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A Survey On Different Types Of Segmentation Techniques

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Abstract—Melanoma is a deadly skin cancer disease that needs to be detected at an early stage so that it can be diagnosed properly. Early diagnosis of melanoma can be done with accurate image segmentation of skin lesions. Segmentation is an important step to accurately define the lesion area and detect the pigmented skin lesion boundary. Segmentation aims to simplify or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is done to locate objects and boundaries in images. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. In this paper, a survey on different types of skin lesion segmentation techniques are studied.

Keywords—Segmentation, Melanoma, Lesion, Dermoscopy, Feature Extraction.

I. INTRODUCTION

Melanoma is a deadly skin cancer disease which accounts for 75% of deaths. It is a malignant tumor of melanocytes. Melanocytes produce dark pigment 'melanin' which is responsible for giving color to skin. Melanoma can be originated in any part of the body that contains melanocytes. Recent trends found that rate of occurrence of melanoma were increasing at an annual rate of 3% approximately for non-Hispanic males and females. If melanoma is detected at Stage I, the 5-year survival rate increases to 96%, but if detected at Stage-IV, survival rate decreases to 5%. It has been a challenging task to differentiate and eliminate benign skin lesions from malignant skin lesions so that a patient can be diagonised at an early stage.

Physicians use dermoscopy to facilitate the diagnosis of melanoma. dermoscopy is a non-invasive technique. A dermoscope is a device used by dermatologist to screen the skin lesion and act as a magnifier and scanner. Differentiating benign and malignant lesions is a difficult task even if we use dermoscopy. Dermoscopy as a tool is useless in diagnosing melanoma at early evolution state. But still there are some situations in which a non-specialist uses dermoscopy to suspect skin lesion using a standard camera. Here a higher detail analysis becomes important.

Segmentation of skin lesion is one of the biggest tasks to do. Segmentation sub-divides a digital image into multiple segments which simplifies the representation of an image making it more meaningful to analyze. Segmentation is a process in which every pixel in a digital image is assigned with a label to differentiate among pixels sharing same label and characteristics. Before classifying the lesion as malignant or benign and extracting features from it, a segmentation algorithm must be used to locate and identify the skin lesion. It is important that the skin lesion segmentation algorithm is accurate since the result of the segmentation is to be used as an input to melanoma classification algorithm.

II. IMAGE SEGMENTATION

Image segmentation is the foundation of object recognition and computer vision. It is the process of subdividing a digital image into multiple regions or objects consisting of sets of pixels sharing same

properties or characteristics which are assigned different labels for representing different regions or objects. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is used to locate objects and boundaries in images. Segmentation is done on basis of similarity and discontinuity of the pixel values. Image segmentation is practically implemented in many applications such as medical imaging, content based image retrieval, object detection, feature recognition (such as face recognition, fingerprint recognition, iris recognition, object recognition) and real-time object tracking in video.

The following steps have to applied for image segmentation process:

1) Preprocessing
2) Image Segmentation
3) Post Processing
4) Feature Extraction
5) Classification

The main aim of the preprocessing step is to determine the area of focus in the image. As the input image may have a certain amount of noise, it is necessary to reduce or remove the noise.The preprocessed image is segmented in its constituent sub-regions. To improve the segmented image, further processing may be required which is performed in post processing. Feature extraction is the method in which unique features of an image are extracted. This helps in reducing the complexity in classification problems and the classification can be made more efficient. Different kind of features present in an image can be intensity-based, textural, fractal, topological, morphological, etc. The aim of the classification step is to classify the segmented image by making use of extracted features. This step uses statistical analysis of the features and machine learning algorithms to reach a decision.

III. IMAGE SEGMENTATION TECHNIQUES

Several general-purpose algorithms and techniques have been developed for image segmentation. These techniques are typically combined with a domain's specific knowledge in order to effectively solve the domain's segmentation problems. There exists many different types of segmentation techniques but there is no particular method which can be applied on different types of images which would generate same result. Algorithm development for one class of images may not always be applied to other class of images. So, there are many challenging issues like development of a unified approach to image segmentation which can be applied to all type of images. Even the selection of an appropriate technique for a specific type of image is a difficult problem.

