Analytical Study on Digital Image Processing Applications

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Abstract

The extreme flexibility of the digital method of image processing makes a wide variety of linear and nonlinear processes possible. The digital image processing techniques developed have been applied to images from a wide range of disciplines. In this paper, we have discussed about various applications such as Image sharpening and restoration, medical field, remote sensing, robotics, color processing, pattern and character recognition, video processing, agriculture, finger print biometrics, forensic, medical palmistry, signature recognition, vehicle detection from satellite images ,etc.

Keywords — *Digital Image Processing, Analytical study on DIP, UV Imaging, Biometrics, Segmentation.*

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I. INTRODUCTION

An image is defined by the mathematical function f(x, y) where x and y are the two co-ordinates horizontally and vertically. Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. Digital Image Processing (DIP) is a rapidly evolving field with growing applications in science and engineering. Image processing holds the possibility of developing the ultimate machine that could perform the visual functions of all living beings [1].

Figure 1.1. How DIP works

In the above figure, an image has been captured by a camera and has been sent to a digital system to remove all the other details, and just focus on the water drop by zooming it in such a way that the quality of the image remains the same

II. APPLICATIONS OF DIGITAL IMAGE PROCESSING

Some of the major fields in which digital image processing is widely used are mentioned below.

- Image sharpening and restoration
- Medical field
- Remote sensing
- Transmission and encoding
- Machine/Robot vision
- Color processing
- Pattern recognition
- Video processing
- Microscopic Imaging

A. Image sharpening and restoration

Sharpness is a combination of two factors: *resolution* and *acutance*. Resolution is straightforward and not subjective. Sharpening is a technique for increasing the *apparent* sharpness of an image. The image restoration are the removal or reduction of degradations which are included during the acquisition of images e.g.; Noise, pixel value errors, out of focus blurring or camera motion blurring using prior knowledge of the degradation phenomenon. This means it deals with the modeling of the degradation and applying the process (inverse) to reconstruct the image. The image restoration has got a wide scope of usage.

B. Medical field

The common applications of DIP in the field of medical are Gamma ray imaging, PET scan, X Ray Imaging, Medical CT, Imaging in the ultraviolet band, Imaging in the microwave band [2]. Clustered micro calcifications (MC) can be an important early sign of breast cancer. They appear as bright spots of calcium

Figure 2.1. Image restoration and sharpening

deposits. Individual MCs are sometimes difficult to detect because of the surrounding breast tissue, their variation in shape (from granular to rod shapes), orientation, brightness and diameter size. Due to the subtlety in the appearance of individual MCs, there is a significant risk that a radiologist may misclassify some cases in breast cancer diagnosis. Recently developed a content-based mammogram retrieval system as a diagnostic aid to the radiologists in their interpretation of mammograms [3]. Digital dermoscopy is a widely used non-invasive tool that combines optical magnification and special illumination techniques to render an improved dermoscopic image for clinical diagnosis of melanoma. Dermatologists have regularly applied this tool for several decades to analyze the surface structure of human skin that is invisible to the naked eyes [4][5]. The ANN method gives the best performance as it neglects the background and displays the required portion of an image that we need. This image processing technique is one of the most efficient ways of detecting lung cancer [6].

C. UV imaging

One important application of digital image processing in the field of remote sensing is to detect infrastructure damages caused by an earthquake. As it takes longer time to grasp damage, even if serious damages are focused on. Since the area affected by the earthquake is sometimes so wide, that it not possible to examine it with human eye in order to estimate damages. It is very hectic and time consuming process. So a solution to this is found in digital image processing. An image of the affected area is captured from the above ground and then it is analysed to detect the various types of damage done by the earthquake.

D. Robot vision

Apart from the many challenges that a robot face today, one of the biggest challenge still is to increase the vision of the robot. Make robot able to see things, identify them, identify the hurdles etc. Much work has been contributed by this field and a complete other field of computer vision has been introduced to work on it.

E. Line follower robot

Most of the robots today work by following the line and thus are called line follower robots. This helps a robot to move on its path and perform some tasks. This has also been achieved through image processing.

F. Colour processing

Color processing includes processing of colored images and different color spaces that are used. For example RGB color model, YCbCr, HSV. It also involves studying transmission, storage, and encoding of these color images.

G. Pattern and Character recognition

Pattern recognition involves study from image processing and from various other fields that includes machine learning (a branch of artificial intelligence). In pattern recognition, image processing is used for identifying the objects in images and then machine learning is used to train the system for the change in pattern. Pattern recognition is used in computer aided diagnosis, recognition of handwriting, recognition of images etc. Character recognition, usually known as optical character recognition and abbreviated as OCR. It is mechanical or electronic translation of images of either handwritten or printed text (usually captured by a scanner) into machine editable text. It is a wide area for researchers in pattern recognition, artificial intelligence and machine vision. For many document input tasks, character recognition is the most cost effective and speedy method available [7].

H. Video processing

A video is nothing but just the very fast movement of pictures. The quality of the video depends on the number of frames/pictures per minute and the quality of each frame being used. Video processing involves noise reduction, detail enhancement, motion detection, frame rate conversion, aspect ratio conversion, color space conversion etc.

