontinuities in the digital images represent the change in pixel intensity. The intensity level of the pixels shows the outline of the various objects within the image. There are many edge detection techniques available as said in [7] and one of these method include the finding of convolution of the given image using components such as 2D filter.

Morphological thinning is an image processing technique that converts the areas of binary values in the image to lines that lie closer to the center [8]. In each of the image area, the obtained lines from thinning process should be connected. By doing this the topology information and the shape information of the image can be obtained. Morphological thinning is a high level technique used to analyze the image in a deeper scale and this is used in many applications such as understanding a diagram or figure, OCR recognition, feature detection and extraction, and to analyze fingerprints [8]. Morphological thinning uses two features such as dilation and erosion. Dilation technique uses a Structured Element to inspect the shapes within the given image by adding pixels. Erosion is a technique used to remove pixels from the given image [9].

Hough Transform is the technique used to identify the imperfect instances of the shapes by using the voting process. This technique is used to identify the various lines in the given image and the location of random shapes such as circles and eclipse [10].

B. Distributed Image Processing

A research was conducted on processing of very large number of image data inside a network of systems connected using parallel virtual machine communications [11]. Here the Edge detection technique was implemented using the sobal operator to provide performance analysis of image processing using various loads, by using different count of machines in the network, varying image sizes and operating systems.

The next research focus about the distributed image processing applied to dermoscopy by using an open internet platform that allows the system to be completely collaborative to fight against malicious melanoma by providing a strong technical platform of teledermoscopy [12]. The maintenance here is limited by using a web browser to access the URL address.

A Partial evolution technique was used to reduce the communication cost of distributed image processing [13]. The partial evolution is an automated program that allows partial execution of a given program. This can be done by pre-

computing the various parts of the given program that are dependent on the input parameters that are known to the user.

A review or study was made on the various image processing techniques used in agricultural applications using a high performance computing environment such as the distributed system. This study provides an understanding of how distributed image processing is done in parallel and distributed environments [14].

C. Security in Image Processing

In recent time the use of internet and communication has increased drastically. The data transmitted should be kept secure and free from hackers. Normal security methods applied in network security is not applicable since they can be hacked easily by using many hacking techniques. Along with data, images can also be sent through internet and to keep them secure researcher have developed techniques such as digital watermarking, visual cryptography and embedding data or another image within the given image to provide security to images. Many techniques such as spatial domain, frequency domain and compressed data domain [15] are used for data hiding and this is applicable for images also.

In the spatial domain method, the data pixels in the spatial domain of the image are arranged in a specific order to include the data that is to be communicated. This method is simple and provides a high data hiding capacity. The quality of the image to which the data is hidden can also be changed by using other image processing techniques.

In the Frequency domain method, the images are first converted into their respective frequency domains and then the data to be made secure is included within the image by modifying the transformed coordinates of the frequency domain of the images.

In the Compressed domain method, the data is embedded within the compressed domain of the given image by manipulating the data coefficients of the compressed image. Since all images are compressed when transferring in the internet, Compression domain method is more efficient.

The next method that can be used to provide security to images is the visual cryptography. Here the given image is made secure visually by using physical means other than by using any algorithms. In Cryptography only the contents of the data being communicated is made secret but in steganography both messages and the communication parties are kept secret. In visual Cryptography, the original image is split into n parts and the person who has access to all the n parts can only reveal the information available in the image. Even if one of the parts is not available the original message cannot be revealed.

Another method to provide security to digital images is the image alignment and image stitching techniques [16]. Mostly image alignment is implemented using automated methods. Image stitching and image alignment can be done in two ways, either direct methods or by using feature based methods. Direct methods are more advantageous since they use all the image data that are available and provide good results. Feature based

methods does not require initialization but they lack the properties that are needed for reliable matching of the image sequence.

The parameters such as gradient domains are used while doing image stitching. To enhance the efficiency, other parameters such as gain compensation, multi-blending etc are used. By combining image steganography and image stitching techniques more security can be provided to images.

D. Image Processing in Document Forensic

In recent researches, the concept of image processing has been used to identify the various characteristics of specific printing techniques. Many research has been done such as characterization of electro photographic printers, gray level co-occurrence feature and Gaussian mixture model (GMM) [17] for printer identification.

