IMAGE PROCESSING AND APPLICATIONS IN ELECTRONICS ENGINEERING DOMAIN – A REVIEW

Vinoth.V.V
Research Scholar
Bharath University
Chennai
vinfo.vv@gmail.com

Dr.T.Krishnakumar
Head- Strategy and Planning
Bharath University
Chennai
drkk@bharathuniv.ac.in

***Abstract*— Image processing plays an important role in the present scenario. This paper reviews different applications of image processing like medical imaging, license plate detection, defect detection, edge detection, character recognition, enhancement, filtering for noise reduction etc. This paper briefly covers digital image processing, medical image processing, Image restoration, noise models, denoising techniques etc. It is found from literature that image processing has many applications globally. So, image processing can be helpful for the areas where image is an input. It is also found from literature that (i) knowledge on noise model is very important part in image processing (ii) Image denoising is necessary action in image processing operation.**

***Keywords*—**Image Processing, Segmentation, Enhancement, Edge detection

I. INTRODUCTION

The subject of image processing emerged in five decades back when it became apparent that many forms of image data would be susceptible to automatic processing, and that computers should be capable of recognizing visual patterns in a wide variety of application areas. However, it has taken nearly forty years for these early hopes to be realised on a wide scale. The reason for the delay has on the one hand been scientific (how can effective algorithms of the right accuracy and robustness be designed?) and on the other technological (how can computer hardware of sufficient power be produced to permit images of non-trivial size to be processed with reasonable speed or even in real time?). Image processing generally refers to digital image processing, but optical and analog image processing are also possible. The acquisition of images (producing the input image in the first place) is referred to as imaging. Image processing is a form of signal processing that have an image as input and output will be an image or a set of characteristics or attributes related to the image. Most of the image processing techniques involve the image as a two-dimensional signal .Image processing involve different techniques like image enhancement, image restoration, image compression etc.

Digital Image Processing

Digital Images are generally produced by a variety of physical devices, including still and video cameras, x-ray devices, electron microscopes, radar, and ultrasound, and used for a variety of purposes, including entertainment, medical, business (e.g. documents), industrial, military, civil (e.g. traffic), security, and scientific. The goal in each case is for an observer, human or machine, to extract useful information about the scene being imaged. Typical of an industrial application is shown in Figure 1.

Fig.1 Digital image processing is used to verify the dimensional accuracy and examine the surface for inclusion and defects.

Digital image processing having one of the methods of artificial intelligence and it combined with fuzzy logic, pattern recognition and machine learning are so valuable in Image technique can be grouped under a general framework-image Engineering (IE). Image Engineering is generally

made up of three layers mainly upper layer as image understanding, Middle layer as Image Analysis, Lower layer as image processing. Image segmentation is the first step and also one of the most difficult tasks of image analysis, which has objective of extracting information which is represented in the form of data from image via image segmentation, feature measurement and object representation. The result of segmentation of image is considerably depends on the accuracy of feature measurement. Image segmentation is the computer-aided so that the computerization of medical image segmentation plays an important role in medical imaging applications. Image segmentation process that subdivides an image into its constituent parts and extracts those parts of interest or objects. Automatic image segmentation also done but the most critical task is that the segmentation result affect all the subsequent processes of image analysis. Image (and video) segmentation is a critical step of image analysis occupying the middle layer of image engineering, which means it is influenced not only from data but also from human factors. Image analysis having the feature measurement, object representation and description, and even the higher level tasks such as object classification and scene interpretation.

Contrast enhancement of an image is an important challenge in the field of digital image processing. Contrast enhancement produces an image that subjectively looks better than the original image by changing the pixel intensities. These techniques find application in areas ranging from user electronics, Bio-medical image processing to aerospace image processing. Of the many techniques available for image contrast enhancement, the techniques that use first order statistics of digital images (image histogram) are very popular. Global Histogram Equalization (GHE) is one such widely used technique. GHE is employed for its simplicity and good performance over variety of images. However, GHE introduces major changes in the image gray level when the spread of the histogram is not significant and cannot preserve the mean image-brightness which is critical to user electronics applications.

