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CAMPARATIVE ANALYSIS OF FACE TRACKING

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***Abstract*— Face detection and tracking algorithms are of great importance for human-machine interaction. This paper describes a face detection framework which is capable of processing images rapidly while achieving high detection rates. This paper gives a broad overview of basic principles and some representative methods for face detection, tracking and facial feature extraction. Face tracking by using CAMSHIFT algorithm that tracks an object based on colour is presented here. Also the limitations of CAMSHIFT are shown. On the face image, Shi and Thomasi algorithm is used to extract feature points and Lucas-Kanade algorithm is used to track those detected features is also described. Comparison of these two algorithms and analysis of it is clearly shown in this paper.**

***Index Terms*— Face tracking, Viola–Jones, CAMSHIFT, KLT.**

I. Introduction

Face tracking is needed for a large number of computer applications: HCI, surveillance, biometry, video compression, human-robot communication, etc. Facial tracking is increasingly finding use in safety applications to detect situations such as sleepiness or inattentive while driving or using hazardous machinery. There is also a growing interest toward emotional intelligence in human-computer interaction paradigms. Face tracking can be deployed to control robots or interact with them. It can be utilized for monitoring health through posture tracking, supervised exercise or integration with other technologies for health related measurements such as body temperature. For tracking the objects in a particular video sequence, various algorithms and schemes have been introduced in the few decades and each algorithm has their own advantages and disadvantages. Any object or face tracking algorithm will contain errors that will cause a drift from the object of interest eventually. For tracker to be accurate over the time frame of the application the better algorithms must be able to minimize this drift. One of the popular and effective approach which is based on color information of tracking include the Camshift algorithm [1-3]. It has been widely used because it is fastest and simplest. Shi and Tomasi [4] described a method called “Good Features”, computing the minimum eigenvalue of the covariance matrix rather than of the cost function defined in the Harris detector [5]. Regions with a high eigenvalue are then set as features.

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II. FACE DETECTION

Face detection is a computer technology which determines the locations and sizes of human face. It helps in detecting facial features and ignores anything else, such as bodies, buildings and trees. Currently human face perception is an active research area in the computer vision community. The first step is human face localization and detection in applications such as face recognition, human computer interface, video surveillance and image database management. A prerequisite for face recognition and/or facial expressions analysis is locating and tracking human faces, although it is often supposed that a normalized face image is available.

Viola Jones Face Detection Algorithm:

Paul Viola and Michael Jones proposed the Viola–Jones [6] object detection framework in 2001. It is the first object detection framework to provide competitive object detection rates in real-time. Even though it can be trained to detect a variety of object classes, it was motivated mainly by the problem of face detection. While achieving high detection rates this face detection framework have the ability of processing images extremely rapidly. There are three key assistance: Firstly, the introduction of a new image illustration called the Integral Image allowing the features to be computed very quickly that are used by the detector. Secondly, building an easy and efficient classifier using the AdaBoost learning algorithm for selecting a small number of critical visual features from a large set of potential features. The third contribution is a process for integrating classifiers in a cascade allowing background regions of the image to be quickly discarding with spending more computation on promising face-like regions.

For proper tracking, the face tracking have to face the following challenges:

1) Object poses in the video frame: In a video file, the appearance of the face region may vary its projection on a video since the face is moving.
2) Occlusions: In a video file, moving face may fall behind some other object which is present in the current scene. In this case tracker may not observe the face. This is known as occlusion.
3) Noise: In the acquisitions process of video, introducing a certain amount of noise in the image or video signal may be possible. The amount of noise relies on sensor qualities that are used in acquitting the video.
4) Ambient illumination: In a video, there is possibility of change in intensity, direction and color of ambient light in appearance of face image in a video frame plan.

