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Tracking of Moving Object based on Active Contour Method

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***Abstract*— In this paper, moving objet is tracked using active contour method using level set concept. Detection of moving object based on active contour method generally gives a information about the color of object, shape and motion whether it is periodic or non-periodic. The detection of moving object is done on the basis of following steps given as first moving object is initially tracked, evolution of color contour, detection of non-periodic motion of object (adaptive shape based), detection of periodic motion of object (dynamic shape based) and abrupt motion. Moving object is also detected in low frame rate videos. First moving object is detected based on the basis optical flow algorithms. Markov Random Field theory is used for the evolution of color contour. For the detection of non-periodic motion of the object, shape information and color contour information are combined. Periodic motion is tracked by using the various techniques like shape mode transition matrix. Particle swarm optimization method is used for abrupt motion.**

***Keywords*— Actie cotour, Markov Random Field Theory, Particle Swarm Optimization, Contour evolution.**

I. INTRODUCTION

The topic tracking of moving object is an active research topic in the field of computer vision, image processing application and image segmentation. This method gives more information about the object such as color of the object, shape of the object and motion of the object whether it is periodic or non-periodic as compared to general object tracking method. This method also detects the moving object in low frame rate videos. In general object tracking method, to detect the moving object it uses shape models like rectangle, ellipse etc. While active contour based process gives more accurate and finer information about the object. The active contour based method gives an information about not only the boundary of the object but also background disturbances [1].

The background subtraction method is used in general object tracking for detection of moving object. In such cases, camera used should be stationary cameras. But in case active contour, there is no effect in process whether camera is stationary or moving camera [1]. It is one the great advantage of active contour.

A. Concept of active contour and its types

The contour of object is generally given by two representation i.e. explicit representations (represented by parameterized curves) and implicit representations (considered as a snake model). The another abbreviation for active contour is 'Snakes Model'. The active contour concept is process which is used to extract the outline of the object even the system consists of noise. The concept active contour is widely used in many applications such as computer vision, image segmentation and other image processing applications. Because of the various properties of active contour like capability of handling topological changes and numerical stability it is divided into the three categories give as edge based active contour, region based active contour and shape prior based active contour.

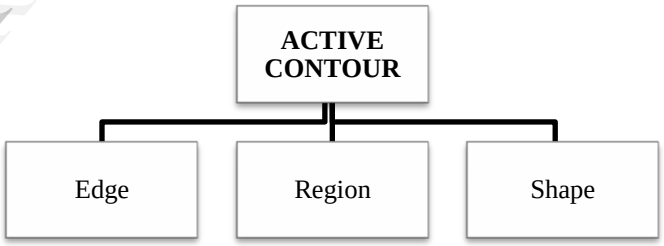

Fig. 1. Types of Active Contour

The first method is edge based active contour method which describes information near to the active contour region i.e. in the form of image gradient. The two well known models such as snakes model and geodesic model comes under this method. But this method is very sensitive to the noise. This method is very simple and easy method, effective.

The region based method is the second type of method of active contour. It is very effective method than edge based method. This method predicts the information about the contour, region near to the contour and information about the moving object using different terms such as mean, variance and histogram. Accuracy and robustness are the main advantages of this method. The color information and texture information are also predicted in this method by using the concept of Markov Random Field Theory and Gaussian Mixture Model respectively.

The last method of active contour is shape prior based method. By using Principle Component Analysis technique, this method is used to recover the blurred, disturbed contour

section. For recovering such sections, active shape model is constructed. But it is always necessary to update shape model continuously to because to adapt changes in the shape of the object. The overall summary of information is given in the TABLE I.

TABLE I. Types of active contour

Edge Method	Region Method	Shape Method
Describes the information near to contour	Describes the information near to contour and is near region	Recovers blurred contour section by using PCA
Snakes model and Geodesic model	Markov Random Field Theory, Gaussian Mixture Model	Principal Component Analysis
Adv.-Simple and effective method	Adv.-Robust and accurate method	Adv.-Effective method
Disadv.-Sensitive to noise	Disadv.-Sensitive to disturbances due to similar color and texture feature	Disadv.-Necessary to update shape model continuosly

B. *Concept of level set*

The level set method is numerical method. This method is used to track the edges or borders of object and interfaces. This method is used when there is evolution of contour in the system. It is given in the form of distance function. The contour C for the given function is given by ϕ [1]:

$$\Phi(x,y) = \begin{cases} 0 & (x,y)\epsilon C \\ d(x,y,C) & (x,y)\epsilon Rout \\ -d(x,y,C) & (x,y)\epsilon Rin \end{cases} \quad (1)$$

Where, Rin = region inside contour, Rout = region outside contour, d(x, y, C) is the Euclidean distance.

Initial contour with overall speed in the normal direction is given as below [1]:

$$\frac{\Phi^{n+1}(x,y) - \Phi^{n}(x,y)}{\Delta t} + (F(x,y) + Fcurv)|\nabla\Phi(x,y)| = 0 \quad (2)$$

Where F(x,y) is the external force, Fcurv is the internal force proportional to the curvature of the contour and has smoothing effect on the contour, n represents the n-th iteration $\nabla\Phi(x,y)$ is estimated as the gradient of the level function at (x,y), and ∇t is the evolution step is the fixed value 0.001.

