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Overview of Image Processing

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Abstract— Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-today life for various applications. Image processing has a number of applications such as: Remote Sensing, Medical Imaging, Non-destructive Evaluation, Forensic Studies, Textiles, Material Science, Military, Film industry, Document processing, Graphic arts, Printing Industry etc.
***Keywords*-image processing, image enhancement, image restoring, remote sensing**

I. INTRODUCTION

Image processing is a form of signal processing for which the input is an image and the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques treat the image as a two-dimensional signal. Image processing is computer imaging where application involves a human being in the visual loop. In other words the image are to be examined and are acted upon by people. The major topics within the field of image processing include: Image restoration, Image enhancement, Image compression etc.

II.HISTORY

In some sense "image processing" dates back to the earliest use of graphics by humans. The cost of processing was fairly high, that changed in the 1970s, when digital image processing proliferated as cheaper computers and dedicated hardware became available. With the fast computers and signal processors available in the 2000s, digital image processing has become the most common form of image processing and generally, is used because it is not only the most versatile method, but also the cheapest. In the early days, topics like median filtering were exciting new research topics. Various techniques have been developed in Image Processing during the last four to five decades. Most of the techniques are developed for enhancing images obtained from unmanned space crafts, space probes and military reconnaissance flights. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc.

III.TYPES OF IMAGE PROCESSING

There are two methods available in Image Processing i.e. analog image processing and digital image processing.

A. Analog Image Processing

Analog image processing is any image processing task conducted on two-dimensional analog signals by analog means i.e. the alteration of image through electrical means. The most common example is the television image. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs.
When creating images using analog photography, the image is burned into a film using a chemical reaction triggered by controlled exposure to light. It is processed in a darkroom, using special chemicals to create the actual image. This process is decreasing in popularity due to the advent of digital photography, which requires less effort.

B. Digital Image Processing

Digital image processing is the use of computer algorithms to perform image processing on digital images. There are three major benefits to digital image processing: a consistently high quality of the image, a low cost of processing, and the ability to manipulate all aspects of the process.
In digital photography, the image is stored as a computer file. This file is translated using photographic software to generate an actual image. The colors, shading, and nuances are all captured at the time the photograph is taken, and the software translates this information into an image.
The principle advantage of Digital Image Processing methods is its versatility, repeatability and the preservation of original data precision

IV. TECHNIQUES OF IMAGE PROCESSING

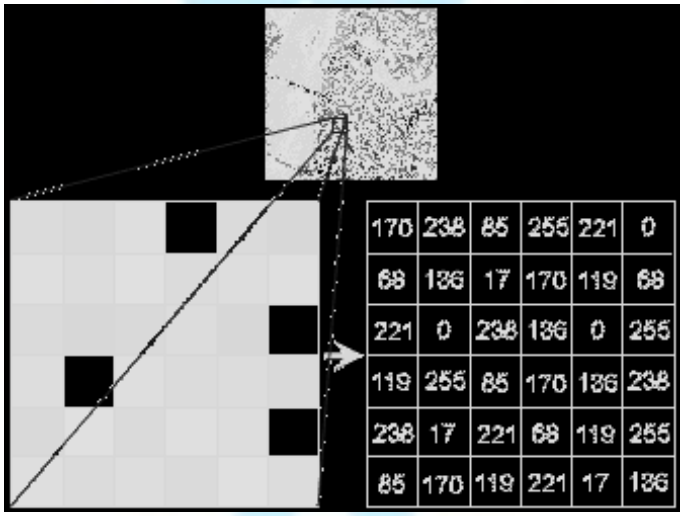
The various Image Processing techniques are:

- Image representation
- Image pre-processing
- Image enhancement
- Image restoration
- Image analysis
- Image reconstruction
- Image data compression

A. *Image Representation*

In computing, all data is logically represented in binary. This is true of images as well as numbers and text. However, an important distinction needs to be made between how image data is displayed and how it is stored. Displaying involves bitmap representation, whereas storing as a file involves many image formats, such as jpeg.

An image is considered to be a function of two real variables, for example, $f(x, y)$ with f as the amplitude (e.g. brightness) of the image at the *real* coordinate position (x, y). The 2D continuous image $f(x, y)$ is divided into N *rows* and M *columns*. The intersection of a row and a column is called as *pixel*. The value assigned to the integer coordinates $[m,n]$ with $\{m=0,1, 2,...,M-1\}$ and $\{n=0,1,2,...,N-1\}$ is $f[m,n]$.



