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# Role of Image Segmentation in Digital Image Processing For Information Processing

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**ABSTRACT**
Digital Image processing is a technique using computer algorithms to perform specific operations on an image, in order to get an enhanced image or to extract some useful information from it. Image segmentation, an important phase in image processing, is the division of an image into regions or categories, which correspond to different objects or parts of objects. This step is typically used to identify objects or other relevant information in digital images. There are generic methods available for image segmentation, but each method has to be applied in a particular context combining the domain information of that particular domain.

***Keywords :-*** Digital image processing, image segmentation, edge detection.

## I. INTRODUCTION

In imaging science, image processing refers to processing of images using mathematical operations in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input may be image like video frame or photograph and output may be image or characteristics associated with that image. Image processing is a rapidly growing technology today, with its applications in various aspects of science, engineering, management, business and day to day life activities and it is a core research area too. Image Processing is a technique useful in enhancing raw images received from cameras/sensors placed for various applications including enhancing images obtained from unmanned spacecrafts, space probes and military reconnaissance flights[1]. Image Processing finds applications in areas such as Remote Sensing, Medical Imaging, Non-destructive Evaluation, Forensic Studies, Textiles, Material Science, Military, Film industry, Document processing, Graphic arts and Printing Industry.

## II. METHODS OF IMAGE PROCESSING

There are two types of methods used in Image Processing and they are Analog image processing and digital image processing

**1)Analog Image Processing**

Analog Image Processing refers to the alteration of image through electrical means. The most common example is the television image. The television signal is a voltage level which varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance is altered. The brightness and contrast controls on a TV set serve to adjust the amplitude and reference of the video signal, resulting in the brightening, darkening and alteration of the brightness range of the displayed image.

**2)Digital Image Processing**

In this case, digital computers are used to process the image. The image will be converted i n to digital form using a scanner or digital camera and then given as input for processing operations by digital computer. 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. The requirements 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. There are efficient software systems, both open source and proprietory, have been developed for image processing. The term digital image processing generally refers to processing of a two-dimensional picture by a digital computer and a digital image is an array of real numbers represented by a finite number of bits[2].

The main advantage of Digital Image Processing methods is its versatility, repeatability and the preservation of original data precision.

The following two principal application areas are majorily the reasons for the growing interest and demand in digital image processing :

(i) improvement of pictorial information for human interpretation, and

(ii) processing of scene data for autonomous machine perception.

Example for the first application area are the enhancement of images in medical field such as MRI image, X-ray image etc to improve the pictorial content of it , thus making it easier for human interpretation. The second application area focuses on procedures for extracting image information in a form suitable for computer processing. Examples include automatic character recognition, industrial machine vision for product assembly and inspection, military recognizance, automatic processing of fingerprints etc.

## III. STEPS IN IMAGE PROCESSING

There are some common steps in image processing as listed below, though all image processing systems would not require all steps together.

1.Image acquisition : An image is captured by a sensor such as a TV camera and it is digitized.

2.Image Preprocessing : The first step in preparing the picture for higher-level processing is called pre-processing and the purpose of pre-processing is two-fold: to eliminate undesirable features that will hinder further processing and to extract the desirable features that represent useful information in the image. Unwanted image attributes include noise (insignificant lines and contours) and the presence of featureless space and the important features include surface details and boundaries such as lines, edges, and vertices. Image preprocessing typically includes a processing step of transforming a source image into a new image which is fundamentally similar to the source image, but differs in certain aspects, e.g. improved contrast. In this step, computer suppresses noise and sometimes enhances some object features which are essential in understanding the image.

3.Image segmentation: The main aim of segmentation is to reduce the information to enable easy analysis. Segmentation is also useful in Image Analysis and Image Compression[3]. In this process, an image is divided into multiple parts and this is typically used to identify objects or other relevant information in digital images. The segmentation has two objectives - i. to decompose the image into parts for further analysis. ii. to perform a change of representation. ie., The pixels of the image must be organized into higher-level units that are either more meaningful or more efficient for further analysis.

In short, segmentation separates an image in to its component regions or objects. Image segmentation needs to segment the object from the background to read the image properly and to identify the content of the image carefully. Because of the same reason, edge detection is a fundamental tool for image segmentation.

4.Representation and description: Representation is transforming raw data into a form suitable for computer processing. Description, which is also called feature extraction, deals with extracting features that result in some quantitative information of interest or features which are basic for differentiating one class of objects from another.

5.Recognition & Interpretation : Recognition is the process which assigns a label to an object based on the information provided by its descriptors. Interpretation is the process of assigning meaning to an ensemble of recognized objects.

Of the different steps mentioned above, Image segmentation, which has emerged as an important phase in image based applications, is going to be dealt in detail in the following section.

