SEGMENTATION TECHNIQUES IN IMAGE PROCESSING

Preeti Panwar
Department of Computer Science & Applications, Kurukshetra University, Kurukshetra
preetipanwar102@gmail.com
Girdhar Gopal
Department of Computer Science & Applications, Kurukshetra University, Kurukshetra
girdhar.gopal@kuk.ac.in
Rakesh Kumar
Department of Computer Science & Applications, Kurukshetra University, Kurukshetra
rakeshkumar@kuk.ac.in

ABSTRACT

Image processing is a form of signal processing. One of the mostly used operations of image processing is image segmentation. Over the last few year image segmentation plays a vital role in image processing . The goal of image segmentation is to partition the pixels into silent image segments i.e., these segments corresponding to individual objects, natural parts of objects, or surface. The problems of digital image segmentation represent great challenges for computer vision. Segmentation techniques which are used in image processing are edge based, region based, thresholding, clustering etc.In this paper, different image segmentation techniques have been discussed.

Keywords: Image, Digital Image processing, Image segmentation, Thresholding.

1. Introduction

Image processing is the general issue in today's world, in the field of computer vision. Image processing is the form of signal processing where both the input and output signals are images. An image may be defines as a two-dimensional functional, f(x, y), where x and y are spatial coordinates, and f is called the grey level or intensity of the image at that point. Images can be two-dimensional signals via a matrix representation, and image processing can be understood by employ one-dimensional signal processing techniques to two-dimensional signals. Applications of image processing are satellite imaging, medical imaging, photography, and image compression etc[1]

Image processing basically includes the following two steps:

- Importing the image via image acquisition tools;
- Analysing and manipulating the image.

1.1 Methods of image processing:-

There are two type of methods used for image processing namely, analog and digital image processing.
Analog image processing refers to the modification of image through electrical means. The most common example is the television image. Analog image processing is mainly used for the hard copies like printouts and photographs.
Digital image processing: - The term digital image processing generally refers to processing of a two-dimension image by a digital computer. The principle advantages of digital image processing methods are its repeatability, versatility, and the preservation of original data precision. The three general phases of digital image processing are pre-processing, enhancement, display information extraction.

2. Digital image processing:

Digital image processing uses computer algorithm to perform image processing on images to improve the quality of the image by removing noise and other unwanted pixels and also to obtain more information on the image. There are fundamental steps in digital image processing. These steps are image acquisition, image enhancement, image restoration, color image processing, wavelets and multi resolution processing, compression, morphological processing, segmentation, representation and description, object recognition. [2] The fundamental steps of image processing are as follows:

1. Image acquisition: Image acquisition is refer as to acquire the image. Acquisition is

as simple as an image that is already in digital form. Generally, image processing is involves by the image acquisition.

2. Image enhancement: Image enhancement is among the simplest and most appealing areas of digital. The enhancement techniques are used to enhance the detail that is simply to highlight certain features of an image.
3. Image restoration: Image restoration is used to improving the appearance of an image. Image restoration techniques tend to be based on mathematical or probabilistic models of image degradation.
4. Color image processing: Color image processing is an area that has been widely used now days because of rapidly use of digital image over the internet.
5. Wavelets: Wavelets are used for representating images in various degrees of resolution. Basically this is used for pyramidal representation and image data compression in which images are subdivided successively into smaller regions.
6. Compression: Compression is a technique that is used for reducing the storage required for saving an image or the bandwidth required for transmitting it.
7. Morphological processing: Image components that are useful in representation and description of shape are extracted from morphological processing and it deals with image extraction tools
8. Segmentation:Segmentation subdivides an image into its essential parts or objects. The level of subdivision is depends on the problem being viewed.
9. Representation and description: Representation and description follow the output of a segmentation stage, which usual is row pixel data, constituting either the boundary of a region or all the points in the region itself.
   Description also called feature selection, deals with extracting the information that result in some qualitative information of interest. It differentiate the one class of objects from another.
10. Recognition: - Recognition is the process of assigning a label (e.g. “vehicle”) to an object based on its descriptors.[3]

3. Image segmentation

Among the various image processing techniques, image segmentation is very important step to analyse the given image and extract data from them[4]. Segmentation is a process to subdivide the image into small image region and that region corresponding to individual surfaces, objects, or natural parts of objects. The level of subdivision is depending on the problem being solved. That is, segmentation should stop when the objects of interest have been achieved.

The goal of segmentation is to change and simplify the representation of an image into something that is more useful and simple to analyse. However, it is the process of assigning a label to every pixel in an image such that pixels with the same label have some predefined characteristics. All of the pixels in a region are similar with respect to some property such as colour, intensity, or texture. Some applications of image segmentation are image processing, medical imaging, computer vision, digital libraries, face recognition, image and video retrieval, satellite image. [5].Based on different technologies, image segmentation approaches are currently divided into following categories, based on two properties of image.