The serial number of the printers that are represented by patterns of yellow dots can be identified by using various projects that use Machine identification code. But some printers such as Samsung clp-510 series, Hp laser 8550 series does not show these patterns of yellow dots. Apart from these other forensic information can be used to identify these kinds of printers. One such method is by using HSV color space. This technique is used to detect the process of printing and making photo copies by using the hue histogram feature of image processing. The features that are used here to differentiate printers are hue contrast, periodicity and ink overspray.

Similar way, fake documents can also be identified and linked to color printers by using scanning methods. Here, the imaged text are captured using high resolution cameras to magnify to each of the characters within the image and are sent to the computer for processing. The uniqueness of the colors, textures and intensities among the document is used to detect fraud document.

The Gray level features can be used to differentiate between inkjet from laser jet print. Current research on gray level features concentrate on the detection of various parameters such as edge roughness of the given text using perimeter based approach. This is used for classifying the various printing techniques used and using this type of printer can also be identified. This is mostly done using low resolution images for a large number of documents.

E. Medical Image Processing using Neural Networks

Preprocessing

Image preprocessing using neural networks (NN) has two categories usually such as image reconstruction and image restoration. For image reconstruction the most used neural network is the Hopfield NN as discussed in recent researches [18]. From the reviews collected from these researches, it proves that the Hopfield NN provides the highest percentage of efficiency. By using the Hopfield NN, the problem of medical image processing, especially medical image reconstruction can be reduced to a problem of optimization that aims to bring the

state of the network to stable. The efficiency is increased here and the energy consumption is less.

But the problem of noise data within the image makes it harder for the reconstruction of images in electrical impedance tomography. To solve this, the problem of nonlinear inverse of the noise data should be calculated. To overcome these new concepts of neural networks such as the self-organizing Kohonen NN and feed forward NN are used. These methods calculate the linear approximate of the inverse problem defined above.

The next feature used for processing medical images is the image restoration. Compared to image reconstruction, the image restoration has been a much higher research area with many works. The various neural networks that have been used for medical image restoration are as below:

- Hopfield NN
- Feed forward NN
- Fuzzy NN
- Cellular NN

By using different neural networks for image restoration [19] as said above, they can be used to distinguish and identify various features of the medical image. In general, during the image restoration process noise is removed from the medical images using the filtering technique as discussed in [20].

Image segmentation

Image segmentation is an important processing method employed in medical image processing. The most used and efficient type of neural network used for the image segmentation process is the feed forward NN. Many researches facilitate the use of feed forward NN in medical image segmentation [21]. This is because the feed forward NN based medical image segmentation is less noisy and the selection of training images needed for the learning process is also less sensitive.

Other than this the Hopfield NN were used for complex problems to try and provide a solution. They are used as alternative methods and not really have the best solution needed for medical image processing. Some of the research works used the Hopfield NN [22].

1) Object detection and recognition

More than half of the time, the Back propagation NN is used for implementing the medical image detection and recognition. Compared with other existing methods, the back propagation NN aims for a higher accuracy in recognition within a limited amount of time for processing the images. The Back propagation NN has been used in many research such as interpretation of mammograms, cold lesion detection in SPECT image, diagnosing classes of liver diseases, separation of melanoma from tumors, distinguish interstitial lung diseases, reduction of false positives in detection of lung nodules using various techniques.

The various other neural networks that play important roles in medical image detection and recognition are as below:

- Hopfield NN [23]

- ART NN [24]

- Radial bias function NN [25]

- Probabilistic NN [26]

- Convolution NN [27]

- Fuzzy NN [28]

III. CONCLUSION

The digital image processing is an important aspect when the technology keeps changing rapidly these days. A number of techniques are available for digital image processing for methods such as feature extraction and image classification. The neural network (NN) plays an important role in digital image processing especially in medical image processing. Apart from the many fields discussed in this paper, there are also other important areas where digital image processing is used such as in weather forecasting, research of space, planets & solar system and in any areas that involves the need of processing images, characters or any other feature related to photography. In the future the concept of digital image processing or to be specific image processing, will reach out to everyone single field in technology.

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