International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249–8958, Volume-1 Issue-3, February 2012

Tracking the human motion in real time using Star Skeleton Model

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***Abstract:** Human motion analysis is receiving increasing attention from researchers. This interest is motivated by wide spectrum of applications. In this paper, a process is described for detecting moving targets and extracting boundaries. From these, "star" skeleton is produced. The star skeletonization is suitable for detecting and analyzing human motion in real time. Also the method does not require great deal of image-based information to work efficiently. Extremal points are extracted in star skeleton like head, hands and legs, their tracking described based on an n*n block of DCTs coefficient. Then we correct the false tracked extremal points such as occluded extremal points.*

***Index Terms:** Human Detection, Image Processing, Occlusion Removal*

I. INTRODUCTION

One of the more active areas is activity understanding from image sequence. Understanding activities involves being able to detect and classify targets of interest and analyze what they are doing. Human motion analysis is one such research area. There have been several good human detection schemes, which use static image sequences. But detecting and analyzing human motion in real time from video image sequence has only recently become viable with algorithms like Pfinder [3] .These algorithms represent a good first step to the problem of recognizing and analyzing humans, but they still have some drawbacks. motion analysis tools which are not constrained to human models, but are applicable to other types of targets, or even to classifying targets into different types. In some real video applications, such as outdoor surveillance, it is unlikely that there will be enough "pixels on target" to adequately apply these methods. What is required is a fast, robust system which can make broad assumptions about target motion from small amounts of image data. This paper describes the "star" skeletonization with correction method for analyzing the motion of human targets. The notion is that a simple form of skeletonization, which only extracts the broad internal motion features of a target, can be employed to analyze its motion. We use Discrete Cosine Transform (DCT) for tracking and matching algorithms which are based on Reference Matrix Descriptors (RMDs) [2]. The 2D tracking process is performed by DCT block it corrects the false tracked points. In section II we review the human Star Skeletonization for reconstruction. In section III we give an overview of algorithm for tracking and matching using DCT matrixes and method to detect and correct occluded joints. Finally section IV is conclusion.

Manuscript published on 28 February 2012.
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II. HUMAN DETECTION

A. Background Subtraction

For real-time target extraction we use the approach background subtraction. Background subtraction provides the most complete feature data, but is extremely sensitive to dynamic scene changes due to lighting and extraneous events. Background image is not fix and it must adapt to Illumination changes, motion changes

like tree branch move and changes in background because of objects entering in scene and stays for longer period without motion.

The basic method is modeling background as color image. Background is estimated as the average or the median of the previous n frames. If the distance between current frame and background is greater than some threshold for some pixel then that is considered as foreground.

B. Target pre-processing

For Star skeletonization we need object contour. No motion detection algorithm is perfect. There will be spurious pixels detected, holes in moving features. Foreground regions are initially filtered for size to remove spurious features, and then the remaining targets are pre-processed before motion analysis is performed.

Foreground region extraction may produce images that contain holes and gabs in the object detected, and may cause objects to be split into more than one connected region, which would make the object to be detected as multiple objects. So we need to apply sequence of dilations and one erosion [6].

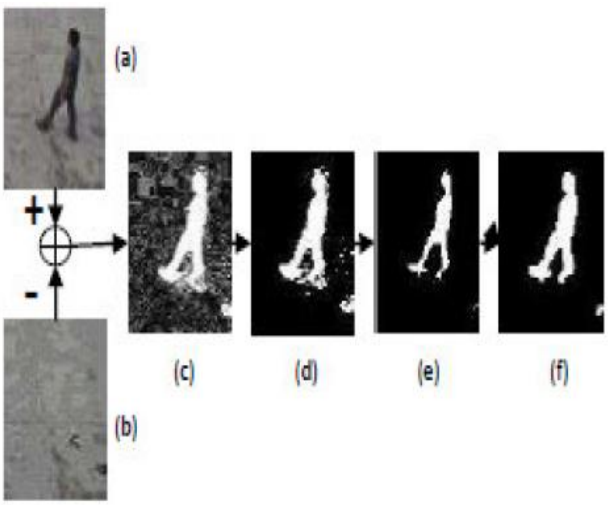

Fig 1: Target pre-processing. A moving target region is morphologically dilated then eroded. Then its border is extracted.

C. Star" skeletonization

An important cue in determining the internal motion of a moving target is the change in its boundary shape over time and a good way to quantify this is to use skeletonization.

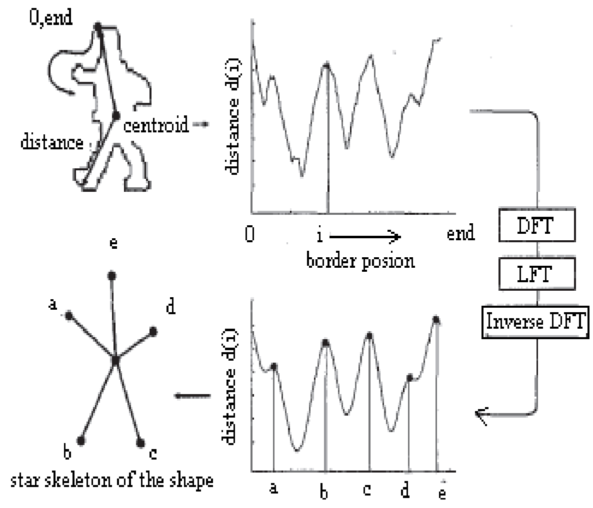

Fig 2: Star Skeletonization

The method proposed here provides a simple, real-time, robust way of detecting extremal points on the boundary of the target to produce a "star" skeleton [1]. The "star" skeleton consists of only the gross extremities of the target joined to its centroid in a "star" fashion

III. TRACKING WITH ERROR CORRECTION

We locate head, hand and leg like extremal points position using uncalibrated monocular video and use them to estimate star skeletal configuration. In the proposed algorithm, head, hand and leg tracking is performed based on an n*n block of DCTs coefficient (descriptor matrix). Then we correct the false tracked extremal points such as occluded extremal.