Object counting is a challenging problem in image processing. It is routinely carried out in different areas of industries, research institutes, laboratories, agriculture industries among others. Object counting is important for quantitative analysis that depends on estimation of certain elements. Figuring out how many objects in an image is required in image analysis. Object counting is used to get certain number of elements from images. These elements act as a source of information for quantitative analysis, motion tracking and qualitative analysis. The conventional method for object counting is manual, time consuming and in non-automatic form. Continuous counting leads to eye fatigue and affects the accuracy of results. However, the process of counting objects is not always straightforward or trivial, even performed manually. Most counting methods have peculiarities that make them tricky to tackle. For example, the objects may occur in large number and overlapped making counting tricky and tedious that in turn leads to error. Manual method must be replaced by computer vision as the results of this method are erroneous and time consuming. Automatic counting of objects is a subject that has received significant attention in last few years with objects as varied as cells, RBCs, fish, eggs etc. Figure 2 shows generalized framework for object counting using image processing [1].

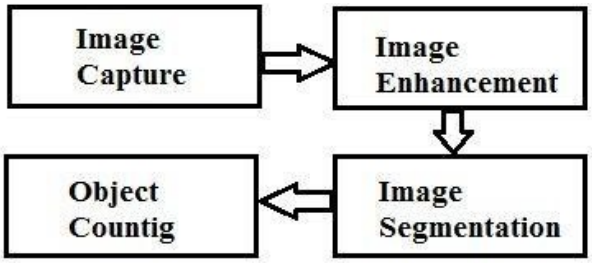

Fig. 2 Generalized Framework for Object Counting using Image Processing

Object counting using image processing has huge applications where automation is to be introduced and time of counting is to be reduced. Some of the main applications of object counting in industrial systems are packaging, quality control, and so on. It is helpful in the research areas where objects are of very small size. Object counting algorithm can be also used to track and identify objects. The present methods can be extended to have counting system based on user selected attributes [2-4]].

II. APPLICATIONS OF IMAGE PROCESSING

There are several applications of image processing which are explained as follows [7]:

Medical imaging

Medical imaging is the technique and process generally used to create images of the human body (or parts and function thereof) for clinical purposes. It refers to a number of techniques that can be used as noninvasive methods of looking inside the body. This means the body does not have to be opened up surgically for medical practitioners to look at various organs and areas. It can be used to assist diagnosis or

treatment of different medical conditions. Medical imaging is one of the most important applications of image processing.

License Plate detection

License plate detection or recognition is one of the wider applications of image processing. This kind of application is employed in parking, access control, tolling, stolen cars, and airport parking to capture the plate numbers and images of the cars/vehicles. In license plate detection method, first step is to enhance the input image by doing filtering and then go for LP localization process involving histogram and mathematical morphology process. Second step is using LP extraction, each character of the LP must be extracted for the reorganization process. And after then image thresholding and classification of connected components and region extraction have been done [8].

Defect Detection

PCB defect detection is one of the significant applications of image processing. Image subtraction is a referential method, compare some feature of the board being tested to a „perfect" image stored in the system memory. Image subtraction is a kind of pixel subtraction process ,where by the numeric value of one pixel or the complete image is subtracted from the another image .The image subtraction operator takes two images as input and third image as output , whose pixel values are simply those of the first image minus the corresponding pixel values from the second image .Image subtraction method is performed in order to get the differences between the two images[7].

Edge detection

The main purpose of edge detection is to divide the image data according to the sharp intensity changes in an image resulting from discontinuities in depth or surface orientation. Different edge detector have been proposed such as Sobel, Robert, DoG etc. which is either based on finding the first order derivative maxima or minima or zero crossings in the second order derivatives of pixel intensity in an image. The Sobel operator performs a 2-D spatial gradient measurement on an image.

