Geometrically Oriented Video Tracking

Vitaliy Tayanov

Abstract - **In this paper one presents the video tracking problem as part of the complex task of video surveillance. A formal consideration of video tracking problem for single and multi-target case have been presented.**

Keywords - **Video tracking, Keypoints, Contours, Assignement, Geometrical approach, IP video camera.**

I. INTRODUCTION

Now, work with video is very popular and easy. This means that you can capture video, separate it on frames, change resolution, compress, etc. Among important tasks on working with video we can mention video surveillance and video understanding. This touches such an important domain in video processing as video tracking and vision-based motion analysis. The process of estimating over time the location of one or more objects using a camera is referred to as *video tracking*. A very modern and interesting part of the last is visual analysis of behaviour of different objects or targets. A lot of different algorithms and approaches based on point-tracking algorithms came from radar community of video tracking. This is what we call as geometrical approach to problems of video trackers building.

II. PROBLEM STATEMENT

A. Single-target problem

The problem of tracking of a single target on a video can be formulated as some discrete estimates in time [1]

$$\mathbf{x} = \{x_k : k \in \mathrm{N}\}, \quad (1)$$

indexed by *k*, based on the information in $\mathbf{I}$. Here the vectors $x_k \in E_s$ are the *states* of the target and E_s is the state space. The discrete time series **x** is a *trajectory* of the target in E_s. The information encapsulated in the state x_k depends on the application. I_k might be mapped onto a feature (or observation) space E_o to highlight the information important to build the track. The observation generated by a target is encoded in $z_k \in E_s$. It should be noticed that, E_o has often a lower dimensionality than that of original image space, E_I (Fig.2).

The transformations from the image space E_I to the observation space E_o concern the *feature extraction* problem. Video trackers propagate the information in the state x_k over time using feature set. And we have to define how to use the image features to produce an estimate of the target state x_k.

B. Multi-target problem

When we have a time-varying number of targets, we can formulate the multi-target state X_k as the vector containing the parameters of the single-target states.

If $M(k)$ is the number of targets in the scene at time k and $F(E)$ is the collection of all the finite subsets of E, then the multi-target state, X_k, is the set

$$X_k = x_{k,1},...x_{k,M(k)} \in F(E_s) \quad (2)$$

The single-target observation vector $z_k \in E_o$ is composed of parameters defining a single detection. We can extend the definition of observation to multiple targets by defining the multi-target observation Z_k as the finite collection of the single target observations, that is

$$Z_k = z_{k,1},...z_{k,N(k)} \in F(E_o), \quad (3)$$

formed by the $N(k)$ observations.

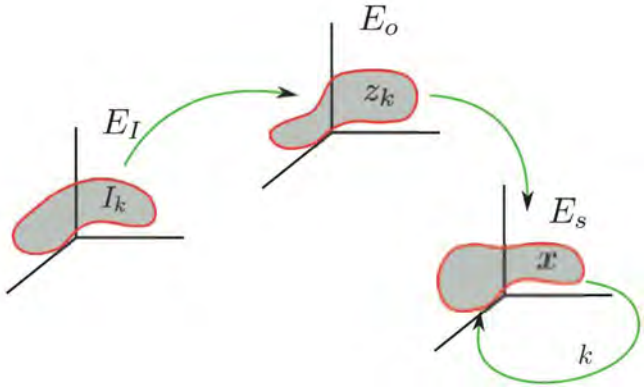

Fig.1. The flow of information between vector spaces in video tracking

III. VIDEO TRACKING BUILDING

The relationship between an object and its image projection is very complex and may depend on more factors than just the position of the object itself, thus making video tracking a difficult task. Among challenges that cause this, one can mention the following factors:

1. *Pose*. A target can change its appearance due to movement or rotation.
2. *Ambient illumination*. Changes in local and global illuminations. Changes in global are often a challenge in outdoor scenes.
3. *Noise*. The certain value of noise could be caused by video camera sensor. Also observations of the target could be corrupted.
4. *Occlusions*. A fail of target observation when it partially or totally occluded by other objects in the scene.

Geometrical approach assumes building the assignments between different frames and for this kind of scenarios (partial and total occlusions) is difficult and ambiguous problem. This also causes using a number of advanced technics based on Bayes networks, particle filters, sampling, Markov models

Vitaliy Tayanov – Lviv Polytechnic National University, 12, St. Bandery Str., Lviv, 79013, UKRAINE E-mail: vtayanov@yahoo.com