IMAGE SEGMENTATION AND ITS CONSIDERABLE METHODOLOGIES IN THE DOMAIN OF DIGITAL IMAGE PROCESSING

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Abstract: Image segmentation is an elemental step in the process of extraction of some useful information from digital images. It tends to divide the image into various regions, the regions may be entities of the real world contained in the scene whose image is being considered. The main objective of segmentation is to make the representation of an image simpler and much easier to evaluate. Image segmentation finds its practical applications in the field of medical imaging and diagnosis, object recognition and detection tasks in the field of artificial intelligence etc. A wide class of problems in segmentation can be accomplished using lower processing levels; however in case of complex scenes, a simple general approach may not lead to correct and complete segmentation, so a means of higher processing levels that use certain specific knowledge of the problem domain is necessary. There is no generally accepted segmentation algorithm that can work for all types of images, a wide range of segmentation algorithms are available that are combined with all necessary information regarding the particular problem area to solve the problem. Any segmentation algorithm can be chosen according to its suitability for the problem in hand.

Keywords: sobel, watershed, MRF, threshold, segmentation, clustering, threshold, canny

1. INTRODUCTION

Digital image processing is one of the emerging area of research in the field of computer science. Due to the latest technological improvements, the manipulation of images by means of digital computer has become easier. In the case of digital image processing we can use wide variety of algorithms in order to extract the features of images as well as to improve the quality of the images by removing all the useless picture elements as well as the noise signals[1].

Image segmentation is an elemental step involved in the field of digital image processing [1][2].The main aim of this technique is to divide or segment an image into various parts or regions such that those regions may have direct relationship with the objects present in the image. The image that is taken under consideration can be coloured or monochromatic in nature[2].The main idea of segmentation is to divide the image into various partitions such that they can be distinguished on the basis of certain attributes like brightness, intensity of colours etc. Segmentation helps in extracting certain necessary information from the image [1] and hence make evaluation easier. Image segmentation is used in number of applications like biological sciences ,robotics etc[1][2].The process of segmentation may find hindrances in segmenting an image while it is being applied to certain medical applications, therefore to achieve correct outcome we need to use different algorithms related to segmentation. The concepts of object recognition, hurdle detection, learning in case of robots etc can be included together in the domain of digital image processing[2]. It is

important to continue applying the process of segmentation to an image until a point is reached where a desired object can be obtained from an image. The manipulation of images in the field of digital image processing is a three level procedure called as Image Engineering. The lowest level involves the manipulation of image at the pixel level that is pixel level processing of images. At the middle level we perform image analysis. Image segmentation acts as an important step from the lower level to the middle level of operation. The higher level of operation deals with the explanation and interpretation of the original image [3].
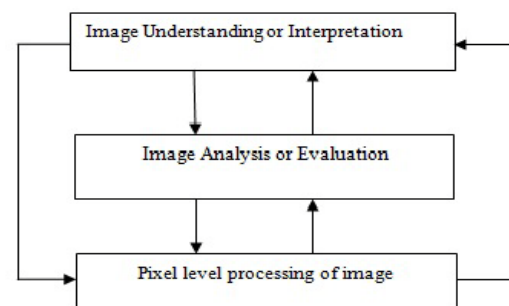

Figure 1: Image Engineering Framework[3]

2. IMAGE SEGMENTATION METHODOLOGIES

Image segmentation is a process of partitioning a digital image into multiple regions where each part refers to a set of pixels; the pixels in each region are identical according to

the principle of homogeneity [5]. Image segmentation algorithms can be divided on the basis of two properties:

- **Detection of discontinuities:** It means to do the partitioning of the image based on detection of abrupt changes in the features of image like intensity [5].
- **Detection of similarities:** It means to do the partitioning of image into number of regions that are identical with respect to certain criteria [5].

A. Segmentation based on edge detection: In this technique, a boundary of an image which is to be segmented is identified. The edges are detected to identify the discontinuities in an image. We find the edges in an image by identifying the pixel values which are then compared with the values of neighbourhood pixels. There are number of edge detectors that are used to detect the edges of an image so as to perform the segmentation like canny, sobel etc [1].

1. Gradient Based method: Gradient means the first derivative of an image. In this method convolution of gradient operator with the image is done. Rapid transition between two regions occurs when there is high value of gradient magnitude [5].

B. Threshold method: This is simple yet powerful and most commonly used segmentation method [5].It is used to differentiate the foreground from the background. In this technique, a grey scale image gets converted into the binary image [2].We choose a proper threshold 'T' to do the partitioning of the image and separate the objects from the background. A pixel (x, y) is considered to be the part of the object if its intensity is greater or equal to the threshold 'T', otherwise the pixel belongs to the background. According to the selection of 'T', there are two types of thresholding methods; Local and global thresholding. In case of global thresholding the value of 'T' remains constant, this method can fail when the illumination of background is not even. However in case of local thresholding, 'T' is not constant and there are number of thresholds used so as to compensate where there is uneven illumination. The shortcoming of this method is that it cannot be applied to the images comprising of multiple channels. Thresholding is also sensitive to noise as the spatial characteristics of an image are not taken into consideration [5].