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Fig. 1: Results of Viola- Jones face detector

III. CAMSHIFT

A modification of Mean-Shift tracking method is the CAMSHIFT object tracking method. The Camshift algorithm is a target tracking algorithm which uses color histogram of moving target as target mode. It is widely used as mean shift algorithm has the advantages that it is simple and fast to process and converge. However, the size of window in this algorithm is changeless so the location of objects cannot be exactly right if the size of objects change a lot. This will make tracking wrong sometimes. Here CamShift algorithm is a significant improvement of mean shift algorithm to make the result more accurate.

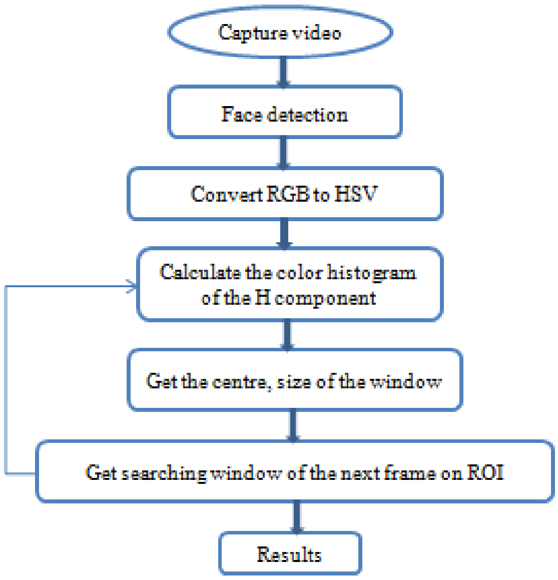

Fig. 2: Proposed methodology of Camshift algorithm

IV. KANADE LUCAS TOMASI

The most popular method for feature point tracking is the KLT algorithm which was introduced by Lucas and Kanade [7] and later extended in the works of Tomasi and Kanade [8] and Shi and Tomasi[4]. The KLT algorithm automatically detects a scattered set of feature points having sufficient texture for tracking them reliably. Afterwards, by estimating for each point translation detected points are tracked that minimizes the SSD dissimilarity between windows centered at current feature point position and the position of translation. In spite of being more than 20 years old, the KLT algorithm is still widely used as compared with other methods because it operates in a fully automatic way and its performance is competitive in terms of feature point quality.

Shi and Tomasi's tracking algorithm is based on an earlier tracker due to Tomasi and Kanade [8], which uses techniques developed earlier in [7] by Lucas and Kanade. Tracking in the Kanade-Lucas-Tomasi [9-10] algorithm is accomplished by finding the parameters that minimize a dissimilarity measurement between feature windows that are related by a actual translation motion model. It is another source of potential parallelism, because each calculation of these parameters are independent.

From the displacement of the tracked points it is possible to compute the movement of the head. Features points on the face are tracked using the Lucas-Kanade (LK) optical flow tracker [11],[12]. For example, if we rotate the head to the left, all the points will have the same displacement and direction to the left, but if we move the head to the left (around the y-axis) some points will move faster than others. This can help with finding the head movement between two frames using the optical flow of the points[13]. The KLT tracks the face in two steps, it locates the trackable features on the face in the initial frame, then tracks each one of the detected features from the face in the rest of the frames by means of its displacement.