Recognition of handwritten digits

Automatic handwriting recognition has a variety of applications at the interface between man and machine [9]. In this application of image processing, the ten digits of English language are divided into two groups. Group 1 consists of digits wit blobs with/without stems. The group consists of digits- 0, 4, 6, 8, 9 and group-2 consists of digits with only stems having digits-1, 2,3,4,5,7. The blobs are identified by region filling method. Figure 3 presents the decision tree for English numerals [9].

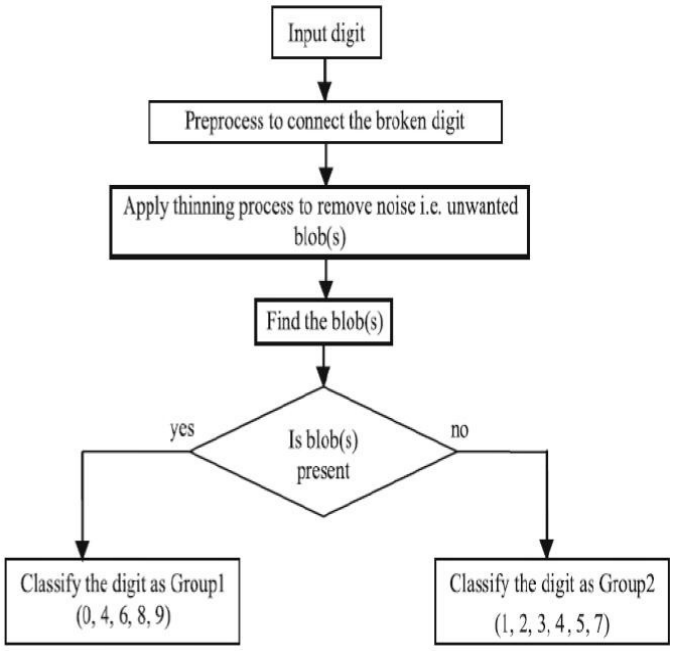

Fig. 3 Decision tree for English numerals

Enhancement of images

Digital image enhancement is one of the most important image processing technology which is necessary to improve the visual appearance of the image or to provide a better transform representation for future automated image processing such as image analysis, detection, segmentation and recognition. Many images have very low dynamic range of the intensity values due to insufficient illumination and therefore need to be processed before being displayed. Large number of techniques have focused on the enhancement of gray level images in the spatial domain. These methods include histogram equalization, gamma correction, high pass filtering, low pass filtering, homomorphism filtering, etc.

Image enhancement is the technique which is based on interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques [10]. Image enhancement simply means, transforming an image *f* into image *g* using *T. (Where T* is the transformation. The values

of pixels in images *f* and *g* are denoted by *r* and *s*, respectively.

$$s = T(r) \quad (1)$$

where *T* is a transformation that maps a pixel value *r* into a pixel value *s*.

Filtering for Noise Reduction

Filtering process can be done by linear and nonlinear filtering method. Gaussian filter and mean filter is the example of linear filter and Median filter is the example of non-linear filter. Noise can be added in images through the camera. Différent types of noise are- amplifier noise, Salt-and-Pepper noise, shot noise, speckle noise [11].

Image Restoration

Image restoration is the process of recovering an image that has been degraded by using a priori knowledge of the degradation phenomenon. Restoration techniques involves modeling of the degradation function and applying the inverse process to recover the original image. This process is processed in two domains: spatial domain and frequency domain. A Model of image degradation and restoration processn is pictorially shown in Fig. 4 [12].

