Surveillance Prioritization

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Abstract

The ability to recognize a person within a moving crowd is a fairly simple task for human beings. Automated surveillance systems try to replicate this behaviour for many purposes like preventing crime, remote identification, detecting violent behaviours, etc. Much research has been made in the field of video surveillance using multiple cameras and to take high resolution pictures of persons. However not many [1, 2] tried to assess how to optimize and prioritize the tasks to enhance the performance of these systems [4]. This review will introduce different simple methods described by [3], on what is surveillance prioritization and what methods can be used.

1 Automated Surveillance

There is a new trend to use multiple cameras for video surveillance [1] but little attention has been given to the problem of performance when there is actually more people in the scene than the number of cameras. In that case we can not increase the number of camera indefinitely and have to find a solution on how to optimize as much as possible the performance of surveillance from a given camera. To do this we might want to take as many high resolution picture of different persons in the scene as we can before they leave the scene.

2 Prioritization an optimization problem

In this section we will introduce the main concept and its improvements used to tackle this optimization issue. However we need firstly to understand what are these main issues. First of all the target motion, we need to be able to take high quality images but the targets are constantly moving. Secondly the continuous process of target arrival, as there is always new targets that will come into the scene. Finally the deadlines, when we have to get the target High Res. image before it leaves the scene. Further more we have to think about the time the camera takes to move up and down (tilt), from side to side (pan) and then to zoom. The first optimization process we will describe is the Kinetic travelling salesperson problem which will then be used as a base and be improved with further requirements.

2.1 Kinetic Travelling Salesperson problem - KTSP

Let's try first to explain what is the Traveling Salesperson problem. It is a combinatorial optimization problem in which we have a set of cities to visit and between each of these cities a weight depending on the distance between the 2 cities. The issue is to find the best possible permutation of cities to visit, having the less weight as possible at the end. Furthermore, knowing that we can visit a city only once and has to come back to its original city at the end.

The Kinetic Travelling Salesperson problem uses the exact same paradigm, only applied to optimize the path planning to get as much remote identification as possible. Take the example of the Figure 1, we have four persons to identify and only one camera. The camera needs to be in a certain position in space in order to take a clear picture of the person. Take into account that we are able to predict the path of each of the persons on the scene, what would be the best set of permutations of the camera to take clear pictures of each persons in the most efficient way, in our case the quickest as possible (Cf. Figure 1, red path).

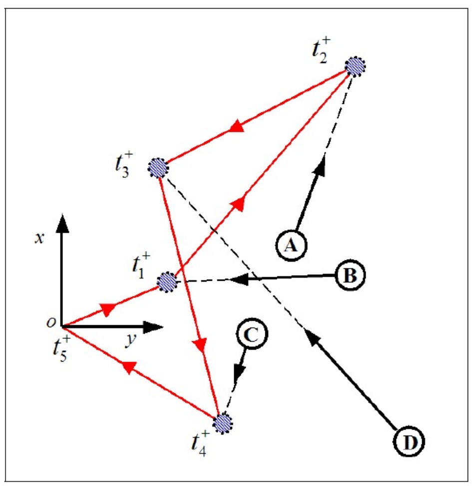

Figure 1: Kinetic Traveling Salesperson Problem applied to video surveillance [3]

In a more formal way, let the set S = {A, B, C, D} be the set of persons to identify. each element of S has a predictable pathway Xa(t), Xb(t), Xc(t) and Xd(t). We know that the camera can move in 3D using Pan, Tilt and Zoom to intercept the path of each target and take a picture. Even though each of these features need some time to execute and is never instant, we know that the speed of the camera is in most case better than the speed of the targets even with the slowest cameras [3]. We now want to find the permutation of the discrete set S that has the shortest final time.

2.2 Time Dependent Orienteering - TDO

We also have to take into consideration that the targets will arrive in a continuous and stochastic fashion. We can not only limit our optimization problem to the KTSP and need to assess the problem of continuous new oncoming targets in the scene. This can been seen as a dynamic optimization problem, and there is no perfect solution for that. The best we can do is to break down the dynamic optimization into small static optimization problem and create a strategy that take care of executing the different actions depending on the system state.

Then if we take into account that we can predict the path of a target and its approximate speed, we can easily know the time window in which we will be able to take a picture before it leaves the scene. And knowing that the KTSP planning computation will take some time we can include this as a Time Dependent orienteering problem. The TDO problem will complete the KTSP in a dynamical fashion, hence be more suitable for real-time constraints such as video surveillance.

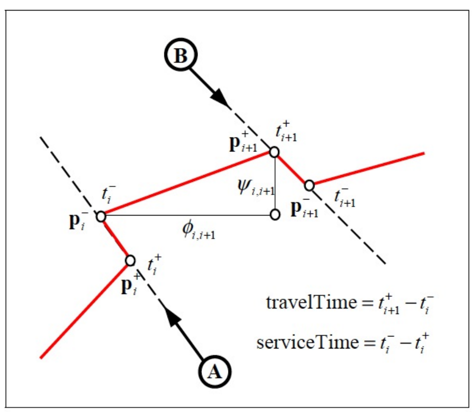

Figure 2: Symbolic scheme for TDO saccade and timings [3]

Formally, the TDO will add maximum and minimum time values for each element of the set S to form triples (Cf. Figure 2), then compose a set T of the maximum number of targets interceptable within an overall time t. However even though breaking this into static optimization problem breaks also the computation complexity. We cannot queue more than 9 moving targets by a simple camera, because the time needed to create an overall turn would not permit to update the planning problem and take care of the new oncoming targets [3].

2.3 Saccades Planning Geometry - SPG

Saccades Planning geometry adds even more real-time constraints to the model and its calculations. In fact this time we will dissociate the pan, tilt and zoom parameters as independent. Hence they can all occur in parallel and only the largest time of the three will be used as a time basis for the calculations of the TDO to change position. We can simplify the model by assuming that during the ptz of the camera the target motion is nearly imperceptible and can be discarded. The result is that we do not need to compute the equation as a function of time.

The use of the real camera time constants for pan tilt and zoom can be retrieved from the camera manufacturer and also taken into account while designing the SPG. This leads finally to a better approximation of the time variables in place during the planning problem for video surveillance and will greatly enhance the performance of the system by prioritizing the correct targets in a correct ordering.

3 Conclusion

The results of [3] have shown an improvement up to 40% on remote identification of the targets. It means that by using the proposed techniques above we can increase the efficiency of the video surveillance system nearly by half, meaning that we can screen more people without involving much more camera systems. The prioritization might not be a necessity in an area with a low density of target at the same time. However it has prove to be a better and cheaper alternative than adding more equipment to the screening scene [1].

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