B. *Image Pre-Processing*

Is used to remove noise and eliminate irrelevant, visually unnecessary information. Noise is unwanted information that can result from the image acquisition process

1. *Scaling*

Image scaling is the process of resizing an image. Scaling is a non-trivial process that involves a trade-off between efficiency, smoothness and sharpness. With bitmap graphics, as the size of an image is reduced or enlarged, the pixels that form the image become increasingly visible, making the image appear "soft" if pixels are averaged, or jagged if not. With vector graphics the trade-off may be in processing power for re-rendering the image, which may be noticeable as slow re-rendering with still graphics, or slower frame rate and frame skipping in computer animation.

2. *Rotation*

Rotation is used in image mosaic, image registration etc. One of the techniques of rotation is 3-pass shear rotation, where rotation matrix can be decomposed into three separable matrices.

3-pass shear rotation

In 3-pass shear rotation there is no scaling i.e. no associated resampling degradations. Shear can be implemented very efficiently.

$$R = \begin{vmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{vmatrix}$$

$$\begin{vmatrix} 1 & -\tan\alpha/2 \\ 0 & 1 \end{vmatrix} \quad \begin{vmatrix} 1 & 0 \\ \sin\alpha & 1 \end{vmatrix} \quad \begin{vmatrix} 1 & -\tan\alpha/2 \\ 0 & 1 \end{vmatrix}$$

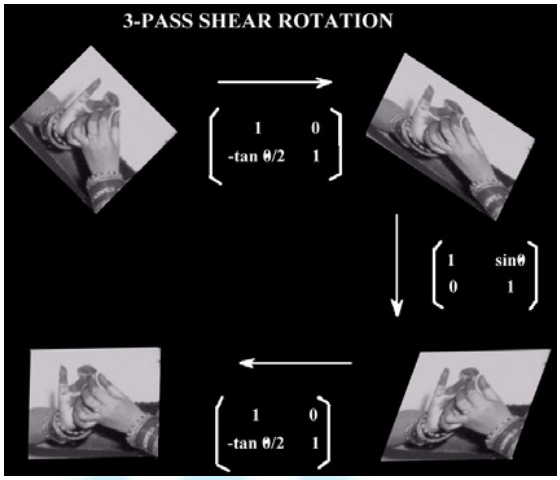


Fig : 3-Pass Shear Rotation

3. *Mosaic*

Mosaic is a process of combining two or more images to form a single large image without radiometric imbalance. If we take pictures of a planar scene, such as a large wall, or a remote scene (scene at infinity), or if we shoot pictures with the camera rotating around its center of projection, we can stitch the pictures together to form a single big picture of the scene. This is called image mosaicking. Mosaic is required to get the synoptic view of the entire area, otherwise capture as small images.

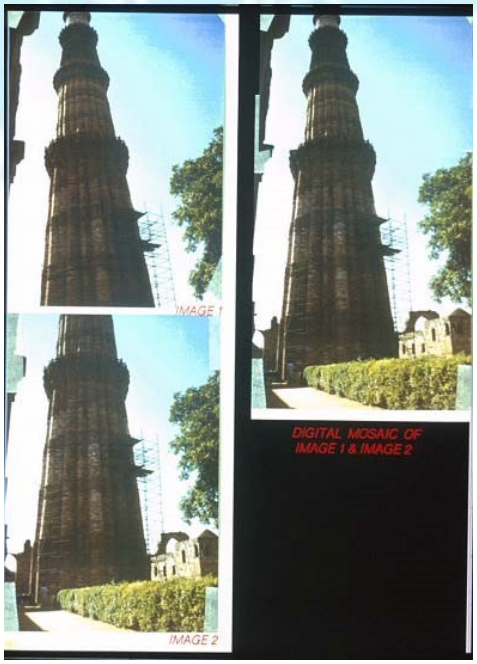


Fig: Image Mosaicking

C. Image Enhancement

Sometimes images obtained from satellites and conventional and digital cameras lack in contrast and brightness because of the limitations of imaging sub systems and illumination conditions while capturing image. Images may have different

types of noise. In *image enhancement*, the goal is to accentuate certain image features for subsequent analysis or for image display [1, 2]. Enhancement methods tend to be problem specific. For example, a method that is used to enhance satellite images may not suitable for enhancing medical images. Although enhancement and restoration are similar in aim, to make an image look better. They differ in how they approach the problem. Restoration method attempt to model the distortion to the image and reverse the degradation, where enhancement methods use knowledge of the human visual systems responses to improve an image visually.

