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Object Tracking and Significance of Color Features: A Review

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Abstract: Object tracking in the video is the most important issue nowadays based on its complexity of processing and accuracy levels. Object motion irregularities, object appearance changes, and non-rigid structures f objects in frames are the main causes of troubles in object tracking. Changes in the pose of the camera and partial and full occlusions are the main factors to be considered for accuracy improvements. Tracking moving objects in video is most important topic these days. Based on color characteristics and changes with respect object and background are to be considered while focusing on accuracy requirements. When non-rigid objects are to be tracked then the specific strategy is to be followed to improve the performance in tracking. The varieties of tracking methods using color features and other possible techniques are addressed in this paper. The survey will be useful for planning the method for tracking objects in video based on their color characteristics.
Keywords: Object tracking in video, Color features

I. INTRODUCTION

Object tracking is a very important task considered in computer vision domain. There is tremendous increase in the interest in object tracking algorithms for the sake of automated analysis of high definition cameras with the advent of powerful computers. There are three primary steps involved in video analysis, viz, moving target detection, consecutive frame sequence based tracking of target, and analysis of variations in motion and behaviour in region of tracking. In real time tracking system color has been widely used. Simplicity of computation, reliability in partial occlusion, variations in rotation, scale and resolution, are geometric cues in which several significant advantages can be seen. Though efficient color constancy is one of the most important factor which affects performance in terms of accuracy.

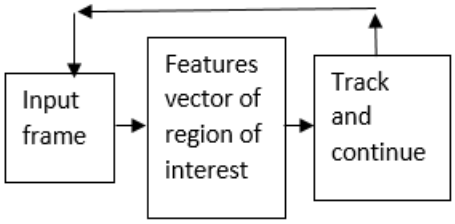

Figure 1: Object tracking in video basic idea

Figure 1 shows the basic idea of object tracking in video sequence where each frame is processed and specified object is tracked along with its feature extraction and matching to keep tracking the tracks. The literature survey is done with this basic idea as focus into which various algorithms developed so far, for object feature extraction and their respective performances in tracking are discussed

II. LITERATURE SURVEY

It's been quiet challenging in subsequent frames from a video taken in real time, for finding the trajectory of an object in motion. Background subtraction algorithms have limitations in case of moving camera scenarios where background is never the constant type of scene. Object tracking in moving camera scenarios is associated with problems such as occlusion, real-time processing requirement, complexity of object motion, non-rigidity of object etc. There are variety of algorithms evolved in past decade to address such problems.

Representation and localization are two primary steps in the tracking of an object. The earlier methods were having main approach which was depending on the modelling of the target object. Nowadays, method of searching the target in subsequent frames have been evolved. For representation of target there are variety of algorithms out of which Color histogram [3-5], feature point [7-9] and object contour [10, 11] etc. are some of the models that are very popular.

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After target representation step there is localization model step. Good level of results can be seen in case of no rigid objects tracking. The method consists of a B-Spline curve and particle filtering method to parameterize the contour to perform tracking [11]. At each frame, to represent each particle from a set of N particles, one B-Spline curve is used. Local map and edges are used for continuously updating and maintaining these set of points. In particle filter tracking, large number of particles will be required for better tracking performance. This algorithm requires high computations and hence fails to track more than one object.

There are also object tracking approaches that use contours a level set array and two linked lists. There is low complexity in the computation due to the non-parametric representation of the contour which tends to decrease the constraint. The algorithm fails to track when there is similarity in the color in foreground and background. To overcome this failure, if object has rich level of texture features then addition of method which extracts feature points and relative descriptor information then results can be improved which is shown in the iterative Newton-Raphson minimization algorithm [8,9]. In subsequent frames corresponding feature points are extracted using this algorithm. The implementation and processing speed is faster and reliable tracking is seen when feature points are used in tracking. When partial occlusion scenarios occurs this algorithm fails and includes object motion in irregular manner.

If the colors histogram is used, in case of the partial occlusion or pose changes of the object, the tracking performs well. 'Camshift' [5] which is one of the very popular algorithms, consists in making a colour histogram of the target object can be used to track it in subsequent frames. Camshift employs an iterative procedure to find the boundary of the object in subsequent frames, that makes use of the mean shift. The boundary position is changed until it finally converges in each frame. Human faces tracking was the primary goal of this algorithm but as experimentation done, it can be used for other objects also.

