VISUAL TRACKING WITH SAPATIO-TEMPORAL CONTEXT MODEL

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Abstract. **Visual tracking is a challenging problem, because the target frequently changes its appearance, randomly move its location and get occluded by other objects in unconstrained environments. Moving object or target in the video changes it state continuously in space with time. Also, other factor i.e. brightness, color intensity and multiple objects heavily effects the moving target tracking task. There are many existing methods and algorithm which tracks the object but not robust to above mentioned factors. So, there is a need to design an algorithm that must be robust to these problems. . In this paper we discuss about various tracking techniques and a robust technique is presented which is based on space time context model. Tracker based on this model completes the tracking task in unconstrained environments.**

Keywords:- **Object tracking, spatio-temporal context learning, Fast Fourier Transform (FFT).**

I.INTRODUCTION

Visual tracking attracts lots of attentions due to its core status in applications, *e.g.* human-computer interaction, video surveillance, virtual reality, etc. For most of these applications, trackers are demanded to work for a long time in unconstrained environments, which greatly challenges the robustness of the trackers. To overcome this difficulty, numerous complex models are designed, but most of them still focus on the appearance of target itself (*e.g.* color, edge responses, texture and shape cues) or the difference between the target and background.

In real-world, the temporal and spatial information is important and necessary in tracking task. In continuous frames, the target appearance changes gradually, and all of the historical appearance variations in pose, scale and illumination have more or less influences and constraints on the next appearance state. For example, no matter what appearance changes happen to a panda, it is still a panda and the tracker should not recognize it as another animal. Meanwhile, the target moves gradually from one location to another location, rather than abruptly and discretely jumps. In another words, the spatial context presents strong or weak spatial correlation between the target and the background. For example, if two similar pandas walk together, it is easy to jump from one panda to another for the trackers which only focus on appearance features. However, if the spatial context constraints are considered, the skip problem will be circumvented because the surroundings around the two pandas are different. Unfortunately, the spatio-temporal context information has not been paid enough attention in the previous tracking strategies. In this paper, we propose a novel tracking framework based on the spatio-temporal structural context to precisely predict the location of the target, which is expected to be more robust than the previous methods

II. FACE DETECTION AND TRACKING APPROCHES.

Face recognition systems typically progress through a number of stages during video processing. The first step is to determine which image regions contain a face via detection or tracking component. Faces are located by distinguishing facial features from those of the background. Next, the face information is extracted and converted into the form required by the recognition algorithm, and then the face is matched against the gallery set. Some recognition systems detect or track faces and performance recognition simultaneously. Detection or tracking is performed to locate faces if their positions in a video frame are not known prior to analyzing a video. Face detection algorithms treat each image as an independent observation and thus do not model motion state across sequences of video frames. Face tracking algorithms, on the other hand, accumulate both spatial and motion information over subsequences of frames to continuously find image regions containing previously detected faces. In both approaches, an algorithm searches for features in the image that indicate the presence of a face. The difference between detection and tracking lies in the size of the search area. Tracking and detection algorithms may only provide a coarse estimation of where a face is a located. A more precise boundary can be determined through a process known as localization. A detailed boundary can be obtained with skin detection techniques, which segment the image region containing the face based on pixel color values. Once located, the image regions containing faces must be extracted and then transformed into the form required for recognition. Typical transformations normalize the face by aligning key facial points, such as the eye centers, to canonical positions; warping the face to compensate for out-of-plane rotation; or smoothing the color or intensity distribution of the pixels in the facial region. Local features, which characterize the information around a set of points, or holistic features, which characterize the appearance of the entire face, are then extracted to form face patterns and passed to the recognition algorithm. These features may also be incorporated into a person-specific model that a tracker can use to locate a particular face in later frames. At a coarse level, the recognition algorithm can exploit the large number of patterns from a sequence in one of two ways. Set-based algorithms discard the temporal dimension yet take advantage of the multitude of available face patterns. Sequence-based approaches explicitly incorporate temporal information into recognition decisions, with the objective of increasing computational efficiency, improving robustness to nuisance factors, or using facial motion cues as biometric characteristics. Overviews of these approaches are provided in the following sections.

1 Set-Based Approach: The set-based approach poses the face recognition from video problem in terms of matching with sets of multiple samples. Set-based algorithms fuse information over the sample set before or after matching individual face images Information fusion allows a set-based face recognition algorithm to attain higher recognition accuracy, increased robustness to nuisance factors or increased efficiency relative to algorithms for face recognition from still images.

