SIGNAL/ IMAGE PROCESSING

Arpit Kudar1 , Gurneet Singh Makked2 ,Vipul Kothifoda3

1Department of Electronics & Communication, Mandsaur Institute of Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya Bhopal (Madhya Pradesh)

Mandsaur, Madhya Pradesh, India

2,3Department of Electronics & Communication, Mandasur Institute of Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya Bhopal (Madhya Pradesh)

Mandsaur, Madhya Pradesh, India

[1arpitkudar01@gmail.com](mailto:1arpitkudar01@gmail.com), 2gurneetmit2010@gmail.com, 3vipulkothifoda@gmail.com

**Abstract**

This paper reveals with the basics of capturing an image, image processing to modify and enhance the image. Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video; the output can be either an image or parameters related to the image. The image signal can be either digital or analog. Digital Image Processing is a rapidly evolving field with growing applications in Science and Engineering. Modern digital technology has made it possible to manipulate multi-dimensional signals. This paper includes image processing operations that mean what operations are performed while processing an image. The fundamental steps of digital Image Processing are described briefly. Digital Image Processing has a broad spectrum of applications. They include remote sensing data via satellite, medical image processing, radar, sonar and acoustic image processing and robotics. The advances in technology have created tremendous opportunities for visual system and image processing. There is no doubt that the trend will continue into the future.

**Keywords-:** Digital image processing, Image Acquisition, Morphological Processing, [Non-photorealistic rendering](http://en.wikipedia.org/wiki/Non-photorealistic_rendering), Multi-Dimensional Signal. .

**1. INTRODUCTION**

Digital: Operating by the use of discrete signals to represent data in the form of numbers.

Image: An image (from Latin imago) or picture is an artifact, usually two-dimensional, that has a similar appearance to some subject-usually a physical object or a person.

Processing: To perform operations on data according to programmed instructions.

Thus the definition of the digital image processing may be given as: Digital image processing is the use of computer [algorithms](http://en.wikipedia.org/wiki/Algorithm) to perform [image](http://en.wikipedia.org/wiki/Image_processing)  [processing](http://en.wikipedia.org/wiki/Image_processing) on [digital images](http://en.wikipedia.org/wiki/Digital_image).  Digital image processing is electronic data processing on a 2-D array of numbers. The array is a numeric representation of an image. It is a subfield of [digital signal processing](http://en.wikipedia.org/wiki/Digital_signal_processing) , and digital image processing has many advantages over analog image processing: it allows a much wider range of algorithms to be applied to the input data, and can avoid problems such as the build-up of noise and signal distortion during processing. In today's world of advanced technology where most remote sensing data are recorded in digital format, virtually all image interpretation and analysis involves some element of digital processing. Digital image processing may involve numerous procedures including formatting and correcting of the data, digital enhancement to facilitate better visual interpretation, or even automated classification of targets and features entirely by computer. Obviously, the other requirement for digital image processing is a computer system, sometimes referred to as an image analysis system, with the appropriate hardware and software to process the data. Several commercially available software systems have been developed specifically for remote sensing image processing and analysis.

**2. IMAGE PROCESSING OPERATIONS**

Image processing operations can be roughly divided into four major categories:

* Preprocessing
* Image Enhancement
* Image Transformation
* Image Classification and Analysis

**Preprocessing** functions involve those operations that are normally required prior to the main data analysis and extraction of information, and are generally grouped **as radiometric or geometric corrections**. Radiometric corrections include correcting the data for sensor irregularities and unwanted sensor or atmospheric noise, and converting the data so they accurately represent the reflected or emitted radiation measured by the sensor. Geometric corrections include correcting for geometric distortions due to sensor-Earth geometry variations, and conversion of the data to real world coordinates on the Earth's surface.



Fig. 1: Image Processing Operations.

The objective of the second group of image processing functions grouped under the term of **image enhancement** is solely to **improve the appearance of the imagery** to assist in visual interpretation and analysis. Examples of enhancement functions include contrast stretching to increase the tonal distinction between various features in a scene, and **spatial filtering** to enhance specific spatial patterns in an image. **Image transformations** are operations similar in concept to those for image enhancement. However, unlike image enhancement operations which are normally applied only to a single channel of data at a time, image transformations usually involve combined processing of data from multiple spectral bands. Arithmetic operations are performed to combine and transform the original bands into "new" images which better display or highlight certain features in the scene. We will look at some of these operations including various methods of **spectral or band** rationings, and a procedure called **principal components analysis** which is used to more efficiently represent the information in multi-channel imagery.