II. FRAMEWORK OF THE SYSTEM

The given system consists of five steps are detecting and tracking moving object by using optical flow algorithm, contour evolution of the contour, non-periodic motion of object contour evolution (adaptive shape based), periodic motion of object contour evolution (dynamic shape based), abrupt motion contour evolution.

For the evolution of contour, the region based method is used and they are represented using level sets. At the starting of the first frame, camera motion is detected and optical flow at each pixel is detected which are used to detect motion regions. And then motion region boundaries are used as initial contour. Then by using initial contours, the colour information is extracted from the frame i.e. colour contour evolution. On the basis of colour contour evolution, shape prior method is used to deal with noise to generate more accurate contour. By using the results of the shape prior, the motion is estimated. The main component of the framework consist of contour based tracking initialization, colour based contour evolution, adaptive shape based contour evolution.

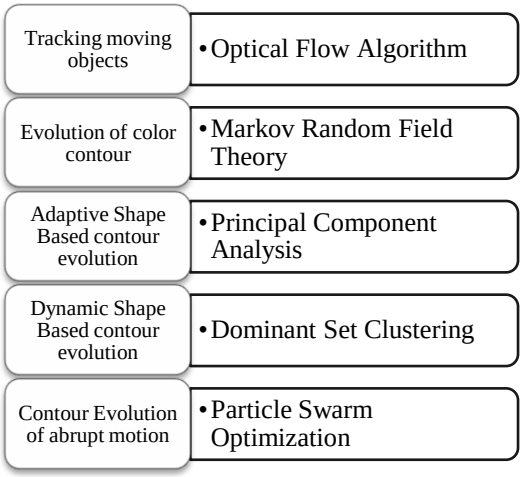

Fig. 2. Framework of system

III. DETECTION AND TRACKING OF MOVING OBJECT

For detection and tracking of the moving object optical flow algorithms are used. By using these algorithms, the object regions and the background regions are separated on the basis of color and texture features.

Optical flow concept

In an image, optical flow is the distribution of velocities of movements of brightness pattern.it generally arises from the motion of the objects and the viewer. It gives the information about the arrangements of the viewed objects and rate of change of arrangements. The optical flow algorithms are used to find segmentation between the different images [8].

A. *Initialization contour in first frame*

The optical flow algorithms are used to detect the moving object and to track its edges. When its edges are tracked, then its edges are considered as boundaries which is used as initial contour in the next frame. Lucas and Kanade's algorithms [2] are used to detect direction of object and Horn and Schunck's algorithms [4] are used to detect the magnitude vectors of object.

For each pixel, optical flow are predicted and it is represented by optical flow velocity vectors component. Then some threshold value is defined for the given system. When predicted optical flow magnitudes are less than defined threshold then it is considered as a background image. To detect the motion regions, shape model is used such as circle or rectangle. The shape model is moved over image. The region which consists of large optical flow magnitudes and optical flow directions is considered as motion region. Such

motion regions are consists of large weight. The formula of motion region are given by ξi and it is given as below [1]:

$$\varepsilon i = \beta \frac{\sum_{x \epsilon Mi} \sqrt{{a_x}^2 + {b_x}^2}}{\gamma_i} - (1-\beta)\Omega_{\arg(a,b)} \quad (3)$$

Where a and b are the optical flow vector component, Mi is the motion region, X is the pixel in the motion region, $\Omega_{\arg(a,b)}$ is variance of direction of vector components, γ_i is the number of pixels within Mi, β is the weight (between 0 and 1) which balances flow vector magnitude.

B. Object and Background Region separation

By using color and texture feature, object and background regions are separated on the basis of Gaussian Mixture Model. To model object and background region, Stauffer and Grimson's method is used [6].

Gaussian Mixture Model is the parametric probability density function and is represented by densities component. They provide greater flexibility and precision in modeling.

IV. COLOR CONTOUR EVOLUTION

In this step, by using probability density function foreground region and background regions are separated. Markov Random Field Theory is used to separate color and texture features. Markov Random Field Theory is used to calculate posterior probability function [5].

Markov random field (MRF) theory gives the information about the correlations between the values of neighbouring pixels for posterior probability and likelihood estimation. According to the MRF theory, the value of a pixel is only correlated with the values of the pixels in its neighbourhood which is assumed to be a square pixel region centred at it, i.e., its value is independent of the values of the pixels outside the neighbourhood.

V. NON PERIODIC MOTION OF OBJECT COTOUR EVOLUTION

In this contour evolution method, to obtain the contour closer to the true contour global shape information and local color information are combined [1]. To determine the shape model i.e. introduced in the contour evolution process, the Mahalanobis distance based criterion is used on the basis of shape registration construction of the shape subspace. The Principle Component Analysis is applied to the update the shape model [11].

VI. PERIODIC MOTION OF OBJECT CONTOUR EVOLUTION

When there are large changes in the shapes of object, then the dynamic shape model is used. To obtain the dynamic shape based contour, shape model and shape constrains are used [10]. To construct the shape models, distance between the two samples are considered and clustering samples are constructed.

VII. ABRUPT MOTION CONTOUR EVOLUTION

Deterministic method is used to detect the abrupt motion between the current frame and previous frame. If the abrupt motion is detected, then the affine motion parameters are estimated by using Particle Swamp Optimization [9] method, and applied to the contour obtained in the previous frame to obtain the initial contour in the next frame. If there is no detection of abrupt motion, then the contour in the previous frame is used as the initial contour in the current frame. The initial contour is then further evolved to provide the segmentation of the object.

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