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# Review: Various Active Contour Based Image Segmentation Methods

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**ABSTRACT**:
**Now a days, image segmentation become the most interesting field for research, as the segmentation task which looks so simple but actually it is very broad field to work. In this review paper, we list out various techniques and briefly discuss them, models used in active contour based segmentation technique.**

**Keywords: Image segmentation, thresholding, clustering, edge detection, energy minimization**

## I. INTRODUCTION

The use of images is done in most of the fields today consisting of image processing and computer vision. Image segmentation forms an integral part of this field [1], which can be used for various applications such as Medical imaging, gaming, robot navigation, detection of unknown objects [2], etc.

Image segmentation is the process of partitioning an image into different parts [2]. Image mainly consists of object part and background part, and portioning of them makes an image more meaningful.

It refers to the process of dividing the image into a number of parts or segments. The segmentation is performed on the basis of certain characterization of the set of pixels. The pixels hence can be categorized together based on their characteristics which include the value of pixels, their color, texture, etc [3]. All the pixels are compared with their adjacent neighbors; those with different characteristics will look different when compared to the group. The basic aim of doing the segmentation procedure is to extract more information from the given image so that maximum information can be extracted. The criterion generally followed is homogenous in nature which groups the pixels on the basis of their color, texture, similarity, boundary, etc. This helps to make a contour around the desired object and hence defines the boundary of a certain area [2].

Mathematically the above statement can be explained as the image I is divided into N number of segments. The image I consists of pixels (x,y) where the image representation can be given as f(x,y). This image is then divided into subparts such as f1(x1, y1), f2(x2, y2)…., fn(xn, yn) ,[2]. The subparts are created so that maximum information can be extracted from the given image. The various practical applications of the segmentation process can range from filtering the images for better visual perception, tracking and detection of objects, medical imaging, recognition of face, eyes, etc. There are a lot of segmentation procedures the selection of a procedure depends upon the output required, type of image and its characterization[1].

The paper is divided into four subsections. Section II consists of the various techniques associated with the image segmentation, Section III consists of various techniques of Active Contour based image segmentation, Section IV and the last part Section IV concludes the review paper.

## II. IMAGE SEGMENTATION TECHNIQUES

A great variety of segmentation methods has been proposed in the past decades, and some categorization is necessary to present the methods properly here. A distinct categorization does not seem to be possible though, because even two very different segmentation approaches may share properties that differ singular categorization.

Various techniques used for Image Segmentation are:

• **Threshold based segmentation:**
Histogram thresholding and slicing techniques are used to segment the image. They may be applied directly to an image, but can also be combined with pre- and post-processing techniques [3].

• **Edge based segmentation:**

With this technique, detected edges in an image are assumed to represent object boundaries, and used to identify these objects [3].

• **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 [2].

• **Clustering techniques:**
Although clustering is sometimes used as a synonym for (agglomerative) segmentation techniques, we use it 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. This goal is very similar to what we are attempting to do when we segment an image, and indeed some clustering techniques can readily be applied for image segmentation [3].

• **Matching:**
When we know what an object we wish to identify in an image (approximately) looks like, we can use this knowledge to locate the object in an image. This approach to segmentation is called matching [2].

## III. ACTIVE CONTOUR BASED IMAGE SEGMENTATION TECHNIQUES

Edge detection refers to the boundaries where there is a sharp change in the intensity or brightness of the image [8]. Hence the obtained boundary marks the edges or the contours of the desired object. This way the object can be segmented from the image by the detection of its edges [5], [6]. The final output that is received by applying edge detection algorithm is a binary image.
Here we mainly focus on Active Contour based Image segmentation techniques which is exist under the category of Edge based segmentation. In Active Contour based segmentation [5] many algorithms are used for segmentation like Snakes model, Boundary model, Nonparametric Shape Prior Model, Geodesic Active contour model [11]etc.

**Snake Model:**

An *active contour* or *snake* [4],[5] is a curve defined in an image that is allowed to change its location and shape until it best satisfies predefined conditions. It can be used to segment an object by letting it settle much like a constricting snake around the object boundary. A snake $C$ is usually modeled as a parameterized curve $C(s) = (x(s), y(s))$, where the parameter $s$ varies from 0 to 1. So, $C(0)$ gives the coordinate pair $(x(0),y(0))$ of the starting point, $C(1)$ gives the end coordinates, and $C(s)$ with $0 < s < 1$ gives all intermediate point coordinates. The movement of the snake is modeled as an energy minimization process, where the total energy $E$ to be minimized consists of three terms:

$$E = \int_0^1 E\big(C(s)\big)ds$$

$$= \int_0^1 E_i\big(C(s)\big) + E_e\big(C(s)\big) + E_c\big(C(s)\big)\, ds$$

The term $Ei$ is based on internal forces of the snake; it increases if the snake is stretched or bent. The term $Ee$ is based on external forces; it decreases if the snake moves closer to a part of the image we wish it to move to. For example, if we wish the snake to move to edges, we may base this energy term on edginess values. The last term $Ec$ can be used to impose additional constraints, such as penalizing the creation of loops in the snake, penalizing moving too far away from the initial position, or penalizing moving into an undesired image region. For many applications, $Ec$ is not used, *i.e.*, simply set to zero. Common definitions for the internal and external terms are [10]:

$$E_i = c_1 \left\|\frac{dC(s)}{ds}\right\|^2 + c_2 \left\|\frac{dC(s)^2}{ds^2}\right\|^2$$

$$E_e = -c_3 \|\nabla f\|^2$$

Where the external term is based on the assumption that the snake should be attracted to edges of the original image $f$. By using other external terms, we can make use of different image features, making the snake follow ridges, find corner points, *etc.* The constants $c1$, $c2$, and $c3$ determine the relative influence of each term on the movement of the snake.