Detecting Discontinuities:-It divide an image based on short change in intensity, this includes image segmentation algorithms like edge detection.[1]

Detection Similarities:-It divides an image into regions that are similar according to a predefined criterion, this includes image segmentation algorithm like region growing, and region splitting and merging, thresholding.[6]

3.1 Edge-based techniques:

Edge detection is a major tool for image segmentation. Edge defines the boundaries between regions in an image. Edge detection of an image significantly reduces the amount of data and filters out unusable information, while keep the important structural properties in an image.

It could detect the variation of grey levels, but it is sensitive to noise. It is main tool in pattern recognition, image segmentation, and scene analysis.[7] Edge are local changes in the image intensity edge typically occur on the boundary between two regions. The main features are extracted from the edges of an image. Edge detection has major features for image analysis. These features are used by advanced computer vision algorithm. Edge detection is used for object detection which gives various applications like biometrics, medical image processing etc.[8]

There are three different types of discontinuities in the grey level like line, point and edges. Spatial masks can be used to detect all the three types of discontinuities in an image. All the edge detection operators are grouped under two groups are:-

1. 1^{st} order derivative: - 1^{st} order derivatives are Sobel operator, Canny operator, Prewit operator, Test operator.
2. 2^{nd} order derivative: - 2^{nd} order derivatives are Laplacian operator, Zero-crossing.[6]

3.2Region based techniques:

Region based methods are based continuity. This technique divide the entire image into sub regions depending on some criterion like all the pixels in one region must have the same grey level. The simplest approach to segment image based on the similarities assumption is that every pixel is compared with its neighbour for similarity check (for grey level, texture, color, shape).

Region based technique is relatively simple and more immune to noise as compare to edge detection method. Edge based method divide an image based on changes in intensity near edge whereas region based methods, divide an image into region that are similar according to set of predefined criteria.[9]

Region growing: - Region growing is a techniques for extracting a region of image based on predefined criterion .Region growing can be prepared in four steps:-

1. Select a group of seed pixels within an image.
2. Select a set of similarity criterion such as grey level intensity or color and setup a stopping rule.
3. Grow regions by attaching each seed those have predefined properties similar to seed pixels.
4. Stop region growing when no more pixels met the criterion for inclusion in that region.[10]

Region splitting and merging: - This method segment the image based on homogeneity criteria. This method works on the basis of quadtrees. It considers the entire image as a single region and then divides the image into four regions based on certain predefined criteria. It checks the regions for the same defined criteria and divides it further into four regions if the test result is negative and the process continues till the criteria is defined. [4]

3.3Thresholding:

Image segmentation by thresholding is a simple but powerful approach for segmenting images. It is useful in select foreground from background. Thresholding operation convert a multilevel image into a binary that is it chooses a proper thresholding T, to divide image pixels into several regions and separate objects from background. Any pixel (x, y) is belong to object if its intensity is greater than or equal to threshold value i.e., $f(x, y) \geq T$, else pixel belong to background. [11]

Based on the selection of threshold value, there are two type of thresholding method:-

1. Global thresholding: - Global thresholding is used when the intensity sharing between the objects of foreground and background are very distinct, a single value of threshold can simply be used to separate both objects apart. In this type of thresholding, the value of threshold T depends on the property of the pixel and the grey level value of the image. Some of the common used global thresholding methods are Otsu method, entropy based thresholding, etc.
2. Local thresholding: -This method divides an image into several sub regions and then chooses different thresholds Ts for each subregion respectively. Some common used local threshold techniques are 2-D

entropy-based thresholding histogram transformation, simple statistical thresholding.[12]

3.4Clustering:

Clustering is an unsupervised learning task. Clustering is defined as process of grouping object based on attributes, so that object with similar attributes lies in same cluster. Clustering is used for the purpose of pattern recognition, image processing, data analysis, and more.Clustering algorithm is classified as hard clustering, k-means, fuzzy clustering, etc.[13]

Hard clustering: - Hard clustering assumes that a pixel can only belong to a single cluster. Thereexist sharp boundaries between clusters. One of the most popular and well used clustering algorithms is k-means clustering algorithm. K-means clustering group n pixels of an image into k number of cluster, where k<n and k is a positive integer. The centroids of the predefined clusters are computed randomly. Clusters are formed on the basis of some similarity features like distance of pixel intensities and gray level intensity of pixels.

