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ARTICLE

A DETAILED STUDY OF DIGITAL IMAGE PROCESSING

Aayushi Dubey[1], Sukhdeep Sharma[2], Shaveta Malik[3], Prateek Jain[4*]

[1,2,3]Department of Computer Science & Engineering, Manav Rachna International Institute of Research and studies, Faridabad, INDIA

[4]Accendere KMS Pvt. Ltd, New Delhi. INDIA

ABSTRACT

The digital image processing (or DIP) is done to get an enhanced or filtered image or to extract any required information from the image by manipulating it. A raw image is converted into a digital image using various algorithms and machinery. DIP is one of the swiftly emerging technologies. It forms key sector for research within computer science and engineering field. It has made its way in a wide variety of fields ranging from medical to space. There are various steps involved to process a digital image and to obtain desired outcomes. In this paper we have discussed the detailed review about the digital image processing, image filtering, its recent trends and challenges faced.

INTRODUCTION

KEY WORDS
Digital image processing, Image filtering, OCR, Analog image

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***Corresponding Author**
Email: prateek.jain@accendere.co.in
Tel.: +91 9810245840

For more than 150 years, photography has been a substance procedure. Pictures are captured on photographic film. This is comprised of layers of light-delicate silver halide emulsion covered on an adaptable base. Film is presented to light in a camera. This makes an inert picture, which is made noticeable by submersion in an answer of chemicals called a 'designer'. Prints are made by anticipating the picture from the film on sharpened paper and handling the material in a progression of concoction showers. A great part of the preparing of both film and paper must happen in obscured rooms to maintain a strategic distance from unessential light achieving the sharpened emulsions.

At first digital images were used in digitized newspaper pictures sent by undersea cable between London and New York. Introduction of the Bartlane cable picture transmission system in the early 1920's reduced the time from more than a week to less than three hours that was required for transporting an image over the Atlantic. Coding of pictures were done for transfer through cables and then rebuilt at the receiving point on a telegraph printer. Early these systems were efficient of coding images brightness in five different levels, later were upgraded in 1929 to fifteen. However, enhancements were continued to be made on methods for transmitted digital pictures over the next thirty-five years, it took the combined development of large-scale digital computers and the space program to highlight the prospects of digital image concepts. 1960s was the time when the development of many digital image processing techniques started. It took place in some famous laboratories and universities including, Bell Laboratories, Jet Propulsion Laboratory, University of Maryland, Massachusetts Institute of Technology, etc. its application covered fields of medical imaging and diagnosis, satellite imagery and weather forecast, character recognition and filtering and enhancement of pictures. In the time of 1970s, DIP advanced with the availability of cheaper computers and hardware required. With the availability of fast computers and signal processors in the 2000s, digital image processing became the most common, versatile and cheapest form of image processing. In 1994 technology of digital image processing for medical applications was initiated in the Space Foundation Space Technology Hall of Fame. New way of image processing was gradient domain image processing which was introduced in 2002 by Rannan Fattel. In this way difference within pixels are manipulated rather than the values of pixels.

Analog vs digital image

Analog signals are used to prepare analog image. It incorporates processing on two-dimensional analog signal. In this kind of handling, the images are controlled by electrical means by changing the electrical signal. For example, the TV image. DIP has advanced over analog image processing with the progression of time due its more extensive scope of uses. An image is a two dimensional signal defined by function f(x, y) where x and y are the coordinates in space. The intensity of the image at that point is the amplitude of the function at any pair of the co-ordinates (x, y).

An image is called a digital image if the values of (x, y) and the amplitude are finite and discrete quantities. A Digital image is made up of a finite number of elements called pixels. Therefore the value of f(x, y) at any point gives the pixel intensity value at that point of an image. Pixels are arranged in an ordered rectangular array. The dimensions of a pixel array represented as a matrix of M columns x N rows determine the size of an image. The image width and height is the number of columns and the number of rows in the array respectively. To refer to a specific pixel, its coordinate is defined at x and y. Image size tells about the number of pixels present in a digital image. Apart from pixel array, MxN, that only provides a rectangular shape for an image, another parameter, intensity, is required to define an exact image. Each pixel in an image has its own intensity value (brightness). If all the pixels present have the same intensity value, the image will have a uniform shade; all black, white, or some other color. The two most basic types of digital images, B&W (have intensity from darkest gray to lightest gray i.e. from black to white) and Color (have intensities from darkest and lightest of colors, red, blue and green), are known as grayscale and RGB images respectively. The range of intensity also varies. The binary code shows color intensity for each pixel. The binary digits are stored in an order and usually minimized to represent in a mathematical form. And then they are interpreted and read for producing an analog version for displaying.

