International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Overview of Digital Image Processing

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Abstract:
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. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. It is one of the fastest growing technologies today, with its use in various business sectors including cooperation of artificial intelligence. This paper gives detail view of digital image processing with various steps and fields of use.

Introduction:
Digital image processing deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output. The most common example is Adobe Photoshop. It is one of the widely used application for processing digital images. It is also known as DIP.Image processing is a method to convert a image into digital form and perform some operations on it to get an enhanced image or extract some useful information from it. At present time image processing is combined with Artificial Intelligence and performing outstanding in various fields. Digital Image processing is a process in which we apply different operations on image to make it more suitable for viewing. Operations can be image compression, segmentation, morphology, transformation and many more. This paper gives introduction to digital image, types of image, Levels of DIP, Steps of DIP.

Keywords: Image Processing, Digital Image, Artificial Intelligence, Image Compression, Segmentation, Morphology

DIGITAL IMAGE:
An image may be defined as a two dimensional function , F(x,y) where x & y are spatial coordinates.The amplitude F at any pair of coordinates(x,y) is called intensity of the image at that point. When x,y and amplitude values of F are finite quantities, we call the image as Digital image. Digital image is composed of finite number of elements , each of which have a particular location and value. These elements are referred to as image element, picture element or pixel.

Representation of Digital Image:-
Images are represented as matrix of row & columns.Suppose that an image has been sampled, So the resulting image has M rows and N columns.The values of the coordinates F(x,y) represents the pixel position and intensity.The value at the origion F(x,y)=(0,0).The next coordinate value in the row f(x,y)=(0,1)

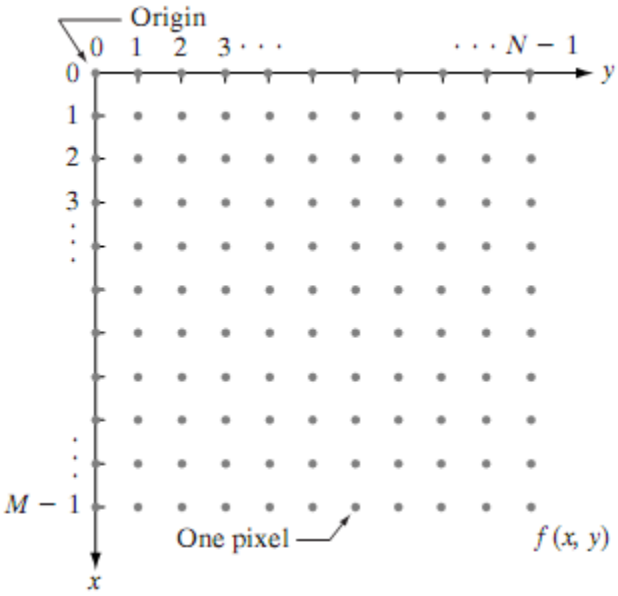

Fig-1 - (Coordinates for digital image)[1]

Thus we can write the digital image in compact matrix form-

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix}.$$

Fig 2-Digital image matrix [2]

Each element of this matrix array represents pixel.

TYPES OF IMAGES :-

Binary Image :- 2 levels only -0 for black & 1 for white
Size- 1 bit/pixel

Gray scale Image (Monochrome image)- 256 levels numbered from 0-255
0 - black
127- gray
255 - white
Size - 1 byte/pixel (8 bits)

Coloured Image -Any colour can be made from combination of red, green, blue (RGB)
RED : 0-255 , GREEN : 0-255 , BLUE : 0-255
Size :- 24 bits /pixel

LEVELS OF DIGITAL IMAGE PROCESSING

There is no clear-cut boundaries for image processing. However there is one useful paradigm that tells

that there can be three types of process- Low, Mid & High level processes.

Low level processes - involve primitive operations such as contrast-enhancement, sharpening of image. Here input and output both are images.

Mid Level processes - Mid level processing involves the task as segmentation. Here input is image but output is attribute exracted from those images.

High- Level processes:-Here input is the image and recognition of individual objects.