3.1. Thresholding

This is the simplest method used for image segmentation. In this method, a certain value is taken for measurement known as threshold. If the value of the pixel in an image is greater than or equal to the threshold value, then it is an object pixel or otherwise it is a background pixel. Thresholding can be applied in three ways: local thresholding, global thresholding and adaptive or dynamic thresholding. Local thresholding technique is the one in which the threshold parameters is consider over small region. Intensity distribution of object and background pixel are sufficiently distinct, then it is possible to use a global (single) thresholding on the entire image. If threshold value depends on the spatial co-ordinates (a, b) themselves then thresholding is referred as dynamic or adaptive thresholding.

Nidhal et al. [1] introduced a new segmentation method depending on histogram thresholding. This algorithm removes the effects of hair and other noise by using Wiener filter. The color image is first converted into the gray scale image and three steps namely, filtering, histogram segmentation and mathematical morphology are done to achieve the desire result of segmented skin lesion. This algorithm is evaluated by comparing its segmented images with images segmented by medical experts and measuring the distance between them by using two metrics (HM and TDR). This approach can be used efficiently to support decision-making problems in skin diagnosis.

The goal of the Wiener filter is to filter out noise that has corrupted a signal. Hammoude Distance (HM) is the measure used to measure the errors between the segmented part of physicians and the segmented part of proposed algorithm True Detection Rate (TDR) measures the rate of pixels classified as lesion by both the automatic and the medical expert segmentation.

3.2. Edge based segmentation

Edge detection is one of the fundamental methods for image segmentation and analysis. Edges are the boundaries between regions in an image, which helps in segmentation, object detection and recognition. Edge pixel is a term in image processing and computer vision, which refers to those pixels at which there is an abrupt change or discontinuity in image brightness or intensity. Edge detection methods require a balance between detecting accuracy and noise immunity in practice. Thus, edge detection algorithms are suitable for images that are simple and noise-free and produce missing edges or extra edges on complex and noisy images. There are many ways to perform edge detection. The majority of different methods may be grouped into two categories:

1) Gray Histogram Technique: In this technique, segmentation is done on the basis of a threshold value. The threshold values used can be global threshold i.e. single valued threshold being applied on the whole image, multiple threshold i.e. arbitrary number of threshold is applied on the whole image and variable threshold i.e. different values of threshold can be applied on different properties of the image. This method is very efficient as compared to other segmentation methods. First, depending upon the color or intensity a histogram is calculated from the entire pixel in the image, and then edges are located on the basis of contours and valleys in image.

2) Gradient Based Method: Gradient can be defined as change in magnitude in the image while traversing from one end to another. This method involves convolving gradient operators with the image. If the gradient magnitude is high, then there is a possibility of rapid transition from one region to another. Then these pixels which form edges and linking of these edges is done to form closed boundaries to result regions. Common edge detection operators used in gradient based method are Sobel, Prewitt, Roberts, or Canny method. Canny method results are good compared to others, but take more time.

3.3. Region based segmentation

Region based segmentation is another image segmentation method in which the image is divided into its constituent sub-divisions which has similar properties known as regions. This segmentation can be categorized into various techniques:

1) Region Growing: It is an approach of image segmentation in which pixel groups or sub-regions are grouped into larger regions based on predefined criteria of growth. One seed pixel and threshold value is selected in this process and check is conducted for every pixel for the given threshold value. If threshold is greater than pixel value then put into one region

otherwise put into another region. A small numbers of seed points are needed to represent the property of region we require. This process will be continued until all the pixels are resulting into the region.

2) Region splitting and merging: It is an approach of image segmentation in which an image is subdivided into a set of arbitrary disjoint regions and then these disjoint regions are merged to satisfy the condition of segmentation. A top-down approach used for splitting an image which results into a quad tree where an image is successively subdivided into smaller quadrant.
3) Graph Based Technique: It is based on pair wise region comparison. In Graph based approach, there is a graph G having vertices V and edges E such that G=(V, E) where each edge is connecting two vertices and have a weight w(vi, vj) which is a measure of dissimilarity between two neighboring elements vi and vj.

Nock et al. [3] proposed a segmentation algorithm based on the idea that perceptual grouping with region merging has to catch the big picture of a scene by only having primary local glimpses on it. The algorithm is based on a model of image generation which captures the idea that grouping is an inference problem.

3.4. Special theory based segmentation

Many different fields have contributed in development of better image segmentation such as clustering based technique, neural network-based technique, genetic algorithm-based technique, wavelet-based technique, and so on.