1	1	1	1	1	1	1	1	1	1
1	0	0	0	1	1	0	0	0	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	0	0	0	0	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	0	1	1
1	0	0	0	1	1	0	0	0	1
1	1	1	1	1	1	1	1	1	1

Fig.1: Assignment of pixel value to an image

Assigning pixel values: In [Fig.1], different values are allocated by individual pixel, as shown in fig black is for 0 and white is for 1. Digital image processing is defined as a method of converting a raw image into a digital form. Manipulation of digital image is handled through digital Computer. The input of the system is a digital image which is used in processing. Image is processed by the system by using capable algorithms which provides an output. For the enhancement of image digital image processing performs processes for better human interpretation and extraction of useful information from the image

Advantages of DIP

- Important characteristics of images, such as, lines, points and edges can be separated from pictures and can be used as a part of industries for correcting or making various products.
- The characteristic of an image like, sharpness, clarity, smoothness can be improved. Image size can be altered, increased or decreased. Images can also be compressed or decompressed hence, producing a better version of image.
- Robots can have the so called vision by their ability to capture the images and extract useful information from them. It makes their working easy in industries and laboratories.
- The damage and faulty items or products can be easily checked. This helps the manufacturers to either rectify those products or simply remove them.
- Weather forecasting has become possible because of the digital images that are captured from the satellites. It has proved very beneficial as we get the weather updates and also the knowledge about the climate conditions of earth. Facts and details about not only the earth, but also other planets are now possible with help of pictures captured (mars, moon, etc.).
- In the field of biology, it is utilized to examine cells and their structure. Since, very minute and microscopic details can be obtained from the digital images, characteristics of cell and its structure is very easy to understand. Therefore, it has been possible to study about the building blocks called cells.
- It is used to examine Medical pictures. Results of X-ray, MRI, CT, etc. are viewed in the form of image and abnormalities and diseases are spotted and rectified.

Disadvantages of DIP

- Different types of noise: Be [1] that as it may, there are three standard noise models with the help of which we get to know the type noise that an image experiences: additive, multiplicative, and impulse noise.

✓ **Additive Noise:** Suppose, f'(x, y) is the noisy form (when noise is present in the image) of an ideal image depicted by, f(x, y) and n(x, y,) the noise function. We get the additive noise by adding the noise function to an ideal digital image. Thermal noise within photo-electronic sensors can have Additive noise as a good model.

✓ **Multiplicative noise:** It is also called speckle noise. This noise is signal dependent and the magnitude has a connection with the original pixel value. For example, Multiplicative noise is an approximation to the noise experienced by images recorded on and from synthetic aperture radar.

✓ **Impulse Noise:** Impulse [2] noise has basically two properties. One is, leaving a pixel unchanged with a probability of '1-p' and the other is replacing it totally with probability 'p'. The result of an error in transmission or an atmospheric or man-made disturbance is usually the sources of impulse noise

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✓ **Quantization Noise:** it occurs at the time when an analog image is converted into a digital image due to the quantization of pixel values. Suppose we have an analog image having brightness values from 0 to 10. Quantizing the image to accuracy 0.1 will give 101 distinct grey levels. The intensity x could be anywhere between (x+.05). Quantization noise is this uncertainty in the true value of x.

- The machines and methodology required is costly. For performing a series of processes on the image, a lot of latest devices are required. Hence, this method is not cost efficient.
- Since the image has to go under a number of processes to obtain desired output, it consumes a lot of time. Each step has sub steps that are to be performed and they should be performed extensively which require time.
- Lack of qualified workers and professionals is also a problem. The procedure is based on latest discoveries and technologies, but people are not qualified enough to handle the process. Therefore, labor deficiency poses a problem too.