COMPONENTS OF DIGITAL IMAGE PROCESSING :-

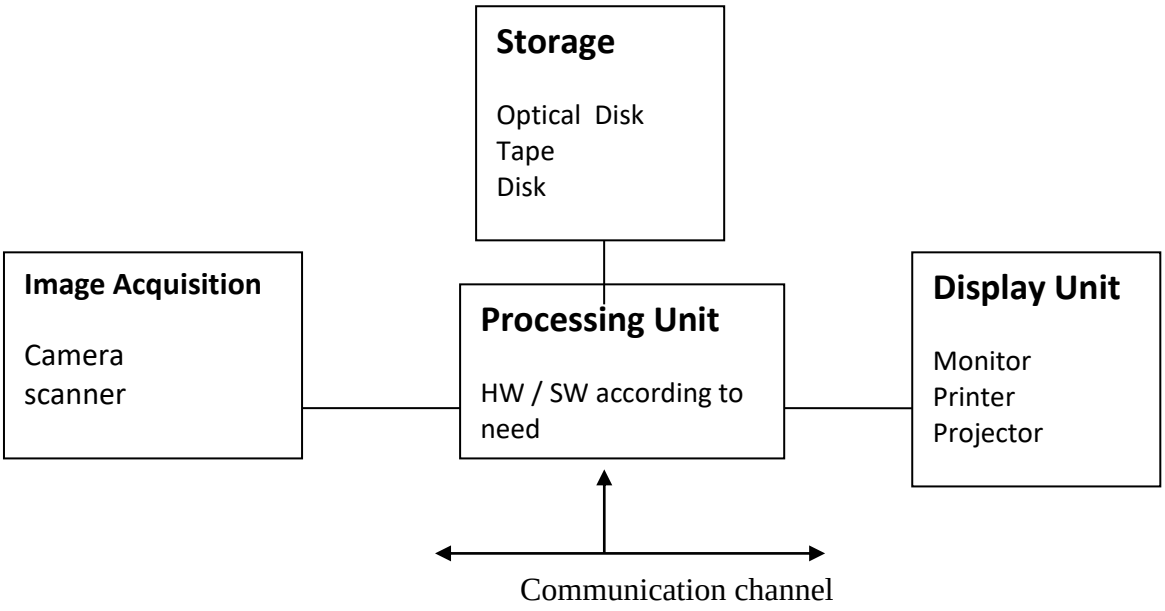

Fig -3 (Components of DIP)

STEPS IN DIGITAL IMAGE PROCESSING

There are various methodologies that can be applied to image according different purposes and objective .It does't mean that every step need to apply on evey image.Its according to our requirements.

Image Acquisition: Image Acquisition is the first step in image processing process.It is defined as the action of capturing or retrieving the image from source. Because without image there can not be any processing.The image is in digital form and completely unprocessed. Generally in this step pre-processing of image such as scaling is performed.An image can be made input by scanner or digital camera.

Image Enhancement: It is the process of adjusting the image so that the results are more suitable for display and further analysis. It is the process of filtering image(Brightness ,removing noise, increasing contrast, etc) to improve the quality.The resulting image will be more suitable than the original image.

It is subjective in nature as for example some people like natural colour and some like high contrasts.That's why this step is subjective in nature differ from person to person.