C. Region Based Segmentation: It is a simpler technique and has higher immunity to noise as compared to edge detection method .The division of image into several regions is done on the basis on certain criteria[5].

1. Region growing method: This method starts with a set of seed pixels, the region grows by adding the neighbourhood pixels that have common properties to the seed pixel [2].

2. Region splitting and merging: In case of region splitting we split an image into number of regions that are coherent with respect to themselves. While as region merging is just the opposite case of region splitting [2].

D. Artificial Neural Networks: A neural network simply mimics a human brain. It is also called as neural net. The artificial neural networks are used to solve the issues related to image segmentation in the field of medicine. Here the basic element of computation is a node [4].

E. Clustering: It is a method in which we make clusters of images that are similar in features. The process of checking the similarity is dependent on the implementation. By using the clustering technique we can detect a group of people in an image on the basis of distance [6].

1. K means algorithm: This is the basic clustering algorithm. This algorithm is used in the case of textured images [1]. It is based on the principle that the sum of squared distances from all points to the centre of cluster in the cluster domain must be minimum [2].

2. Fuzzy K means algorithm: This algorithm is based on two steps. Firstly the smoothing of histogram is done for each of the colour component, the first and second order derivatives of the histogram are obtained to find the valleys in the histogram that are treated as thresholds later on. A certain area around the threshold is considered safe and accordingly the pixels that are not falling in the safe region are assigned to the cluster based on colour values , a centre of cluster is also calculated .This whole step is known as coarse segmentation. This step is followed by the assignment of each pixel that belongs to safe region to the closest possible cluster by calculating some fuzzy membership functions. This step is hence known as fine segmentation [2].

F. watershed method: In this method the concept of mathematical morphology is used. In the classical way, we first pierce the regional minima of the surface of an image. Then the image is slowly immersed into a lake of water. The water will try to flood the image around the basins related to different minima. A dam is erected in between the waters so as to avoid their merging. The dam will act as a watershed when the image is completely immersed in the water [1].

G. Pattern Recognition method: This method is used to model the relationship between the input and the output. However this is one of the complicated methods to implement and has certain restrictions on shape and size [1].

H. Inversion method : This method is used to produce the facial movement of a given face based on the continuous muscle activity [1].

I. Model based method: This method is also known as markov random field (MRF) based segmentation. It is used in doing colour segmentation of images. It is a very faster method that other traditional methods.

3. COMPARISON OF VARIOUS TECHNIQUES

Here a brief summary regarding the merits and demerits of various segmentation algorithms is discussed.

Edge Detection method
Merit:
This algorithm is quite efficient in nature.
Demerit:
Produces distorted output due to the deformations in the transitions.

Threshold method
Merits:
a. This algorithm is applicable for real time applications.

b.   It is cost efficient.

Demerits:

a.   This Algorithm is sensitive to noise.

b.   Here some useless edges are created because spatial transformations are not considered here.

Region based method

Merits:

a.   This algorithm is highly pliable in nature.

b.   Easy for implementation.

Demerit:

Here accuracy varies due to the selection of seed point.

Artificial neural networks

Merit:

This algorithm can utilise the properties of neural networks very well and hence we donot need to write complex programs .

Demerit:

a.   It takes time to train the neural networks.

b.   Result may be affected by the process of initialisation.

c.   It is necessary to avoid over training of network.

Clustering method

Merit:

This algorithm relies on the use of basic algorithm.

Demerit:

It has high complexity in terms of time and space.

Watershed method

Merits:

a.   This model is based on morphology.

b.   By this, the capture range is improved.

Demerit:

In this algorithm there may the risk of over segmenting an image.

Pattern recognition method

Merit:

This method maps the relationship between the input and output.

Demerits:

a.   Its implementation is complex.

b.   Here we have certain constraints on the shape and size.

Inversion method

Merits:

a.   In this algorithm, we obtain good quality of briskness.

b.   Non-linear optimizers are used.

Demerit:

A same output may be produced due to different EMG.

Model based method

Merits:

a.   It can be accustomed for colour segmentation.

b.   It is highly galloping than the traditional approach.

Demerits:

There should be some similitude between the image elements.

4. ADVANTAGES OF SEGMENTATION IN VARIOUS FIELDS

- In case of medical imaging, suppose a patient comes with the symptoms of headache, blurred vision etc. On performing CT scan of the brain, that is usage of segmentation, it reveals tumour.
- In case of object detection that is detection of hurdles, faces etc and recognition of images.
- Recognition tasks such as finger print recognition, iris detection etc.
- In the field of criminology, metrology, industrial works etc.

5. DISADVANTAGES OF SEGMENTATION

Image data ambiguity in one of the main problems often accompanied by information noise. There are number of segmentation algorithms available, however it is necessary to use the appropriate algorithms according to our specific needs. For certain tasks the segmentation techniques become unattractive due to the huge computational costs.

6. CONCLUSION

This paper presents a review of segmentation and various techniques used in segmentation. A number of segmentation algorithms are present by which we can perform segmentation of images that are either simple or complex in nature. Segmentation algorithms are ad-hoc in nature, however the complexity of different algorithms may vary from each other. Image segmentation is a very challenging field and is yet in the critical phase of its development.

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