Another limitation is when the size of object is smaller than the pixel size. This usually happens when we are dealing with microscopic objects. In this case certain steps cannot be implemented as one pixel might contain more than required portion of object leading to inefficiency

FUNDAMENTAL STEPS OF DIGITAL IMAGE PROCESSING

As mentioned earlier, we process a digital image to obtain an upgraded version of the image for better human perception or to extract significant information from the image. In order to process a digital image, it has to go through a series of steps [Fig.2].

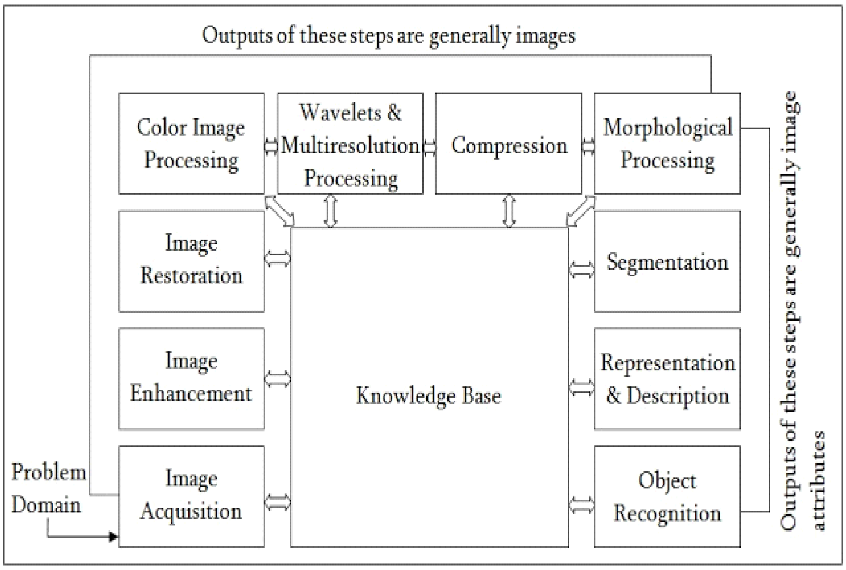

Fig. 2: Flowchart of the steps of digital image processing

Image acquisition

Before [3] processing any image, acquiring of image by a camera and converting it into an individual must be done so that it can be worked upon. This process is called image acquisition. The process of image acquisition is classified into the following levels such as amount of energy exhibited from an object we want to capture, system which works on energy focusing such as optical system, a sensor used for measuring the amount of energy exhibited from an object.

- Energy: The source of illumination is generally the electromagnetic waves. Radar, infrared, X-ray and visible region of the electromagnetic spectrum forms the source of energy.
- It source can also be from some fewer conventional sources, such as illumination pattern generated from a computer and ultrasound.

The objects required for the image are also vast. They can range from micro elements like a molecule to big elements like a human body or the sun. Therefore, the source of energy needed to illuminate depends upon the type of object that is to be captured.

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The following formula can be used to find the amount energy (E) when we know the frequency (f) or wavelength (λ) of the source:
c= speed of light.
$\lambda = c \div f$, $E = h * f \Rightarrow E = h * [c \div \lambda]$

- Optical system: After illumination, camera must capture the reflected light from an object source. When a light sensitive material is put near the object, it will capture a picture of the object. Light coming from various points focuses on the object will lead to a faulty image on blending. The arrangement is to put some sort of hindrance between the object and the detecting material. The image formed will be upside-down. Therefore, systems work in a manner to resolve their problems. Lens is a main part of the optical system. Image is formed, magnified or focused based upon the characteristics of the lens we are using [Fig.3]. To zoom or magnify an image the following formula is used:

$b/B = g/G$

Where, g- distance between object and lens,
b- Distance between the lens and point of intersection of rays,
B- Size of object in image, G-real height of the object