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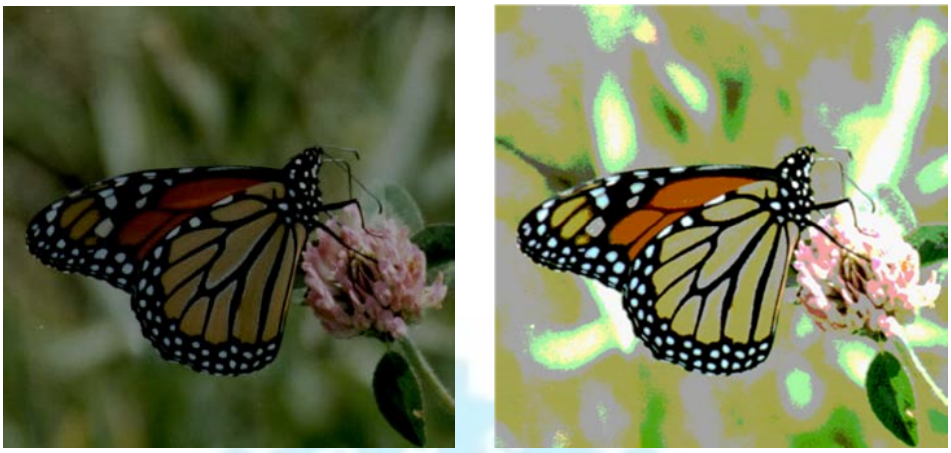


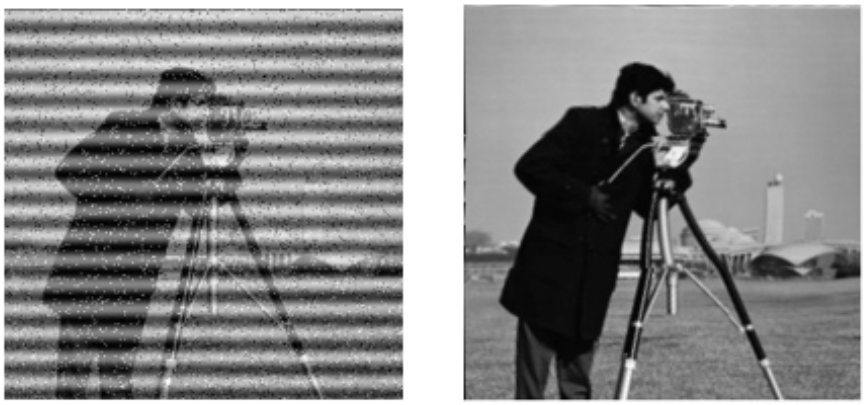
Fig: Image Enhancement

D. Image Restoration

Image restoration refers to removal or minimization of degradations in an image. This includes de-blurring of images degraded by the limitations of a sensor or its environment, noise filtering, and correction of geometric distortion or non-linearity due to sensors.

Is the process of taking an image with some known, or estimated degradation, and restoring it to its original appearance. Image restoration is often used in the field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed.

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a. Image with distortion **b. Restored image**

Image Restoration

E. Image Analysis

Image analysis is concerned with making quantitative measurements from an image to produce a description of it. Image analysis techniques require extraction of certain features that aid in the identification of the object. Image analysis involves manipulating the image data to determine exactly the information necessary to help solve a computer imaging problem. This analysis is typically part of a larger process, is iterative in nature and allows us to answer application specific equations. Image

analysis is primarily data reduction process. Segmentation techniques are used to isolate the desired object from the scene so that measurements can be made on it subsequently. Quantitative measurements of object features allow classification and description of the image.

F. Image Reconstruction

Image reconstruction encompasses the entire image formation process and provides a foundation for the subsequent steps of image processing. The goal is to retrieve image information that has been lost in the process of image formation. Therefore, image reconstruction requires a systems approach that takes into account the entire process of image formation including the propagation of light through inhomogeneous media, the properties of the optical system, and the characteristics of the detector. In contrast to image enhancement, where the appearance of an image is improved to suit some subjective criteria, image reconstruction is an objective approach to recover a degraded image based on mathematical and statistical models.

G. Image Data Compression

Involves reducing the typically massive amount of data needed to represent an image. This done by eliminating data that are visually unnecessary and by taking advantage of the redundancy that is inherent in most images. Image processing systems are used in many and various types of environments, such as:

1. Medical community
2. Computer – Aided Design
3. Virtual Reality
4. Image Processing.



a. Image before compression (92) KB **b. Image after compression (6.59)KB**

Fig : Image Compression.

H. Image Segmentation

Image segmentation is the process that subdivides an image into its constituent parts or objects. The level to which this subdivision is carried out depends on the problem being solved, i.e., the segmentation should stop when the objects of interest in an application have been isolated. Segmentation is one of the key problems in image processing. A popular method used for image segmentation is thresholding. After thresholding a binary image is formed where all object pixels have one grey level and all background pixels have another - generally the object pixels are 'black' and the background is 'white'. The best threshold is the one that selects all the object pixels and maps them to 'black'.

V.APPLICATIONS

A. Remote Sensing

Remote sensing can be defined as any process whereby information is gathered about an object, area or phenomenon without being in contact with it. Remote sensing makes it possible to collect data on dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the Cold War made use of stand-

off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed.

B. Medical Imaging

Medical imaging is the technique, process and art of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities.