Fuzzy clustering: - Fuzzy clustering can be used when there are no defined boundaries between objects in an image. Fuzzy clustering divides the input pixels into cluster on the base of some similarities criterion. Similarity criterion can be distance, connectivity, intensity etc. Fuzzy clustering algorithms include FCM (fuzzy c means) algorithm, Gaussian mixture decomposition, FCV (Fuzzy c varieties), Gusatafson-kessel etc.[14]

3.5Artificial Neural Network:

A neural net is an artificial representation of human brain. It tries to simulate its learning process. In recent years, artificial neural networks areused to solve the problem of medical image segmentation. Neural network based on simulation of life, especially the human brains learning process. Each node can perform some basic computing. [15]

In this, firstly the image is mapped into a neural network where every neuron is represented by apixel. The neural network is trained with training sample set. It helps todetermine the connection and weights between nodes. With the help of trained neural network the new images are segmented. Neural network segmentation includes two important steps:

(1) Feature extraction: - The input data of neural network is determines in this step. Some important features from images are extracted.
(2) Image segmentation:- The features that are extracted from the image are segmented in this step.

Neural network have fast computing and highly parallel computing ability makes it suitable for real time application. It improves segmentation results when the data deviated from a normal situation. It is high robustness that makes it immune to noise.[12]

3. Conclusion

Digital image processing uses computer algorithm to perform image processing on the image. The overview of various segmentation methodologies applied for digital image processing is explained briefly in this paper. Throughout this study of various techniques, it is concluded that image segmentation is the crucial part of image processing. The segmentation technique of the image could be used as per the required application. Since image segmentation is affected by lots of factors such as type of image, color, intensity, level of noise, etc. thus there is no single algorithm that is applicable on all types of images and nature of problem.

Reference

[1] S. Saini and K. Arora, “A Study Analysis on the Different Image Segmentation Techniques,” *International Journal of Information & Computation Technology,* vol. 4, pp. 1445-1452, November 2014.

[2] J. Singla, “TECHNIQUE OF IMAGE REGISTRATION IN DIGITAL IMAGE PROCESSING - A REVIEW,” *International Journal of Information Technology and Knowledge Management,* vol. 5, pp. 239-243, December 2012.

[3] R. Rafael C. Gonzalez, Digital Image Processing, 2002.

[4] R. S. A. M. Khan, "Image segmentation methods:A Comparative Study," *International Journal of Soft Computing and Engineering (IJSCE),* vol. 3, no. 4, September 2013.

[5] A. G. Amandeep Kamboj, "Simulink Model Based Image Segmentation," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 2, no. 6, june 2012.

[6] H. Narkhede, "Review of Image Segmentation Techniques," *International Journal of Science and Modern Engineering (IJISME),* vol. 1, no. 8, july 2013.

[7] G. S. A. K. Pooja Sharma, "Different Techniques Of Edge Detection In Digital Image Processing," *International Journal of Engineering Research and Applications (IJERA),* vol. 3, no. 3, pp. 458-461, may-june 2013.

[8] M. Muthukrishnan.R, "EDGE DETECTION TECHNIQUES FOR IMAGE SEGMENTATION," *International Journal of Computer Science & Information Technology (IJCSIT),* vol. 3, 2011.

[9] P. G. Manjot Kaur, "A Review on Region Based Segmentation," *International Journal of Science and Research (IJSR),* 2013.

[10] P. S. D. Rajeshwar Dass, "Image Segmentation Techniques," vol. 3, no. 1, march 2012.

[11] N. K. K. S. Salem Saleh Al-amri, "Image Segmentation by Using Thershod Techniques," *JOURNAL OF COMPUTING,* vol. 2, no. 5, may 2010.

[12] A. K. A. K. Rohan Kandwal, "Review: Existing Image Segmentation Techniques," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 4, no. 4, april 2014.

[13] G. D. Mohit Agarwal, "Application of clustering technique for Image Segmentation," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 3, no. 4, april 2013.

[14] P. J. Shah Nilima, "Review on Image Segmentation, Clustering and Boundary Encoding," *International Journal of Innovative Research in Science,,* vol. 2, no. 11, november 2013.

[15] D. G. R. K. R. V. K. R. M. Jogendra Kumar, "REVIEW ON IMAGE SEGMENTATION TECHNIQUES," *International Journal of Scientific Research Engineering & Technology (IJSRET),* vol. 3, no. 6, september 2014.

[16] H. H. Z. K. M. Cheng, "Final Project Report – Image Processing Techniques," 2006.

[17] J. Singla, "Techniques of Image Registration in Digital Image," *International Journal of Information Technology and Knowledge Management,* vol. 5, pp. 239-243, december 2012.