## IV. IMAGE SEGMENTATION

Image segmentation, one of the significant aspects of image processing, is a long standing problem in the research area of computer vision. The main aim of segmentation is to extract the ROI(Region of Interest)for image analysis. The division of an image into meaningful structures, ie., image segmentation, is often an essential step in image analysis, object representation, visualization, and many other image processing tasks. Segmentation plays an important role in image processing since separation of a large image into several parts makes further processing simpler. These several parts that are rejoined will cover the entire image. Segmentation may also depend on various features like colour or texture that are contained in the image. Before denoising an image, it is segmented to recover the original image. The main aim of segmentation is to reduce the information and hence making easy analysis possible.

There exists several image segmentation techniques, which partition the image into several parts based on certain image features like pixel intensity value, color, texture, etc and these techniques are categorized based on the segmentation method used. A great variety of segmentation methods has been proposed till now and they fall in to the following major categories.

**a)Threshold based segmentation**

Thresholding is the simplest method of image segmentation. Thresholding techniques may be applied directly to an image, but can also be combined with pre and post-processing techniques. In threshold based segmentation, pixels are allocated to categories according to the range of values in which a pixel lies[4]. For example, if an image is to be segmented, pixels with values less than 128 can be placed in one category, and the rest can be placed in the other category. The boundaries between adjacent pixels in different categories of this image can be superimposed in white on the original image. The new image is said to be threshold segmented the image into the two predominant types.

There are three types of thresholding algorithms - Global thresholding, Local thresholding and Adaptive thresholding.

**i)Global thresholding** : The global threshold is applicable when the intensity distribution of objects and background pixels are sufficiently distinct. In the global threshold, a single threshold value is used in the whole image. When T depends only on f(x,y) (in other words, only on gray-level values) and the value of T solely relates to the character of pixels and this thresholding technique is called global

thresholding technique .When the pixel values of the components and that of background are fairly consistent in their respective values over the entire image, global thresholding could be used[5]. There are a number of global thresholding techniques such as: Otsu, optimal thresholding, histogram analysis, iterative thresholding, maximum correlation thresholding, clustering, Multispectral and Multithresholding.

**ii)Local thresholding:** A single threshold will not work well when we have uneven illumination due to shadows or due to the direction of illumination. Local thresholding is applicable in such situations. The idea is to partition the image into m x m sub images and then choose a threshold. If threshold T depends on both f(x,y) and p(x,y) , this thresholding is called local thresholding . This method divides an original image into several sub regions, and chooses various thresholds Ts for each sub region reasonably. After thresholding, discontinuous gray levels among sub images must be eliminated by gray level filtering technique. If threshold T depends on both f(x,y) and p(x,y), this thresholding is called local thresholding[6] . This method divides an original image into several sub regions, and chooses various thresholds Ts for each sub region reasonably. After thresholding, discontinuous gray levels among sub images must be eliminated by gray level filtering technique. Some of the local thresholding techniques are simple statistical thresholding, 2-D entropy-based thresholding and histogram-transformation thresholding.

**iii)Adaptive thresholding:** Adaptive thresholding typically takes a grayscale or color image as input and, in its simplest implementation, outputs a binary image representing the segmentation. For each pixel in the image, a threshold has to be calculated. If the pixel value is below the threshold it is set to the background value, otherwise it assumes the foreground value. In adaptive thresholding, different threshold values for different local areas are used.

Adaptive thresholding is used to separate desirable foreground image objects from the background based on the difference in pixel intensities of each region[7]. The drawback of this method is that it is computationally expensive and, therefore, is not appropriate for real-time applications.

**b)Edge based segmentation**

With this technique, detected edges in an image are assumed to represent object boundaries, and are used to identify these objects. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing[8] . Image Edge detection significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image.

**c)Region based segmentation.**

Where an edge based technique may attempt to find the object boundaries and then locate the object itself by filling them in, a region based technique takes the opposite approach, by (e.g.) starting in the middle of an object and then "growing" outward until it meets the object boundaries. In this technique, pixels that are related to an object are grouped for segmentation.The thresholding technique is bound with region based segmentation. The area that is detected for segmentation should be closed. Region based segmentation is also known as Similarity Based Segmentation. There would not be any gap due to missing edge pixels in this region based segmentation. The boundaries are identified for segmentation. In each and every step at least one pixel is related to the region and is taken into consideration. After identifying the change in the color and texture, the edge flow is converted into a vector[3].From this, the edges are detected for further segmentation.

**d)Morphological methods**

In image processing, morphology is the name of a specific methodology for analyzing the geometric structure inherent within an image. Morphological techniques verify the image with a small template called structuring element. This structuring element is applied to all possible locations of the input image and generates the same size output. In this technique the output image pixel values are based on similar pixels of input image with is neighbors. This operation produces a new binary image in which if test is successful it will have non-zero pixel value at that location in the input image. There are various structuring elements such as diamond shaped, square shaped and cross shaped. The base of the morphological operation is dilation, erosion, opening, closing expressed in logical AND, OR notation and described by set analysis. The morphological filter which can be constructed on the basis of the underlying morphological operations, are more suitable for shape analysis than the standard linear filters since the latter sometimes distort the underlying geometric form of the image. Morphological watersheds is also a morphology based technique, but unlike the typical morphological filters, the watersheds transformation is not composed of the primitive morphological operations. The initial concept of the watersheds transformation as a morphological tool was introduced by H. Digabel and C. Lantuéjoul[9]. Later, a joint work of C. Lantuéjoul and S.Boucher led to the development of extension of this algorithm to the more general framework of grayscale images. Watershed represents the boundaries between adjacent catchments. If one combines the grey level of each point at an altitude, it is possible to define the watershed transform as the ridge forming the boundary between two watersheds. This is to compute the watershed of the said relief and watersheds thus obtained correspond to regions of the image.