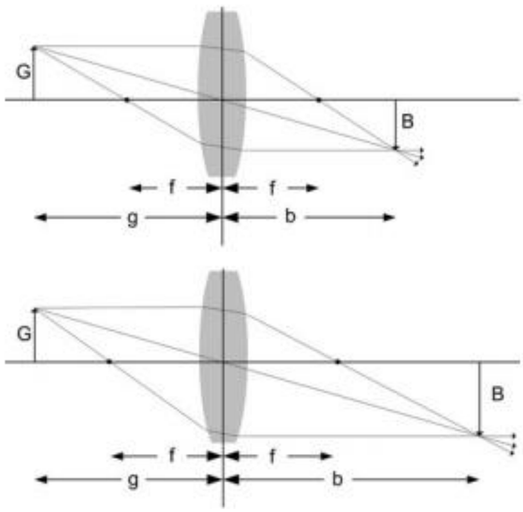

Fig.3: Optical zoom due to different focal lengths

Image sensor: Image sensors [Fig.4] are used in cameras comprise of a 2-D array of cells. Every cell present denotes a pixel which measures the amount of light incident on the object converting it into a voltage. This voltage is transformed into a digital number. This digital number is directly proportional to the light intensity.

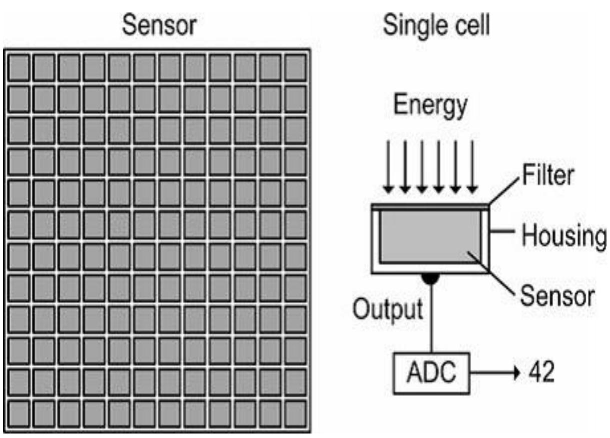

Fig.4: Image sensor

The image may be unfocused. Till the rays from one point are in a particular pixel, it stays focused. When rays from more than one point intersect in that pixel, it will receive light from more than one point and become unfocused.
These are the two formulae to determine the field of view (FOV) of the camera [Fig.5] in order to take a focused image:
$FOV_x = 2 * \tan^{-1}[(\text{width of sensor} \div 2) \div f]$
$FOV_y = 2 * \tan^{-1}[(\text{height of sensor} \div 2) \div f]$

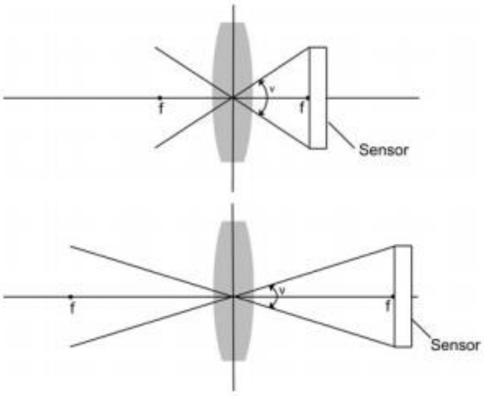

Fig.5: FOV of two cameras having different focal lengths

Image enhancement

Basically, the idea behind enhancement techniques is to focus on several characteristics or features in an image like variation in brightness & contrast etc. Image enhancement manages the digital images to obtain outputs suitable for further image analysis or displaying. For example, noise can be removed and image can be sharpened or brightened making it easier to identify features. Techniques [4] like filtering with morphological operators, equalization, Contrast-limited adaptive histogram equalization (CLAHE), contrast enhancement, linear/ non-linear contrast stretch, and decorrelation stretch are some useful techniques for image enhancement. This is further discussed under the topic 3(image filtering).

Image restoration

Image [5] restoration deals with improving the appearance of an image. Restoration techniques tend to be based on mathematical models of image degradation. The purpose [6] of image restoration is to manage the noise that corrupts an image. Noise or degradation can be of many types like motion blur, camera misfocus. Suppose we encounter a situation of motion blur, we can restore the original image by performing an undo function if we know about the blurring function. If the ideal image $f(n_1, n_2)$ would has a point source or single intensity point, it would be noted as a spread-out intensity pattern1 $d(n_1, n_2)$, and is called point-spread function [Fig.6].