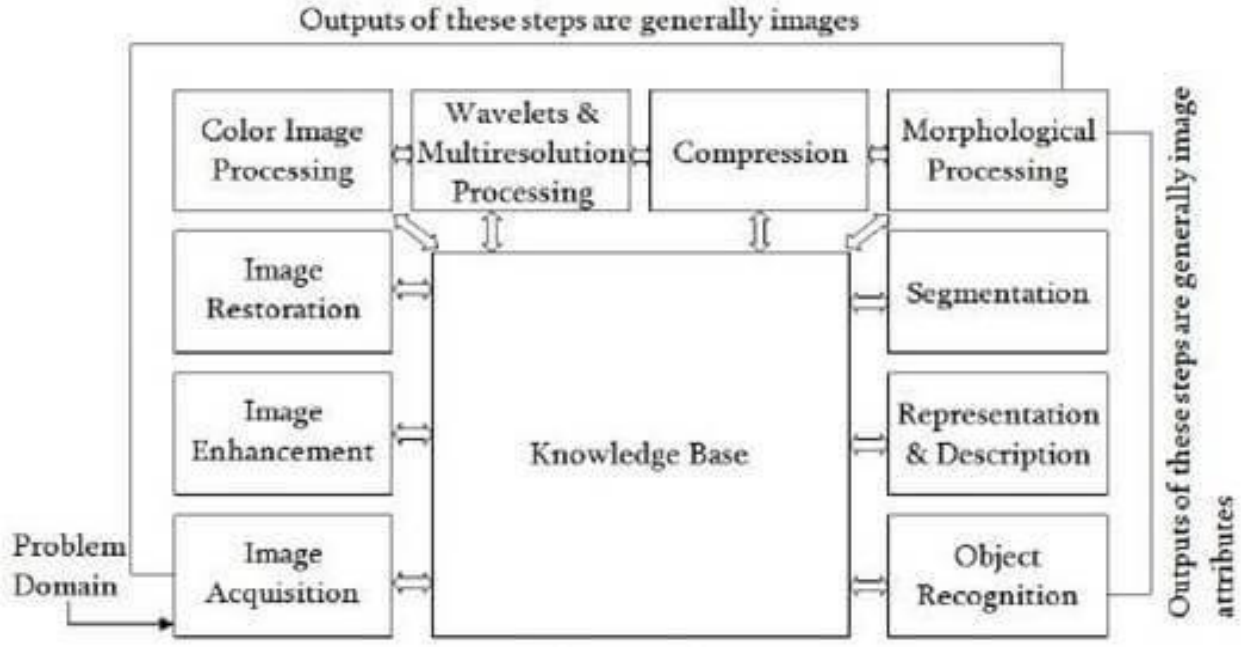

Fig-4 (Steps of DIP)[3]

Image Restoration :-It is the process of recovering an image that has been degraded by some functions. Thus it is the process of improving appearance (reducing blurring etc) of an image by mathematical or probabilistic models. 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.

Colour image processing :- It has become more popular since the use of the digital image has increased. This may include color modeling and processing in a digital domain etc.

Wavelets and multiresolution processing :- Wavelets are the foundation for representing images in various degrees of resolution.

Compression :-It involves the technique for reducing the size of the image with minimum deterioration in its quality.This is particularly for transfer the image on internet as if its size is large it require more bandwidth. Image compression is familiar to most users of computers in the form of image file extensions, such as the jpg file extension used in the JPEG (Joint Photographic Experts Group) image compression standard.

Morphological Processing :-It deals with extracting image components that are useful in image representation and description of shape.Thus input will be image and output will be components and attributes of image.

Segmentation :-It is the process of portioning a digital image into multiple segments.It is generally used to locate objects and boundaries of objects.It is one of most difficult task in image processing because it need to be perform in very systematic manner. It is repetitive process and and it and is beiong performed until the desired results are achieved.

Representation and description :-Representation and description always follow the output of segmentation stage.

- Representation deals with converting the data into suitable form for computer processing.**Boundary representation** is used when the focus is on external shape characteristics e.g. corners.**Regional representation** is used when the focus is on internal properties. E.g. texture.
- Description deals with extracting image attributes gives quantitative results and differentiate one object from another.

10)Object Recognition :-It is the process that assigns a label to an object based on its description.Each and every object is identified and highlighted.

Knowledge Base :- Knowledge may be as simple as detailing regions of an image where the information of interest is known to be located, thus limiting the search that has to be conducted in seeking that information. Knowledge about a problem domain is coded into an image processing in the form of knowledge database.

CHARACTERISTICS OF DIGITAL IMAGE PROCESSING

- It uses software, and some are free of cost.
- It provides clear images.
- Digital Image Processing do image enhancement to recollect the data through images.
- It is used widely everywhere in many fields.
- It reduces the complexity of digital image processing.
- It is used to support a better experience of life.

APPLICATION OF DIP :-

1. Image Correction, Sharpening, and Resolution Correction. Often, when we wish to make old images better.
2. Filters on Editing Apps and Social Media.
3. Medical field and Technology
4. Computer / Machine Vision
5. Pattern recognition
6. Video Processing
7. Image restoration - restoration of old image
8. Blurring image :- to blurr certain parts of the image
9. Tracking moving objects (Used in self driving cars)
10. Transmission & encoding
11. Increasing brightness of the image

ADVANTAGES OF DIGITAL IMAGE PROCESSING

- Image reconstruction (CT, MRI, SPECT, PET)
- Image reformatting (Multi-plane, multi-view reconstructions)
- Fast image storage and retrieval
- Fast and high-quality image distribution.
- Controlled viewing (windowing, zooming)

DISADVANTAGES OF DIGITAL IMAGE PROCESSING

- It is very much time-consuming.

- It is very much costly depending on the particular system.
- Qualified & experienced persons can be use the system of image processing .

Conclusion

Image processing is the process of transforming an image into a digital form and performing certain operations to get some useful information from it. The image processing system usually treats all images as 2D signals when applying certain predetermined signal processing methods. Image processing is a way to convert an image to a digital aspect and perform certain functions on it, in order to get an enhanced image or extract other useful information from it. It is a type of signal time when the input is an image, such as a video frame or image and output can be an image or features associated with that image.In present times image processing is used in Medical Image Retrieval ,Traffic Sensing Technologies, Image Reconstruction, Face Detection and many more such applications. In future these applications can be used in more improved form with artificial intelligence .

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