**d)Model based segmentation**

Markov Random Field (MRF) based segmentation is known as Model based segmentation. An inbuilt region smoothness constraint is presented in MRF which is used for color segmentation. Components of the color pixel tuples are considered as independent random variables for further processing. MRF is combined with edge detection for identifying the edges accurately[10].

**e)Clustering techniques.**

Segmentation is also done through Clustering. A basic clustering algorithm such as K-means is used for segmentation in textured images. It clusters the related pixels to segment the image. Segmentation is done through feature clustering and there it will be changed according to the

color components. Segmentation is also purely depending on the characteristics of the image. Features are taken into account for segmentation. Difference in the intensity and color values are used for segmentation. For segmentation of color image, Fuzzy Clustering technique can be used, which iteratively generates color clusters using Fuzzy membership function in color space regarding to image space. The technique is successful in identifying the color region. In real time clustering based segmentation, A Virtual attention region is captured accurately for segmentation[3]. Image is segmented coarsely by multithresholding. It is then refined by Fuzzy C-Means Clustering. The advantage is applied to any multispectral images. Though clustering is sometimes used as a synonym for agglomerative segmentation techniques, this term is used here to denote techniques that are primarily used in exploratory data analysis of high-dimensional measurement patterns. In this context, clustering methods attempt to group together patterns that are similar in some sense. Clustering is a powerful technique that has been used in image segmentation. The cluster analysis is to partition an image data set into a number of disjoint groups or clusters. K means clustering is one of the popular method because of its simplicity and computational efficiency[11].

## V.EDGE BASED DETECTION TECHNIQUES

Since edge detection is in the forefront of image processing for object detection, it is crucial to have a good understanding of edge detection algorithms. The edge representation of an image significantly reduces the quantity of data to be processed, yet it retains essential information regarding the shapes of objects in the scene. This explanation of an image is easy to incorporate into a large amount of object recognition algorithms used in computer vision along with other image processing applications. The major property of the edge detection technique is its ability to extract the exact edge line with good orientation. It is generally difficult to judge the performance of the edge detection techniques. The performance of edge detection techniques are always judged personally and separately, dependent to its application[12]. Edge detection is a fundamental tool for image segmentation. Edge detection methods transform original images into edge images benefits from the changes of grey tones in the image. In image processing especially in computer vision, the edge detection treats the localization of important variations of a gray level image and the detection of the physical and geometrical properties of objects of the scene. It is a fundamental process detects and outlines of an object and boundaries among objects and the background in the image. Edge detection is the most familiar approach for detecting significant discontinuities in intensity values.

Edges are local changes in the image intensity. Edges typically occur on the boundary between two regions. The main features can be extracted from the edges of an image and this provides major features for image analysis. These features are used by advanced computer vision algorithms. Edge detection is used for object detection which serves various applications such as medical image processing, biometrics etc. Edge detection is an active area of research as it facilitates higher level image analysis. There are three different types of discontinuities in the grey level like point, line and edges[13]. Spatial masks can be used to detect all the three types of discontinuities in an image.

There are many edge detection techniques in the literature for image segmentation. The most commonly used discontinuity based edge detection operators are Roberts edge detection, Sobel Edge Detection, Prewitt edge detection, Kirsh edge detection, Robinson edge detection, Marr-Hildreth edge detection, LoG edge detection and Canny Edge Detection. The performance of edge detectors are to be evaluated as there is no guarantee that the edge detectors can detect all edges[14]. Some of the problems of the edge detectors are – missing valid edge points, classifying the noise points as valid edge points and smearing edges.

Edge detectors often do not produce continuous edges. Often the detected edges are not sharp and continuous due to the presence of noise and intensity variations. Therefore edge linking is used to detect the presence of edges and to connect them to their neighbours to avoid breaks. Continuity is ensured by techniques such as hysteresis thresholding and edge relaxation[15]. Thresholding produces uniform

regions based on the threshold criterion. Edge relaxation is the process of re-evalutation of pixel classification using its context.

## VI.CONCLUSION

Segmentation of region of interest in real world images is the one major hurdle for effective implementation of image processing applications as segmentation process is often difficult. The success or failure of image segmentation determines the success of image processing applications. Therefore the user has to try many segmentation algorithms and pick an algorithm that performs the best for the given requirement[16]. Validation of a segmentation algorithm is carried out to evaluate the accuracy of the segmentation method based on a truth model[17]. Several works are in progress researching in improving the efficiency of segmentation algorithms.

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