The Kernel-based-tracking algorithm (KBT) [4] uses a Kernel weighted colour histogram o depict the distribution of colour of the object. The weight distribution is done as, for the pixels at the boundary of the object are assigned smaller weights and the pixels that are around the object center are given higher weights. Mean shift method is used for the target localization in iterative manner.

Kernel weighted histogram with mean shift have been found to perform very well. It is found that performance of algorithm decreases as whenever there are changes in object size [12].

A. Color Feature Extraction

Combination of Red (R), Green (B) and Blue (B) channels are used for extracting features from color image. To create candidate features Collins and Liu [10] use different linear combinations of the R G and B channels. A variety of common features are formed with linear combinations, viz, image intensity, single channel features or two-channel features.

Most other algorithms use RGB, HSV or YCbCr color spaces based color histogram. Swain and Ballard [11] propose the three dimensional (3D) RGB histograms, showing that they are a stable representation of an object both in the presence of occlusion and change of view. Image indexing in large databases is main application of their feature extraction method.

Nummiaro et al [12] use an elliptical search area method. To give less weight to pixels from the center to outward direction, R, G, B histogram with 8x8x8 bins with inverse-square weighing is used. A particle filter is combined with the method. The combination shows success in pedestrian, vehicle, and face tracking.

To achieve pedestrian tracking in low light condition, Takala and Pietikainen [13] proposed a method using a combination of the 3D RGB histogram and a color correlogram, which shows better results.

Wang and Yagi [14] created method with a feature descriptor from histograms in three different color spaces. Linear histograms from the R, G, and B channels, from HSV the hue and saturation channels, and from the normalized *rg* color space the *r* and *g* channels, are used to create the feature vectors. This combination of features shows better results on standard datasets.

To handle illumination and occlusion Xiao et al [21] use an HSV color histogram combined with a block-sparse representation. This showed increased accuracy in tracking. complex backgrounds and object morphological changes are also less effective on accuracy with the algorithm's update strategy. In order to create a more robust feature descriptor the proposed method Color DRIFT uses a somewhat similar method to combine an HSV histogram with non-color features.

Occlusion happens when a tracked object or its key attributes used to recognize its identity is not available for a camera sensor. Occlusion occurrences has variety of causes.

It may be due to background and foreground scene changes or due to one or more object overlapping in the scenes. When two objects being tracked occlude each other, inter-object occlusion occurs.

III. OCCLUSION HANDLING

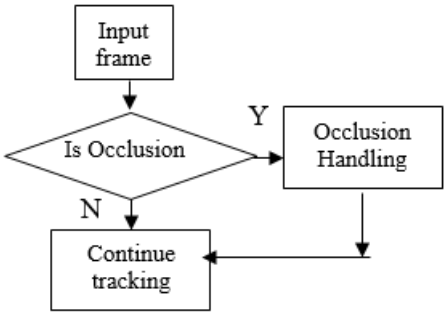

Figure 2: Occlusion handling scenario

It is a straight forward task of handling occlusion in a single object scene. Figure 2 shows the occlusion handling inclusion in regular tracking algorithm. In this case, detecting object appearance in the tracking task will only be involved. However, handling occlusion becomes complicated for scene with multiple object appearance. The multi-object trackers problem as a challenging problem for inter-object occlusion, [15]. In the sense that the same model is used to describe each target or Especially when the targets are identical.

Severity of occlusion and state of occlusion are main parameters that effects on occlusion handling performance. There are variety of combinations that depict occlusion definitions. The tracked object appears as a single blob having all tracking features exposed during non-occlusion for tracking. It can be seen that accuracy of most of the existing tracking methods that are based on appearance attribute to track a target such as Template Matching and Mean Shift [15]is considerably high.

During tracking Partial occlusion happens when some of the key features of the tracked object are hidden behind some other objects of non interest.

When a tracked object is completely not visible, full occlusion happens. When full occlusion occurs, no one method that rely on image appearance could continue to track the object because there will be no more appearance clue left in the scene for occlusion. Kalman filters are used for estimating the location and motion of objects in video as indicated in [16,17,18]. Object spatial motion model is used to handle full occlusion during tracking which is incorporated by many of the state of the art tracking methods.