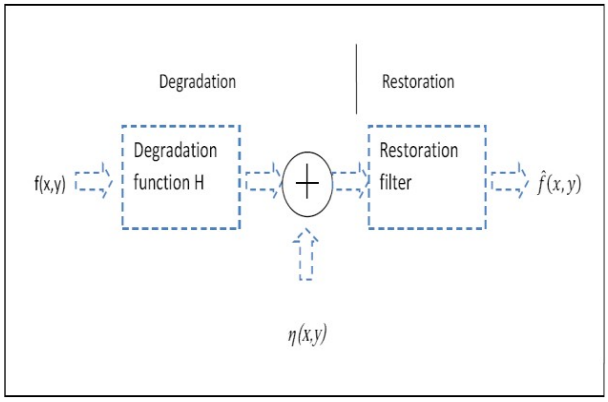

Fig. 4 A Model of image degradation and restoration process

III. NOISE MODELS

Noise reveals unwanted information in digital images. Noise produces undesirable effects such as artifacts, unrealistic edges, unseen lines, corners, blurred objects and disturbs background scenes. To reduce these undesirable effects, prior learning of noise models is essential for further processing. Digital noise may arise from various kinds of sources such as Charge Coupled Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) sensors. In some sense, points spreading function (PSF) and modulation transfer function (MTF) have been used for timely, complete and quantitative analysis of noise models. Probability density function (PDF) or Histogram is also used to design and characterize the noise models. Here we will discuss few noise models, their types and categories in digital images. In order to restore an image we need to know about the degradation functions. Different models for the noise are described in this section. The set of noise models are defined by specific probability density functions (PDFs). Some commonly found noise models and their corresponding PDFs are given below [12]. The important and widely used noise models are listed below: .

- Gaussian Noise
- Rayleigh Noise
- Uniform Noise
- Impulse (Salt-and-Pepper) Noise
- Exponential Noise

Denoising Techniques

The noise removal is done by filtering of the degraded image. Basically the filtering is done in two different methods viz.

- Filtering in spatial domain
- Filtering in frequency domain

Spatial Domain Filtering

The most widely used filtering techniques in Image Processing are the Spatial Domain filtering techniques. Spatial Domain is referred as the grid of pixels that represent an image. The relative positions and the values of a local neighborhood of pixels are the factors that are used in Spatial Domain filtering technique

Frequency Domain Filtering

The frequency domain is an alternate way to represent an image. It deals with the frequency of the gray levels of the pixels in the image i.e. the variation in the gray level. Considering the frequency components of an image can provide an insight and rationale
for certain filtering and processing operations.

IV. MEDICAL IMAGE PROCESSING

Medical Image Processing (MIP) has been undergoing a revolution in the past decade with the advent of faster, more accurate, and less invasive devices [13]. This has driven the need for corresponding software development which in turn has provided a major impetus for new algorithms in signal and image processing [14]. A key research area is the formulation of biomedical engineering principles based on

rigorous mathematical foundations in order to develop general-purpose software methods that can be integrated into complete therapy delivery systems; the systems support the more effective delivery of many image-guided procedures such as biopsy, minimally invasive surgery, and radiation therapy [15]. Medical image processing can describe as an optically formed duplicate, counterpart, or other representative reproduction of an object, especially an optical reproduction of an object formed by a lens or mirror [16]. Typical medical image process is shown in Figure 5.

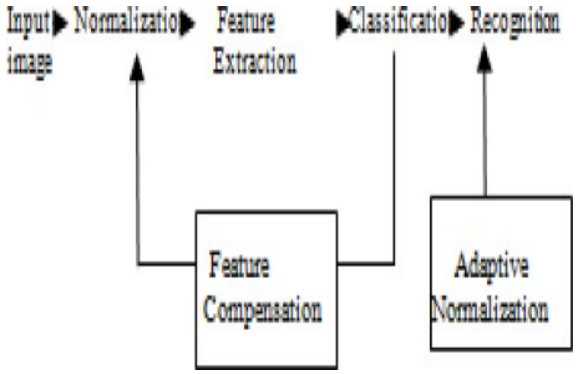

Fig. 5 Typical medical image process

V. SUMMARY

Image processing techniques are helpful for object counting and reduce the time of counting effectively. Proper recognition of the object is important for object counting. The accuracy of the algorithm depends on camera used, size of objects, whether or not objects touching and illumination conditions. From the review, it can be concluded that image processing has many applications in today‟s world scenario. So, image processing is helpful for the areas where image is an input. It is also noticed that image restoration mainly required prior knowledge of the degradation function. Techniques can be developed to estimate these degradation functions more accurately. Further, it can be concluded that there is the need for development of feature extraction method that will be less time consuming and still effective. Also, public medical image database should be developed where categorized medical images can be made available to test system being developed by researchers.