I. Signature Recognition

Signature verification and recognition is also an important application, which is to decide, whether a signature belongs to a given signer based on the image of signature and a few sample images of the original signatures of the signer. Handwritten signatures are imprecise in nature as their corners are not always sharp, lines are not perfectly straight, and curves are not necessarily smooth. Furthermore, the fonts can be drawn in different sizes and orientation in contrast to handwriting which is often assumed to be written on a baseline in an upright position. Therefore, a robust handwritten signature recognition system has to account for all of these factors [7].

J. Human authentication by face and fingerprint biometrics

People are required to be verified as a valid individual to be able to access ATMs, airports, labs, buildings, files, etc. Biometric enables an identity-based method which can provide sufficient security for these applications. Currently, biometric systems make use of finger prints, voiceprints, face characteristics, iris features, retina images, signature etc. Biometrics cannot be stolen and forging is practically impossible [8].

K. Medical Palmistry

Palmistry is a science which observes human palm by different aspects and derives conclusions about nature of the person. Since from ancient times, many civilizations like Indian, Chinese, Persian, Egyptian, Roman and Greek, people were used to get guidance about their present and future by means of palmistry. It includes attributes of human, like, health, psychology, intelligence, lifestyle and other related entities. Medical palmistry can be considered as one of the branches of palmistry. By using this medical palmistry, probable diseases can be identified by observing some symbols in human palms such as iceland, cross, grill, spot, star, square and circle. Additionally shapes of palm and fingers also play very important role in such decision making for identification of diseases [9].

L. Vehicle Detection from Satellite Images

The approach described that the accuracy rate of vehicles captured from satellite images. It simply workout the full numbers of vehicles within the desired space in the satellite image and vehicles are shown underneath the bounding box as a small spots [10].

M. Forensic

Digital image forensics (DIF) aims at providing tools to support blind investigation. This brand new discipline stems from existing multimedia security-related research domains (e.g. Watermarking and Steganography) and exploits image processing and analysis tools to recover information about the history of an image. Two principal research paths evolve under the name of Digital Image Forensics. The first one includes methods that attempt at answering question a), by performing some kind of ballistic analysis to identify the device that captured the image, or at least to determine which devices did not capture it. These methods will be collected in the following under the common name of image source device identification techniques. The second group of methods aims instead at exposing traces of semantic manipulation (i.e. forgeries) by studying inconsistencies in natural image statistics [11].

N. Agriculture

Plant breeders need an efficient tool to monitor a number of plant traits to achieve a higher yield. A long boom was attached to a farm vehicle to carry different sensors, cameras and other measurement equipment. A program was developed to read sensors signals and to geo-tag data using GPS for future retrieval. Three programs were developed for image acquisition via webcam and still cameras and a central program for data processing and data visualization. The efficiency of different system architecture including different data transmission networks was examined by conducting several laboratory and field tests [12].

III. METHODOLOGY

The following are the phases of a digital image processing. The block diagram of digital image processing is as shown in the figure 3.1.

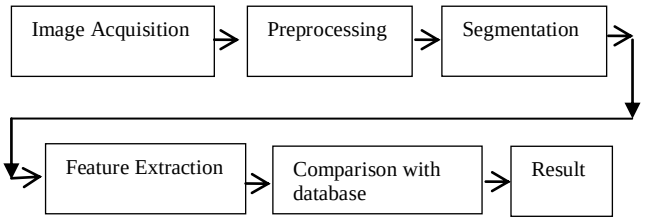

Figure 3.1.Block diagram of digital image processing

A. Image Acquisition

It is the first step or fundamental step of digital image processing. Under image acquisition the image is given in digital format. Generally, this stage of image acquisition stage involves pre-processing, such as scaling etc. An image can be made input by some sort of scanner, digital cameras or with the help of aerial cameras .This image should be a high quality image with greater resolution, which helps in proper image analysis.

B. Preprocessing

Some pre-processing operations are required to be performed on the input image. The aim of pre-processing techniques is to improve the image data to suppress the unwanted distortions and to enhance some features of the input image. When processing high resolution images, the image size is needed to be reduced because of the reason that processing on high resolution images takes a longer time. Then after the color image is converted into grey scale image, because less information is needed to be provided for each pixel. In fact grey color is the one in which the red, blue and green components contain equal intensities; therefore it is necessary to specify a single value of intensity level for each pixel.

C. Edge Detection and Segmentation

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image

segmentation and data extraction in areas such as image processing, computer vision, and machine vision. Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

D. Image Restoration

Image restoration is an area, in which the appearance of an image is improved. Image restoration techniques are based on mathematical models or probabilistic analysis of an image. There are various filter available or can be designed for the restoration and to enhance the quality of an image.

E. Output Image

After using various image processing techniques accompanied with morphological operation on digital image, the object of interest from the given image can be obtained.

IV. CONCLUSION

In this paper we have analyzed the various applications of digital image processing in different areas such as image sharpening and restoration, UV imaging, medical field, human authentication by face and fingerprint biometrics, Forensic, Vehicle Detection from Satellite Images, Agriculture and Medical Palmistry. New findings in image processing area will change the world. Advance researches in image processing and artificial intelligence will involve voice commands, language translation, recognizing and tracking people and recognizing and tracking people and things, diagnosing medical conditions, performing operation & surgery. We can also use the digital image processing technique in finding the anomalies of respiratory system, which leads to the detection of covid-19.

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