If $h(n_1, n_2)$ denotes the point spread function of the linear restoration filter, the restored [7] image is given by

$$\hat{f}(n_1, n_2) = h(n_1, n_2) * g(n_1, n_2)$$
$$= \sum_{k_1=0}^{N-1} \sum_{k_2=0}^{M-1} h(k_1, k_2) g(n_1 - k_1, n_2 - k_2)$$

Formula 1: Restored image

Or in the spectral domain [Fig.7] by, F (u, v) = H (u, v) G (u, v)

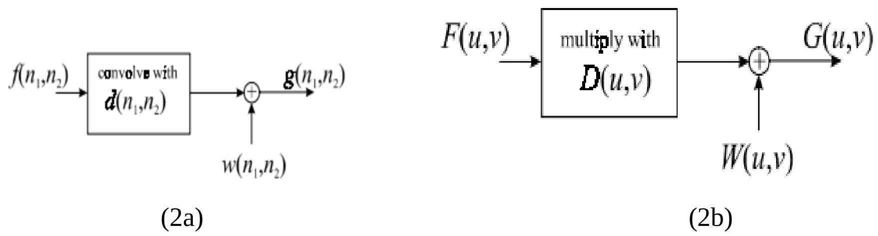

Fig.6: Model of image formation in (2a) spatial domain and (2b) Fourier domain

Ways for image restoration

- Inverse Filter: In this method we assume a known blurring function for the image. Here, restoration gives good results when the image is free of noise but the output is bad when it has noise.
- Weiner Filtering: image restoration is done using wiener filtering; it maintains a balance between de-noising and inverse filtering. It gives better results than an inverse filter.
- Wavelet Restoration: Here, three wavelet based algorithms are implemented to restore an image.
- Blind Deconvolution: In this method, no assumptions about the image are made. Moreover, we don't have information about the blurring function and noise. Therefore, restoration is hard.

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Color image processing

Because of the significant increase in the use of digital images over the internet, color image processing is an area gaining importance. This technique includes color modeling, processing in a digital domain etc. An image may contain a lot of information in the color. More light corresponds to more intense colors as intensity is proportional to amount of light. Grey level is known as the measure of intensity. The intensity is a physical quantity as it is determined by energy, whereas, the perception of the color is determined by brightness or luminance. Color primarily depends on how an object reflects light. The color of source of light and the human vision properties must also be considered.

Wavelets and multiresolution processing

To represent images in various degrees of resolution, we use the concept of wavelets. Here, images are subdivided successively into smaller regions for data compression and pyramidal representation.

Compression

Compression basically deals with techniques to reduce the storage required to save an image or the bandwidth to transmit it. Image compression is the method of minimizing or decreasing the image data so that it can be represented with a good quality. We can do this my reducing the noise or defects that corrupt the image.

Morphological processing

It deals with tools for extracting image components useful in the representation and description of shape. Morphology is a set of operations that works by processing images based on shapes. To create output image of same size, a structural element is applied on the input image using morphological operations. Each pixel present in the image is compared with its neighboring pixels when the operations are performed. Dilation and erosion are the most basic morphological operations. Pixels are added to the boundaries of objects in an image in dilation, while erosion is used for eradicating them. The rule used to process the pixels defines the operation as dilation or erosion. In both the operations, we get to know about the state of any given pixel present in the output image by applying the rule to that particular pixel and its neighboring pixels in the input image.

Segmentation

Segmentation is dividing image into regions and objects. Under the procedure of segmentation an image is partitioned into its constituent parts or objects. Segmentation partitions an image into distinct regions that contains each pixel having similar attributes. These regions should strongly relate to features of interest. Meaningful segmentation is the first step from low-level to high-level image description in terms of features, objects, and scenes. Segmentation determines the success of image analysis. Segmentation techniques are of two types, contextual and non-contextual. The latter group pixels together based on some global attribute e.g. grey level or color. Contextual techniques additionally exploit these relationships, e.g. group together pixels with similar grey levels and close spatial locations.