REFERENCES

[1] Amruta Pandit, Jyoti Rangole (2014), “Literature Review on Object Counting using Image Processing Techniques”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 4, April 2014, 8509-8512

[2] Jayme Garcia Arnal Barbedo, “Automatic Object Counting in Neubaur Chamber,” Proc. of XXXI Brazilian Telecommunications Symposium, Fortaleza, Dec. 2013.

[3] Xiaomin Guo and Feihong Yu, “A Method of Automatic Cell Counting Based on Microscopic Image,” 5th International Conference on Intelligent Human-Machine Systems and Cybernetics, Vol. 1, Aug. 2013. pp. 293-296.

[4] Venkatalaksmi. B and Thilagavathi. K, “Automatic Red Blood Cell Counting Using Hough Transform,” Proc. of 2013 IEEE Conference on Information and Communication Technology, Apr. 2013, pp. 267-271.

[5] J.N. Fabic, I.E. Turla, J.A. Capacillo, L.T. David and P.C. Naval, Jr, “Fish Population Estimation and Species Classification from Underwater Video Sequences using Blob Counting and Shape Analysis,” 2013 International Underwater Technology Symposium (UT), Mar. 2013. pp. 1-6.

[6] Haider Adnan Khan And Golam Morshed Maruf, “Counting Clustered Cells Using Distance Mapping,” 2013 International Conference On Informatics, Electronics And Vision (ICIEV), May 2013. Pp. 1-6.

[7] Beant Kaur, Jasleen Kaur (2013), “Applications Of Image Processing: A Review”, Proceedings Of International Conference On Electrical, Electronics And Computer Engineering, 25th August 2013, Bhopal, India

[8] Sami Ktata, Faouzi Benzarti, Hamid Amiri, “ License Plate Detection Using Mathematical Morphology”, IEEE Sciences of Electronics, Technologies of information and Telecommunications,21-22 March,2012.

[9] Sadhana, “Classification and recognition of handwritten digits by using mathematical morphology”,Vol.35, part 4, August 2010, pp.416-426

[10] Raman Maini, Himanshu Agarwal, “A comprehensive Review of Image Enhancement Techniques”, Journal of Computing, Volume 2, issue 3, March 2010.

[11] Pawan Patidar, Manoj Gupta, Sumit Srivastava, Ashok Kumar Nagawat, “Image De-noising by various filters for different noise”, International Journal of Computer applications, Vol. 9-No. 4, November 2010.

[12] Siba Prasad Tudu, A Bharath Kumar Reddy, Image Restoration Techniques, B. Tech Thesis, National Institute of Technology, Rourkela, May 2013.

[13] Hashemi,R.H., and Bradley, W.G., (1996). MRI: the Basic, Williams & Williams Baltimore.

[14] Sigurd Angenent, Eric Pichon, And Allen Tannenbaum, (2005). Mathematical methods in medical image Processing, Bulletin (New Series) Of The American Mathematical Society Volume 10, Pages 719-725.

[15] Zhou,Z., Liang, Z.P., Cofer, G.P., Beaulieu, C.F., Suddarth, S.A. and Johnson, G.A., (1993). Reduction of Ringing and Blurring Artifacts in Fast Spin-echo imaging, Journal of Magn.Reson.Imag., Vol 3, pp. 803-807.

[16] Fessler J., (2009).Introduction to Medical Imaging SystemsIntroduction to Medical Imaging Systems, 21:21 (student version).