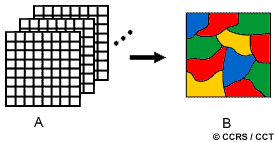


Image classification and analysis operations are used to digitally identify and classify pixels in the data. Classification is usually performed on multi-channel data sets (A) and this process assigns each pixel in an image to a particular class or theme (B) based on statistical characteristics of the pixel brightness values. There are a variety of approaches taken to perform digital classification. We will briefly describe the two generic approaches which are used most often, namely **supervised** and **unsupervised** classification.

**3. FUNDAMENTAL STEPS OF DIGITAL**

**IMAGE PROCESSING**

There are some fundamental steps but as they are fundamental, all these steps may have sub-steps. The fundamental steps are described below with a neat diagram.

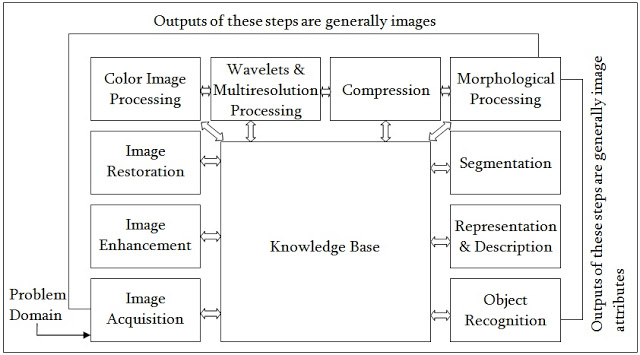
[](http://1.bp.blogspot.com/-3V-spFVAIi4/TqgMy7qjW2I/AAAAAAAAAXU/ObN8msgHie0/s1600/block_diagram_of_dip_tanmayonrun.blogspot.com_fig.jpg)

Fig. 3: Fundamental Steps of Digital Image Processing.

*A. Image Acquisition*

This is the first step or process of the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling etc.

*B. Image Enhancement*

Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Such as, changing brightness & contrast etc.

*C. Image Restoration*

Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

*D. Color Image Processing*

Color image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. This may include color modeling and processing in a digital domain etc.

*E. Wavelets and Multi resolution Processing* Wavelets are the foundation for representing images in various degrees of resolution. Images sub-division successively into smaller regions for data compression and for pyramidal representation.

*F. Compression*

Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it. Particularly in the uses of internet it is very much necessary to compress data.

*G. Morphological Processing*

Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.

*H. Segmentation*

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

*I. Representation and Description*

Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundary of a region or all the points in the region itself.

*J. Object Recognition*

Recognition is the process that assigns a label, such as, “vehicle” to an object based on its descriptors.

*K. Knowledge Base*

The knowledge base also can be quite complex, such as an interrelated list of all major possible defects in a materials inspection problem or an image database containing high-resolution satellite images of a region in connection with change-detection applications.

**4. APPLICATIONS**

A. Image Processing is vastly being implemented in Vision Systems in Robotics. Robots capture the real time images using cameras and process them to fulfill the desired action. A simple application in robotics using Vision Systems is a robot hand-eye coordination system.. The operation to be performed is controlled by the micro-controller, which is connected to the ports of the fingers of the robot’s hand. Using the software programs the operations to be performed are assigned keys from the keyboard. By pressing the relative key on the keyboard the hand moves appropriately .Here the usage of sensors/cameras and Edge Detection technique is related to Image Processing and Vision Systems. By this technique the complexity of using manual sensors is minimized to a great extent and thereby sophistication is increased. Hence image processing is used here in the study of robotics.

B. In the field of Medicine this is highly applicable in areas like Medical imaging, Scanning, Ultrasound and X-rays etc. Image Processing is rapidly used for MRI SCAN (Magnetic Resonance Imaging) and CT SCAN (Computer Tomography). Tomography is an imaging technique that generates an image of a thin cross sectional slice of a test piece.

There is a wide range of applications of the digital image processing. Some of them are

* [Computer vision](http://en.wikipedia.org/wiki/Computer_vision)
* [Face detection](http://en.wikipedia.org/wiki/Face_detection)
* [Feature detection](http://en.wikipedia.org/wiki/Feature_detection_%28computer_vision%29)
* [Lane departure warning system](http://en.wikipedia.org/wiki/Lane_departure_warning_system)
* [Non-photorealistic rendering](http://en.wikipedia.org/wiki/Non-photorealistic_rendering)
* [Medical image processing](http://en.wikipedia.org/wiki/Medical_image_processing)

**5. FUTURE OF DIGITAL IMAGE**

**PROCESSING**

The digital Image Processing is now finding wide range of uses in different modern applications. Few of them (in which researcher are trying developments) include:

•Expert Systems

•Parallel Processing

•Neural Networks

 And many more …

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