C. Forensic Science

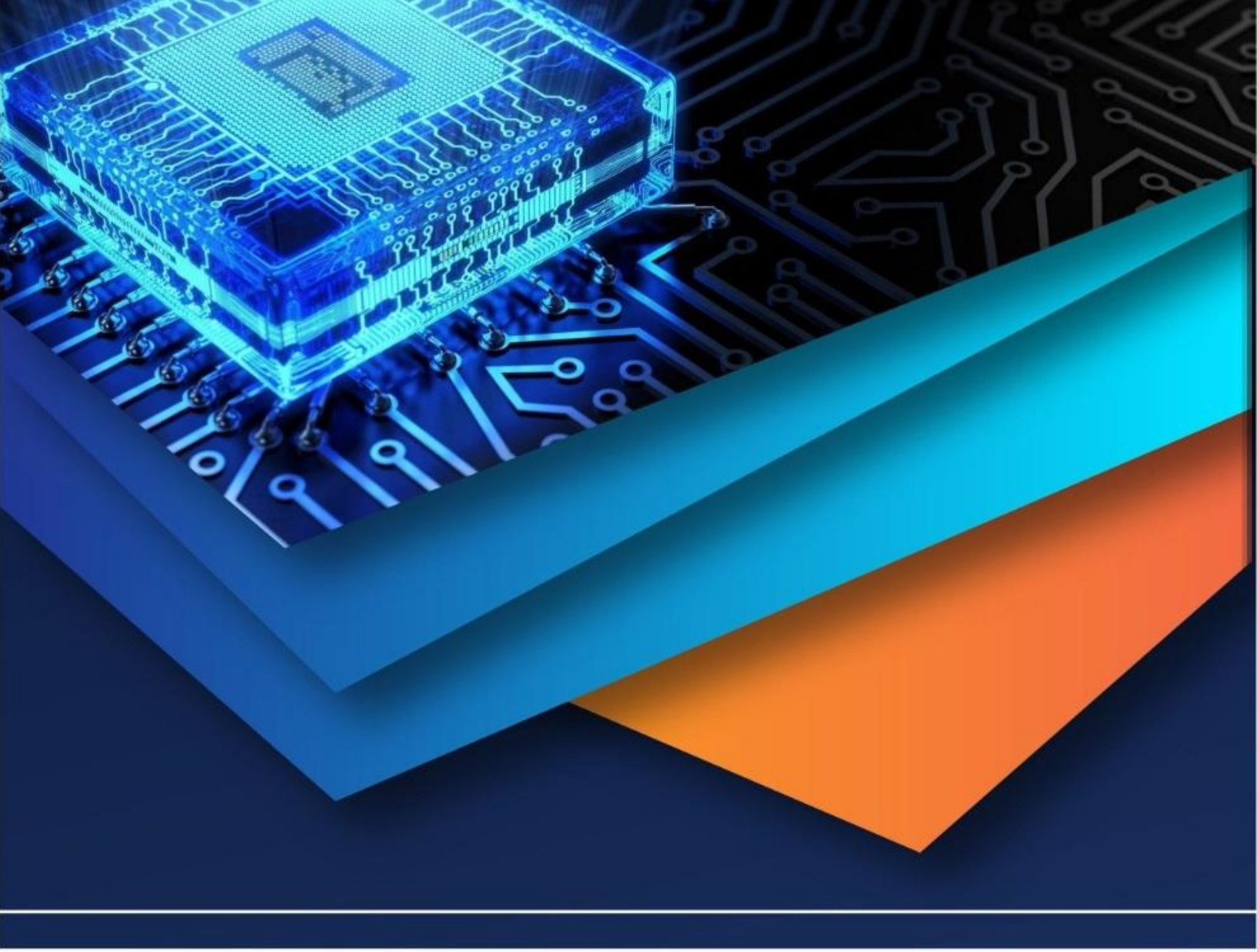
Forensic imaging processing is a method of improving a digital image (surveillance, closed circuit TV, infrared, etc.) using a variety of computer techniques. Forensic image processing (FIP) involves the computer restoration and enhancement of surveillance imagery. The goal of FIP is to maximize information extraction from surveillance imagery, especially imagery that is noisy, incomplete, or over/under exposed.

D. Textile

Image processing and pattern recognition have been successfully applied in many textile related areas. For example, they have been used in defect detection of cotton fibres and various fabrics. In this work, the application of image processing into animal fibre classification is discussed. Integrated into / with artificial neural networks, the image processing technique has provided a useful tool to solve complex problems in textile technology. Three different approaches are used in this work for fibre classification and pattern recognition: feature extraction with image process, pattern recognition and classification with artificial neural networks, and feature recognition and classification with artificial neural network. All of them yields satisfactory results by giving a high level of accuracy in classification.

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