Figure 1 shows the object image and snake evaluation towards object. First one shows the initial snake position and in further images shows the further evaluation of snake towards object boundary. In the last image snake completely tracks the object boundary which gives shape of the object perfectly.

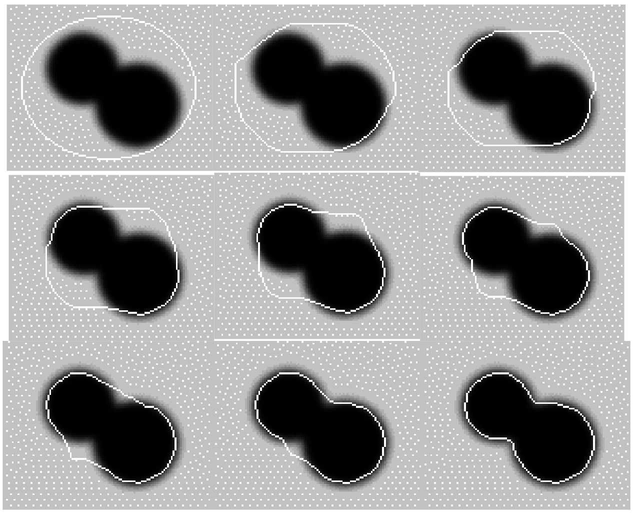


***Figure 1.*** *Example of a snake. The sequence of images shows the evolution of the snake from a user-defined original position to its final state [3].*

Snake model gives good result with the expense of more calculations and time. But it fails with low quality images [10].

**Nonparametric Shape Prior Model:**

We consider image segmentation problems that involve limited and low-quality data. Such segmentation problems are ill-posed and require the incorporation of prior information about the objects to be segmented. When human experts segment images, they clearly make use of such prior information[2], [3].

For example, a radiologist can usually manually segment an organ (e.g. the prostate) in a magnetic resonance image, although the boundaries are mostly invisible to a layperson[3].

In this section, we address the problem of estimating an unknown shape probability density[6]. Given *n* example training curves *C*1, . . . , *Cn*, we first align1 them to obtain the aligned training set *C*1, . . . ,*Cn*.. Ideally, this operation removes the pose variability in the training data, and what remains is just shape variability. The problem then is to estimate *p* ˜*C* ( ˜ *C*) from which the training samples ˜ *C*1, . . . , ˜ *Cn* are drawn.

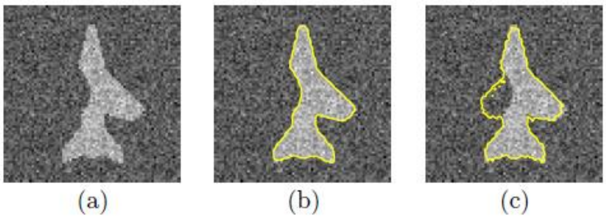
This density is a probability density over an infinite dimensional space. We would like to leave the shape of this density unconstrained, therefore we adopt a nonparametric density estimation route. Assuming that we are given a distance metric

*dC*( • , • ) in the space of curves *C*, we can form a Parzen density estimator as follows:

$$\hat{p}_{\tilde{C}}(\tilde{C}) = \frac{1}{n}\sum_{i=1}^{n} k(dC\,(\tilde{C},\tilde{C}_i),\sigma)$$

Where *k*( • *, σ*) denotes a Gaussian kernel with kernel size *σ*,
i.e.

$$k(x,\sigma) = \frac{1}{\sqrt{2\pi\sigma^2}}\, exp(-\frac{x^2}{2\sigma^2})$$



*(a)Test image. (b) Result without a shape prior. (c)Result with the nonparametric shape prior.*
***Figure 2:*** *Segmentation of an occluded aircraft image.*

Figure 2 shows airplane's image (a), low quality image), image (b) shows object detection and the third one shows prediction of the air-plane image.
Evaluation of the nonparametric shape prior for a candidate curve for segmentation is given in terms of distances between the candidate curve and the training curves. We considered the template metric and the $L2$ distance between signed distance functions, but other metrics can also be used for nonparametric shape priors.

Nonparametric Shape Prior Model gives comparatively good result with the low quality images but in this model prior information require.

## IV. CONCLUSIONS

In this paper various Image segmentation techniques are discussed, it is a very important topic in the field of image processing and computer vision. Various algorithms of Active Contour Based Segmentation are included in this paper. All these algorithms have a promising future as they have become the focus of contemporary research. Though the research in this area is being done since decades still there is no one segmentation technique that can be applied to every kind of image or which is universally accepted. There are various factors that affect the image segmentation process such as: homogeneity of images, spatial characteristics of the image continuity, texture, image content. Due to all the above factors this segmentation problem still remains a major concern in the image processing and computer vision fields.

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