Discovering discontinuities

Derivatives are used to discover discontinuities in the image. A line is considered as a one-dimensional function f(x). The first derivative is calculated as the difference between two adjacent pixels.

$$\frac{\partial f}{\partial x} = f'(x) = f(x+1) - f(x)$$

$$\frac{\partial^2 f}{\partial x^2} = f''(x) = f(x+1) - 2f(x) + f(x-1)$$

Formula 2: Difference between two adjacent pixels

Detection of isolated point

Laplace function (second order derivative) is used over a two dimensional function.

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2}$$

$$\frac{\partial^2 f(x,y)}{\partial x^2} = f(x+1,y) - 2f(x,y) + f(x-1,y)$$

$$\frac{\partial^2 f(x,y)}{\partial y^2} = f(x,y+1) - 2f(x,y) + f(x,y-1)$$

$$\nabla^2 f(x,y) = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$

Formula 3: Laplace function

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Similarly, line and edge detection can be done.

Representation and description

Segmentation stage, followed by both representation and description, is generally a raw pixel data that consists either the boundary of a region or all the points in the region. Representation helps in changing the raw data into a form that is suited for further computer processing. Attributes are extracted that help in differentiating objects of different classes to provide information that comes under the description part.

Object recognition

The process of recognition is used to identify or assign a label, like "fruit" to an object after it has been recognized and match the description.

IMAGE FILTERING

Filtering is used for modifying or enhancing any image. An image is filtered to emphasize or remove certain features. Smoothing, sharpening, and edge enhancement are some image processing operations implemented with filtering. Filtering can be called a neighborhood operation, where on applying algorithms to values of the pixels in the neighborhood (location of a set of pixels relative to that pixel) of the corresponding input pixel, determines the value of any given pixel in the image obtained as output. For image filtering and enhancement power law transformations, contrast stretching, median filter, negative image transformation, histogram equalization are used.

Image filtering algorithms

Median filter

This [8] [9] method which is a low-pass filtering, non-linear method, is basically used for removing image salt-and pepper noise. It has a potential to remove all the noise. The pixels that are clean are not affected. Isolated pixels are removed; it doesn't matter whether they are bright or dark.
Median Filter Algorithm

- Read the image from left to right, top to bottom pixel by pixel.
- Initiate a 3 x 3 mask (neighborhood windows), starting from the pixel, whose value is going to change after filtering.
- Extract all 3 x 3 mask elements and put into the 1-D element array.
- Sort the 1-D element array in ascending order.
- Extract the middle value of sorted element array Replace the current pixel value in the image with the medium pixel value in the 1-D element array,
- Move to the next pixel.
- Repeat steps 3 to 6 until end of the image.

Contrast stretching

This method attempts to improve an image by stretching the intensity values' range it contains to make full use of possible values. The restriction is to linearly map input values to output values.
Contrast stretching Algorithm

- Read the image pixel by pixel.
- Determine the limits over which image intensity values will be extended. These lower and upper limits will be called a and b, respectively (for standard 8-bit Gray scale pictures, these limits are usually 0 and 255).
- Compute the value limits (min. = c, max. = d) in the unmodified picture.
- Then for each pixel, the original value r is mapped to output value s using the function,
- $s=(r-c)\{(b-a)/(d-c)\}+a$

Histogram equalization

This technique is commonly used to enhance the images. For example, there is a dark image. As a result, its histogram will lie towards the end or lower end of the grey scale and all the image details are gathered into the dark end of the histogram. A much clearer image can be obtained on expanding the grey levels present at the dark end and thereby, producing a histogram that is distributed uniformly.
Histogram equalization Algorithm

- Read the image pixel by pixel.
- Counts the occurrence of each pixel value in the image (256 values).
- Compute the cumulative number of pixels (unscaled values).
- Multiply each unscaled value with the scaling factor [G-1/MxN] to obtain the new scaled value.

Where G is the maximum grey level, M is the number of image rows, N is the number of image columns.

- Allocate a nearest available brightness values to the new scaled value

Transformation of negative image

We obtain the negative of an image by the negative transformation where grey levels lie the range [0, G-1] expressed as, s = G - 1 – r. The result of this expression is producing a negative like image by just the reversal of the grey level intensities of that image. Direct mapping of the result into the grey scale is done.