• Fusion before matching - the data or features extracted from each face image can be aggregated together prior to recognition. The features or pixel values from an individual image can be unraveled to form a vector; concatenation of the vectors from different frames can yield a single vector with the information from an entire set. A major drawback of this representation stems from its sensitivity to the number of faces and the order in which the vectors are concatenated together. In contrast, super-resolution methods attempt to recover high frequency image content from the aggregated frames with the objective of constructing high resolution images. Some 3D modeling techniques also draw data from multiple frames, only with the goal of approximating the geometric structure of the face to achieve pose invariance. In addition, the entire set of faces can be represented with linear subspaces or nonlinear manifolds, constructs with well-defined metrics that measure distances between sets or the variations that they share in common.

• Fusion after matching - Pose, illumination and expression variations complicate face recognition by effecting how the face appears. Image sets can be sampled via frame selection algorithms to increase the likelihood that the probe and gallery sets will have similar compositions with respect to the nuisance factors. Additionally, some techniques for achieving pose invariance use 3D head models to synthesize gallery images with similar orientations to the faces in the set of probe images.

These techniques can be complemented by score, rank or decision level fusion schemes that integrate information over the probe and gallery images to produce a single match decision. In score level fusion, the match scores across the probe frames are combined via summation, multiplication, or by taking the minimum or maximum score for each gallery entry. The estimated identity corresponds to the gallery entry with the highest fused score. The rank level fusion method first ranks gallery entries by their match score in descending order for each frame. The gallery entry with the lowest sum of ranks over the frame set serves as the estimated identity. Finally, decision level fusion is performed by assigning a vote to the gallery entry with the best match score for each face image from the set. The estimated identity is the gallery entry with the most votes.

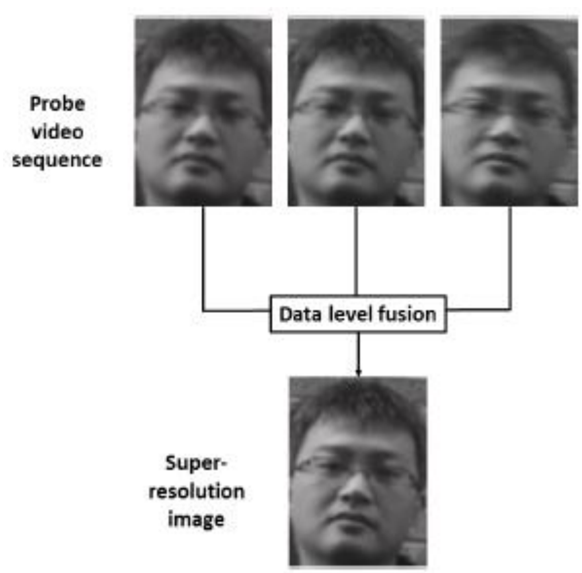

Figure 5: Super-resolution process.

For this example, the spatial information from a set of adjacent video frames was fused together using the iterative back project super-resolution algorithm. Face detection is the first stage of a face recognition system. A lot of research has been done in this area, most of that is efficient and effective for still images only. So could not be applied to video sequences directly. In the video scenes, human faces can have unlimited orientations and positions, so its detection is of a variety of challenges to researchers. Generally, there are three main processes for face detection based on video. At first, it begins with frame based detection. During this process, lots of traditional methods for still images can be introduced such as statistical modeling method[3],neural network-based method[4], SVM-based method[5],HMM method[6], BOOST[7] method and color-based face detection[8], etc. However, ignoring the temporal information provided by the video sequence is the main drawback of this approach. Secondly, integrating detection and tracking, this says that detecting face in the first frame and then tracking it through the whole sequence. Since detection and tracking are independent and information from one source is just in use at one time, loss of information is unavoidable. Finally, instead of detecting each frame, temporal approach exploits temporal relationships between the frames to detect multiple human faces in a video sequence. In general, such method consists of two phases, namely detection and prediction and then update-tracking. This helps to stabilize detection and to make it less sensitive to thresholds compared to the other two detection categories.