1) Genetic Algorithm Based Segmentation: A genetic algorithm is a heuristic search method that imitates the process of natural selection and evolution for optimization of search problems. Genetic algorithm is a part of evolutionary algorithms (EA), which uses techniques like selection, crossover, mutation and inheritance. Solutions are represented by a population of individual chromosomes, each made of genes having their own property. Crossover is done to combine two chromosomes to generate a new individual. Mutation is applied on a small set of individuals to alter their chromosomes which may generate optimal individuals thus, resulting optimal result.
2) Neural Network Based Segmentation: An artificial neural network is an imitation of a real nervous system. Neural networks are systems of interconnected "neurons" which communicate with each other and compute values from inputs by forward feeding or backpropagate information through the network. Each neuron represents a pixel. The mostly used neural networks are Kohonen and Hopfield ANNs.
3) Clustering Based Segmentation: Clustering is a process of grouping of pixels into various classes without any prior information such that pixels belonging to the same class should be similar to each other. This technique can be classified into two types: Hierarchical clustering and Partition clustering. In the hierarchical clustering, the distance between each pattern is calculated. In the partition clustering, centroid of cluster is calculated. Several clustering based image segmentation algorithm exists such as Fuzzy c means clustering algorithm and K-Means clustering algorithm.
4) Wavelet Based Segmentation: This technique uses wavelet transform for features extraction associated with individual image pixels. Wavelet transform has been used as a good image representation and analysis tool mainly due to its multi-resolution analysis, data reparability, compaction and sparsity features in addition to statistical properties. Wavelets provide the inpainting feature for images. Inpainting is the art of modifying an image in a form such that it is not easily detectable by an ordinary observer.

Hina et al. [2] presented a skin lesion segmentation algorithm based on genetic algorithm. This algorithm contains two phases. One is Pre-processing and the other Post-processing. In the first phase the loaded image is filtered, equalized and normalized. Then in the second phase the objects of image are segmented and features are extracted from it. Then Genetic Algorithm is applied to find out the best chromosome. The first step includes extracting R, G, B components of the digital image after it has been loaded and are shown separately.After extracting the R, G, B components a 3*3 mask Median Filter is applied to the image to remove the background noise. It is a non-linear digital filtering technique used to detect edges of the image and to smoothen it.

Histogram Equalization method includes adjusting contrast of an image. The global contrast of the image is increased by adjusting the intensities. The areas which have a lower contrast are given a higher contrast. With this the image becomes easier to analyze and the visual quality is improved. Normalization is a kind of object recognition that removes the intensity values by preserving the color values. Through normalization the shadows and lightening changes are removed. The constituent regions or objects are segmented i.e. subdivided to make the image more meaningful to analyze. Here each pixel in an object has a similar label and share certain visual characteristics. For each pixel the intensity value is found and texture vector is extracted. Then a Feature Vector Table (FVT) is obtained. At last, genetic algorithm is applied which include initialization, mutation, cross-over and selection. The process repeats itself till the best chromosome is extracted.

Avinash et al. [4] proposed an approach for color image segmentation. In this method foreground objects are distinguished clearly from the background. As the HSV color space is similar to the way human eyes perceive color, first RGB image is converted to HSV (Hue, Saturation, Value) color model and V (Value) channel is extracted, as Value corresponds directly to the concept of intensity/brightness in the color basics section. Next an Otsu's multi-thresholding is applied on V channel to get the best thresholds from the image. The result of Otsu's multi-thresholding may consist of over segmented regions, and finally K-means clustering is applied to merge the over segmented regions. Finally background subtraction is done along with morphological processing. This proposed system is applied on Berkley segmentation database.

Madan et al. [5] proposed system to achieve automatic segmentation of skin lesions from digital images using Fuzzy c-Means clustering with automatic image annotation which is carried out using different methods and by adding some new features like automatic image segmentation using Fuzzy c-Means Clustering and Automatic Image Annotation.

IV. CONCLUSION

This paper presents a review on image segmentation and its different techniques that are used in various fields such as biomedical field, computer vision, medical imaging and image processing. The review is aimed at providing an overview of current image segmentation techniques. Segmentation has a promising future and a lot of research work is required for developing a common segmentation technique which can be applied universally.

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