IV. CONCLUSIONS

This paper provides study of various techniques used for object tracking in the video. The addressed methods mainly focus on color based feature extraction methods and their performances of respective authors. The effects of occlusion and handling methods are addressed which shows variations in methods with respect to severity of occlusion and respective depth of features of objects in region of interest.

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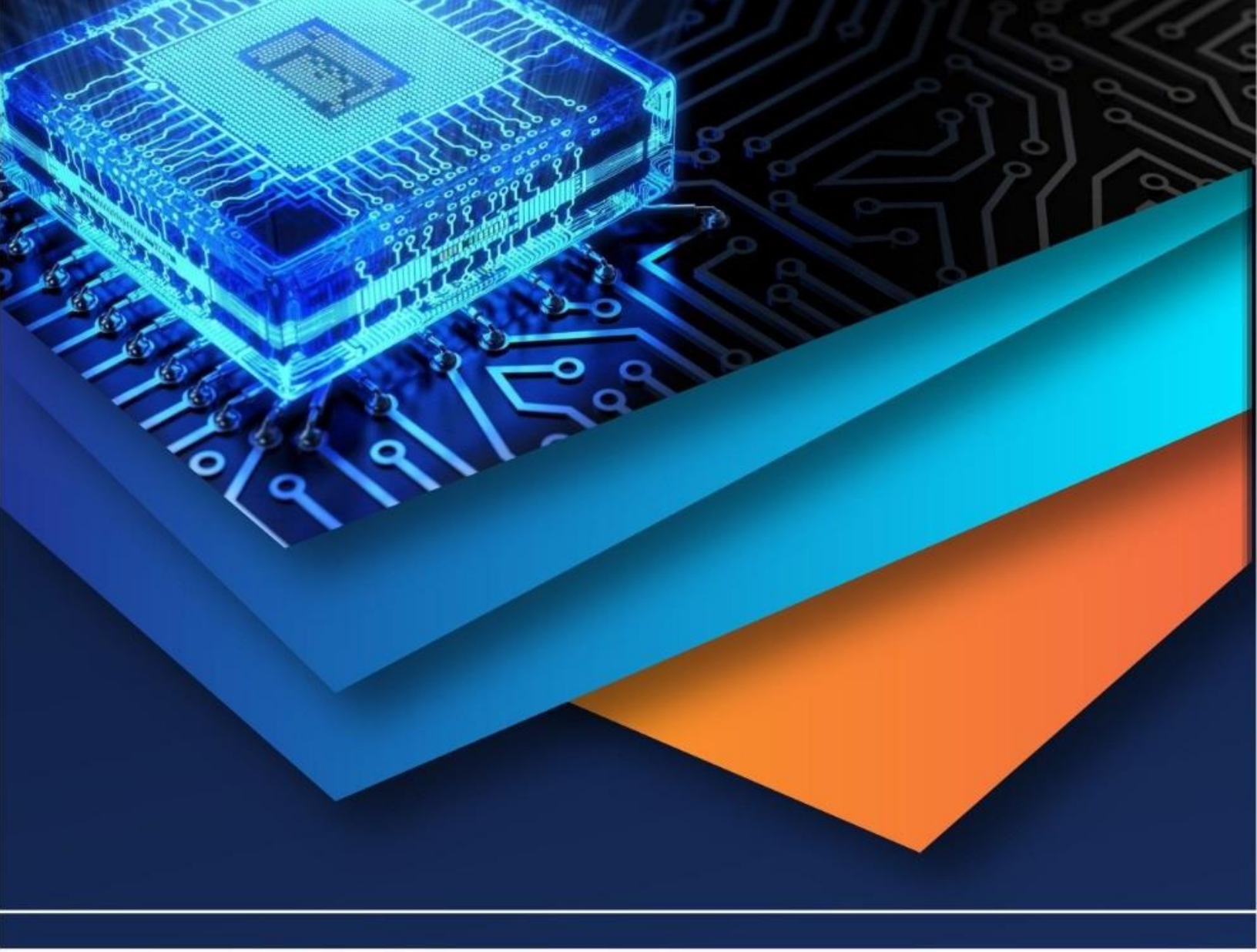

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