Power law transformation

It is also called as gamma correction. Different levels of enhancements can be obtained for various values of γ. Different monitor display show images having different clarity and light level and so, nowadays, almost every monitor has built-in gamma correction in it and to give user the best experience monitors correct and improve all images shown on it automatically.

APPLICATIONS OF DIP

DIP has shown a good growth in recent years especially in the fields of computer science and technology. The advances and wide availability of image processing hardware has further increased the usefulness of image processing.

Medical applications

The field of medicine has a wide use of digital image processing. Gamma ray imaging is based on gamma ray detection and is used in nuclear medicine where a patient is injected with radioactive isotope that emits gamma rays as it decays. These emissions are collected by gamma ray detectors and images are produced. X ray imaging is used in medical diagnostics. Magnetic resonance imaging (MRI) is a technique where patient is placed in a powerful magnet and pass radio waves through his body in short pulses. Each of the pulses causes a responding pulse to be emitted by the patient's tissue. Digital subtraction angiography (DSA), Projection radiography and x-ray computed tomography (CT), Ultrasound imaging using reflection of ultrasonic waves within the body are also used.

Restorations and enhancements

This is a process of transforming a corrupt image into a clean image free of noise. Noises or corruption can be of various forms like camera mis-focus, motion blur, etc. Image restoration is usually done by reversing the cause of noise. Its main objective is to reduce the noise and recover the loss of resolution. The techniques to process the image are performed in either of the two domains, image or frequency. Deconvolution technique which is the most used technique is performed in the frequency domain.

Pattern recognition

For better character recognition and understanding of different patterns, it requires the removal of noise. After recognizing the pattern, relationships about the characters and information from it is extracted for representing the pattern. The pattern is then classified on the basis of representation. To solve pattern recognition issues, there are two approaches, structural approach and discriminant approach. In the latter, a set of features are taken out from the pattern. Feature vectors and division of feature space helps in detecting each pattern. Whereas, in the former method, each pattern is displayed as a combination of its parts or components also called sub patterns or pattern primitives. Now by matching and referring each pattern structure according to a set of predefined rules, pattern recognition is done.

Computer vision

Computer [1] vision as the name suggests is the ability of computers and machines to see. Computer vision works on the idea of artificial intelligence where machines are designed so as to obtain useful information from images. The 2-D images are transformed into 3-D for a better perception of object. The image data can be of various types like video sequencing, different views from multiple cameras, multidimensional image from medical scanners, etc. Some examples are:

- Controlling processes (e.g., robots and automatic machinery used in industries).
- Detecting events (e.g., people counter).
- Organizing information (e.g., arranging in sequence or indexing database of pictures).
- Modeling objects or environments (e.g., testing of industrial products, medical use where image study is required).

Face detection

Face detection is the technology where location, sizes and other features of human face is detected from the image ignoring every other thing in the image. Early algorithms for face-detection focused on the detection of front side of human faces, whereas latest algorithms solve the recurring problem of multi-view face detection. Multi-view face detection is either in-plane rotation where rotation is along the axis from

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the present face to the position of observer or it can be out-of-plane rotation where the rotation axis is left-right or vertical.

Remote sensing

Remote sensing is based on the idea of obtaining information about any object by either the use of recording or wireless sensing devices that are not in contact with the object. the examples of remote sensing are, images taken from satellites that tell about the condition of earth, weather detection that affect the voyage of ships, take offs of planes and other human activities, medical uses including MRI, PET, X-RAY.

There are a variety of other applications. First is the category of video processing that also covers digital cinema and the concept of high resolution display and super high definition (HD) image processing. Second, a variety of hybrid techniques that are a basis of agriculture and other related areas also form a part. Third, fields of interest for the present and the upcoming generation like image transmission and coding and robot vision which will be an essential part of upcoming technology.

RECENT TRENDS OF DIP

OCR designed for Indian regional languages

OCR, [10][11] expanded as Optical character recognition is type of text translator. It detects the text and the converts it into a machine editable form. In the machine, text can be either handwritten or typed. Applications of OCR include clearance of bills in shops and shopping malls, clearing of stocks, desktop publications, sorting or cataloguing in libraries. Post mails, cheques, and many other documents are sorted using the automatic reading technique. As the topic suggests, this is a research on how Indian regional languages can be interpreted. The figure [Fig.6] will give you an idea about how the procedure is carried out.