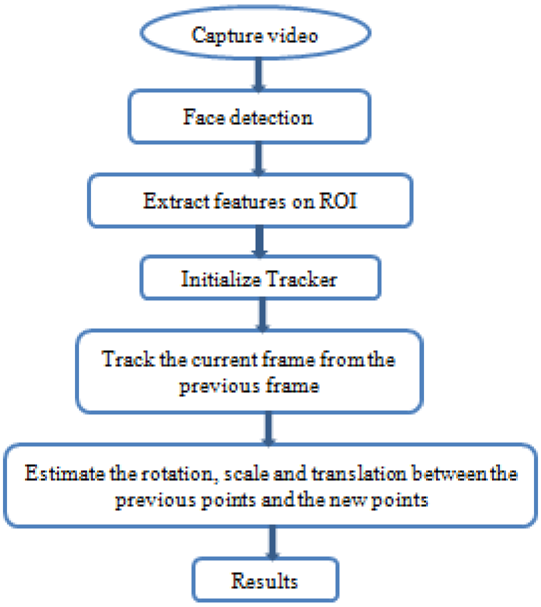

Fig. 3: Proposed methodology of KLT algorithm

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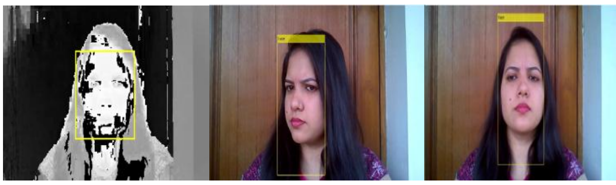
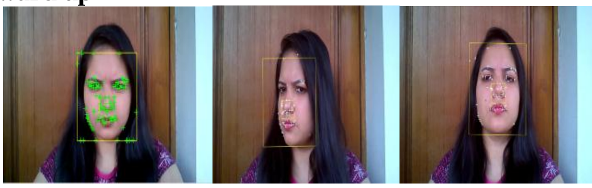
V. COMPARATIVE ANALYSIS



(a) (b) (c)

Fig: 4 Camshift Algorithm under Shadow (a) Hue image (b) Head is moving toward right (c) Head is moving toward up



(a) (b) (c)

Fig: 5 KLT Algorithm under Shadow (a) Detected features (b) Head is moving toward right (c) Head is moving toward up

(a) (b) (c)

Fig: 6 Camshift Algorithm under sunshine (a) Hue image (b) Head is moving toward right (c) Head is moving toward down

(a) (b) (c)

Fig: 7 KLT Algorithm under sunshine (a) Hue image (b) Head is moving toward right (c) Head is moving toward down

Face is detected by Viola–Jones algorithm as shown in figure 1. This algorithm is best used when the frontal face is clearly visible and recognized. Comparison between Camshift algorithm and KLT for face tracking is shown in the above figures. Fig. 2 shows the working of camshift algorithm and fig. 3 shows the working of KLT algorithm. Figure 4 shows the results of camshift algorithm taken under shadow. Firstly, the image is captured from video and converted into HSV and only hue image is taken into consideration as given in the Fig.4 (a). Face tracking takes place after getting the hue histogram from hue image. This is shown in Fig.4 (a) and (b). We can see from fig.4 (b) and (c) that only face is not getting tracked, neck region is also getting tracked as neck has similar color to the face. Fig.5 (a) shows the detected features by using Shi and Tomasi algorithm. Next the face tracking takes place by Lucas and Kanade algorithm as shown in Fig.5 (b) and (c). These videos are also taken under shadow. Similarly fig. 6 and fig. 7 are taken under sunshine and tracking takes place in the similar way. The advantages of camshift algorithm is that it is computationally efficient with the performance of real time tracking. Camshift is invariants to scaling and rotation. It also has some limitations. It has problems with multi hue object. If the object has more than one hue, the tracker tend to track the most significant object part and leave the small part untracked. The problem also occurs in the case of complex background. Because it only takes hue component, problems may occur if the object past a background that has similar colors to the object. It is sensitive to changing illuminant. From the results, I conclude that KLT can track the face properly in the outdoor environment while camshift fails.

VI. CONCLUSON

We have presented an approach for face detection which minimizes computation time while achieving high detection accuracy. So I conclude that, Viola Jones can properly detect face Camshift detects face by using a feature to track them, that feature can be skin tone or contrast background or any feature of the face. Here, we have used skin tone as a feature and converted the first frame to hue channel data and then detects the face in the rest of the video. There are limitations of Camshift algorithm that it cannot track the face properly with similar color background and also tracking fails in varying illuminations. KLT detects face based on the eigenvectors detected from the first frame and uses features for tracking but it fails to track if displace is large. I can conclude that the tracking of objects differs from one object to another and several parameters can affect the results of tracking. Result analysis shows the comparison of these two algorithms in this paper.

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