Algorithm starts with background subtraction and then star skeletonization to specify head, hand and leg like extremal points positions in initial frame. Then for each extremal point, descriptor matrix is computed and saved as "Reference Descriptor Matrix" for the same point. In the next stage, all extremal points are tracked with its own RDM and are updated based on frequency regions.

After finding extremal points positions in next frame, the correction algorithm will correct the primal extremal point position.

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A. Joint Tracking Process

Tracking and database matching is discussed briefly in this section.

1) Descriptor Matrix

We use DCT block for tracking and matching purposes. "Descriptor Matrix"[4] for the point Pi is n*n DCT coefficients matrix. By putting the image window of fixed size (n*n) centered on point Pi into matrix A, a descriptor matrix (DM) for Pi is then compute by

$$F(u,v)=C(u),C(v)\left[\sum_{x=px-n/2}^{x=px+n/2}\sum_{y=py-n/2}^{y=py+n/2} f(x,y)\cos\frac{(2x+1)\cdot u\pi}{2n}\cos\frac{(2y+1)\cdot v\pi}{2n}\right] \quad (1)$$

Where px and py are pi coordinates. Also, if x=0; C(x) =1/√n otherwise C(x) = √2/n There are n^2 coefficients in each DM matrix divided into three frequency regions. We use this three frequency region for tracking and matching algorithm. Matrix distance: in special frequency region is defined according to the following equation:

$$Mdis_{frequencyregion}(M,N) = \sqrt{\sum (M^2_f - N^2_f)} \quad (2)$$

$$f \in frequency\ region$$

2) Reference Descriptor Matrix (RDM)

These matrices save tracked extremal points information of previous frames and database information and used to find Corresponding extremal points in tracking process. We generate a reference descriptor matrix for each extremal point (RDM1 ...RDM5).

Reference descriptor matrix for extremal point j (RDMj) is loaded from descriptor matrix for extremal point's j after initialization and updated after finding new tracked extremal point j and correction in next frame. Updating routine is different in each frequency region

3) Tracking

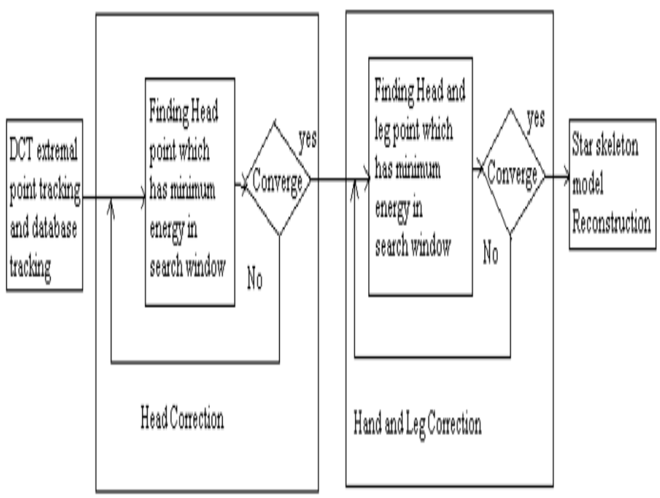
The tracking process is based on frequency domain matching techniques. Tracking process aims to find extremal point in successive frames search window (SWDMs). Finding best match is performed by selecting minimum matrix distance between low and middle frequency of *RDMj* and search window descriptor matrices (SWDMs). We consider best matching point in the search window as tracked extremal points at frame t+1 and save its matrix distance named "Mdis" as a parameter to determining the best tracked extremal points. These extremal points are initial tracked joints at frame t+1 and will be used as "start points".

4) Database matching process

The database consists of required information for different poses of video sequences of number of subjects. Measuring similarity between human pose in current frame (Pf) and human pose in database (requires two kinds of matrix: DDMs and FDMs, which will be defined later. If pose distance is smaller than Δ, corresponding occurs; therefore points and middle frequency of RDM must be corrected. Pose distance is defined by:

$$Pdis_p(p_f, p_d) = \sum_{j=1}^{5} Mdis_{low,mid}(DDM_j, FDM_j)$$

Fig.3 Occlusion Correction Algorithm



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$$DDM_f = \begin{cases} RDM_f & f\text{: low frequency} \\ Database_f & f\text{: middle frequency} \\ 0 & f\text{: high frequency} \end{cases}$$

Database descriptor matrix (DDM) is generated using low frequency of RDM (for extremal points similarity) and middle frequency of database (for edge similarity)

B. Correction

After tracking process, we have primal location of all extremal points. The correcting process is based on the minimization of energy function. Its basic idea is to correct extremal points position in each frame. Energy function is computed for every pixel in the search window (SW). Finding best match is performed by selecting point with minimum energy. Energy function is constructed to correct tracked joint location according to global pose of body.

IV. CONCLUSIONS

In this paper, a method for human detection via star skeleton model is described. This system uses an adaptive background model robust against long-term changes, illumination changes and repetitive clutter motion in the scene. A method for solving temporal occlusion problem using energy functions is described. In this method, extremal point tracking is performed based on an n*n block of DCTs coefficient (descriptor matrix). Then we correct the false tracked joint such as occluded joint using an energy function which can estimate false joint position.

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