2 Model-based Approaches: Hager and Belhumeur[29] used a parametric model for tracking. Active Appearance Model (AAM) was introduced by Cootes, which contains a statistical model of the shape and grey-level appearance of the object of interest to encode shape and texture information. An Active Model for facial feature tracking. Adaptive template tracking extended the idea of AAMand gained better results. Isard and Blake combined condensation algorithm with active contours which parameterized by low dimensional vectors. The similar algorithm was generalized, which took advantage of active contour with adaptive condensation as well and utilized color information.

3 Color and shape based Approaches: Color and shape are important cues for tracking, based on which many methods are proposed. In [3], a robust face tracking method based on condensation algorithm which combined skin color with facial shape was presented. Moreover, skin color and facial shape trackers were constructed as the observation measure respectively. The result showed that the method was even robust in the situation of sudden change of lighting. Similarly, [6] proposed the use of anew color space method based on Linear Discriminate Analysis method which integrated color and shape into condensation algorithm. Integrated tracking procedure with the spatial domain and proposed a Bilateral Learning (BL) approach [7]. Their algorithm mainly selected reliable samples to update the color and spatial model within EM framework. Moreover, it didn't need accurate shape model. In [38], an enhanced mean-shift tracking approach using joint spatial-color feature and a novel similarity measure function was proposed. Second and recently, facial feature tracking comes into focus. Though the approach is very sensitive to occlusion, scale or resolution changes, it is precise and reliable under planar movement. Meantime, gabor wavelet jets and gray-level profiles are integrated for effective and efficient feature representation. In addition, a multi-model tracking approach is used to estimate the feature point positions dynamically. Tracking was fitted into Kalman filtering framework in which the non-linear system was approximated by a local linear model. Tracking by means of continuous detection and introduced illumination invariant local structure features within Kalman filter. The third category is tracking based on the combination of head and feature. A method for tracking several features of a non-planar target undergoing an arbitrary 3D movement. Multiple kernel tracking methods can track objects undergoing parametric transformations. Moreover, the method extends the result to more general situations.

Evolutionary methods of SSGA and Particle Swarm Optimization (PSO) to perform the multiple human heads tracking. Besides, it could also reduce the computational cost. A data fusion particle filter for head tracking method was proposed based on the color and edge cues. A Boosted Adaptive Particle Filter (BAPF) was presented [25] to enable estimation of the proposal distribution and the posterior distribution with a much higher degree of accuracy.

4 Real-time tracking methods: Real-time tracking catches much attention recently. Existing real-time tracking techniques include: CAMSHIFT [23], condensation [24] and adaptive Kalman filtering. When the object is far away from the camera, the algorithm fails to track. Due to the efficiency in tracking performance and computational capacity, chroma distribution-based face tracking approaches have been presented. For example, [21] proposed a face tracking algorithm based on the skin and lip chroma transform. A statistical color model and deformable template for tracking multiple faces [23].In [24], it exploited a statistical approach based on the mean-shift algorithm, which is consisted of a gradient ascent search over the skin color distribution. In [25], the head is modeled as a texture mapped cylinder and tracking was formulated as an image registration problem in the cylinder's texture map image.

III. OVERVIEW OF MAIN FACE RECOGNITION TECHNIQUES.

1 Eigenface Technique: It utilizes two dimensional global grayscale images representing distinctive characteristics of human face describing what is common to groups of individuals and where they differ most. Just as any color can be created by mixing using primary colures (RGB), vast majority of faces can be reconstructed by combining features of approx100-150 eigen faces. The performance depends on number of eigenvectors. If it is too small, important information about identity may be lost. If too high, weight corresponding to small eigen values may be noisy.

Limitations: i. One of the assumptions in eigen face is that variability in the underlying images corresponds to differences between individual faces. This assumption is, unfortunately, not always valid.

ii. Other factors that may "stretch" image variability in directions that tend to blurred entity in PCA space include changes in expression, camera angle, and head pose. Since the eigenvectors are determined only by data variability, you're limited in what you can do to control how eigen face behaves. However, you can take steps to limit, or to otherwise manage, environmental conditions that might confuse it. For example, placing the camera at face level will reduce variability in camera angle.

iii. Lighting conditions, such as side lighting from windows, are harder for a mobile robot to control. But you might consider adding intelligence on top of face recognition to compensate for that. For example, if your robot knows roughly where it's located, and which direction it's facing, it can compare the current face image only to ones it's seen previously in a similar situation.

2. Neural Network Technology: Extracts features from the entire face as visual contrast element, quantifying, normalizing and compressing them into template code. After that, it uses a specialized algorithm to determine that parts one by one to find the matching image or features in the database.