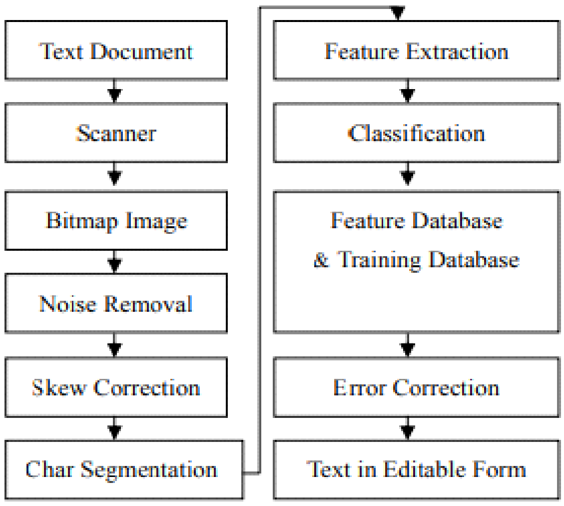

Fig.7: Flowchart of OCR process

Firstly, the text whether in paper or in the form of typed document, is scanned and converted into an image. This image is passed into an OCR. The image is then processed by detecting and removing the noise to obtain a better version of it. Screw correction is then applied to improve the image alignment. To study the characters, they are separated using the segmentation step. After this, the character recognition is done. There are a few studies that are going on in this field. In short, image acquisition, preprocessing, feature extraction, line segmentation are some of the steps involved. A Malayalam OCR has been developed by K Jithesh. This OCR has an accuracy of 97% for good quality prints and is capable of recognizing about fifty characters per second. A neural network based model has been proposed by Amritha Sampath which is used for recognizing handwritten text. Another model for recognizing handwritten characters has been proposed by Raju. In this model, the image processing goes through a low and high pass filters to extract the needed information. Characteristics like different handwriting styles, tilting of text, etc. is kept in mind in this model. An OCR for printed Hindi text that is written in the Devnagri script has been proposed by Veena Bansal. They have assured an accuracy of 93% for the printed text. A survey has been conducted by Aditya Raj which is based on feature extraction and classification methods that are used on OCR for Indian scripts. This survey covered 17 different Indian regional languages and also its features and the accuracy.

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CONCLUSION

Digital image processing is the method of improving the image quality to extract useful information from it. The concept of enhancing an image for better human perception or for obtaining important data from it has been carried out from centuries. Earlier analog images were processed. With the progress of science and technology, the concept of processing digital images came into existence. To process a digital image, it has to go through a series of steps. An image is first acquired. It then goes through processes like image enhancement, image restoration, image segmentation, image compression, etc. Many algorithms and formulae have been discovered in order to carry out the digital image processing. DIP has a variety of applications in present. This concept forms a basis of many medical researches and diagnosis. Important fields like computer vision, pattern recognition, remote sensing, etc. also work on the concept of DIP. Since DIP is a widely used method, it has a lot of advantages. The images processed are clear and are capable to provide even minute information. It is a faster process. It has made its place in almost every field. The process, still, is not trustworthy. Many times the information needed is not accessible. It requires big machinery and smart and qualified labor. Hence, the process is costly. Recent trends as discussed in the paper are the concept of OCR. This is an evolving field and will have a great amount of use in future. Digital image processing and enhancement can be used in the field of forensics and examination where images can be captured and or taken from video recordings, cleared and enhanced to find facts that may be useful in detecting culprits and provided as an evidence in the courts. It can also be used to medical examinations to get a better picture of diseases and recovery. It [12] may be utilized to explore space and planets. With the growth and advancement in the field of artificial intelligence and image processing, it will be soon possible to interpret spoken commands and language translation that will be useful in communication. It will also be possible to track people, locate things, and also the invention of self driven transports.

CONFLICT OF INTEREST

None

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FINANCIAL DISCLOSURE

None

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