3. Dynamic Link Architecture or Graph Matching: It is an extension to classify artificial neural networks. Memorized objects are represented by sparse graphs, whose vertices are labeled with a multi-dimensional description in terms of local power spectrum and whose edges are labeled with geometric distance vectors that can be described by vector representation the position and size of facial features such as eye, eyebrows, nose, and mouth.

4. Automatic Face Processing: It is the most rudimentary and easy to understand. It simply uses distance ratios between key facial features.

5. *Fisherfaces/Subspace LDA*: Fisher's Linear Discriminant and produces well separated classes in a low-dimensional subspace, even under severe variation in lighting and facial expressions. The Eigenface technique, another method based on linearly projecting the image space to a low dimensional subspace, has similar computational requirements. Yet, extensive experimental results demonstrate that the proposed "Fisherface" method has error rates that are lower than those of the Eigenface technique for tests on the Harvard and Yale Face Databases.

6. *Innovativeness & Usefulness*: Existing algorithms can be enhanced along with development of new algorithms. FRVS will assist security personnel's in keeping track of all the people entering and leaving a secured zone. The core functionality of FRVS will allow real time tracking, recognition and retrieval of stored relevant information of human faces in a video stream. Today this is based mainly on magnetic cards. A system based on face recognition could be safer and cheaper.

Main areas in which it could be used are:

- Surveillance.
- Site Access.
- Criminal Investigation.
- House-Hold security. Etc.

The other used techniques are: Fingerprints, Hand geometry, IRIS, Retina, Voice, and Signature.

Advantages of FRVS over other techniques: Face recognition has number of advantages. Firstly, it is non-intrusive. Whereas many techniques require the subject's cooperation and awareness in order to perform, an identification or verification, such as looking into eye scanner or placing their hand on fingerprint reader, FRVS could be used without subject's notice.

Limitations: Due to dynamic nature of face a face recognition system encounters various problems during the recognition process. A robust face recognition system should have:

i. Scale invariance: The same face can be presented to system at different perspective and orientations. eg. Frontal, and profile views. Besides head orientation may change due to translation and rotation.

ii. Illumination invariance: Face images of same person can be taken under different illumination condition, as position and strength of light source can be modified.

iii. Noise invariance: The robust face recognition system should be insensitive to noise generated by camera or frame grabbers.

iv. Emotional Expression: Face images of same person can differ on expressions when smiling or laughing. Also, beards, moustaches can be present,

Face tracking is a significant procedure in face recognition system. Tracking exploits the temporal correspondence between frames. In general, face tracking can be divided into three categories, head tracking (color-based, model-based and shape-based), facial feature tracking and combination of head and facial feature tracking. For video processing, real-time is its foremost feature to be considered. First category for tracking is model-based, they usually include statistical models [26] and exemplar-based [27]. Hongliet al. applied effective boundary saliency map to the subsequent tracking process on the basis of previous segmented result [28].Generally, the major steps in tracking stage are the boundary matching and connection. The former construct to determine the face boundary and the latter is employed to extract the region between two key points.

IV. PROBLEM FORMULATION.

From the above literature it can be concluded that existing method for moving object tracking in the videos are not much robust that could track the target with changing pose, scale, multiple objects and illumination. The proposed space-time structural context based tracker here, greatly differs from the previous published models. For temporal context part, a new incremental subspace model is constructed to represent the gist of target with low dimensionality feature vectors, in which several sequential positive samples are packed into one subspace to update the model. Most of the appearance information of the target, including pose, scale, and illumination are efficiently incorporated into the model to help predict the next state of the target. For the spatial context part, we introduce the contributors that are the regions having the same size and consistent motion correlation with the target.

V. RESULT.

MATLAB R2008a software has been taken as an implementation platform for implementation of proposed methodology. Image processing toolbox and general MATLAB toolbox are used from the software. The global temporal context model is constructed by the linear subspace method, which is updated with continuous positive samples and the correlation between them is considered. The appearance information of contributors will also be considered in our model, and the pairwise features are produced by the difference between target and contributors to describe the spatial correlations. The target and contributors will be decomposed into small blocks, hence the intra- and inter- structural information can be described. Instead of building complex motion models to represent the correlation between the target and contributors, our approach will efficiently utilizes boosting method to select the most representative weak relations to construct a strong supporting field.

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