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Smart Surveillance System Using Optical Flow

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ABSTRACT

With constant advancement in video analysis techniques, involuntary visual surveillance steadily emerges for consumer applications. Human movement analysis involves locating, tracking and identification of individuals. In this paper, we present a framework for the detection and tracking of moving people. In order to detect foreground objects, first, optical flow algorithm is applied. This is then combined with the illumination insensitive template matching method to accurately track the object for visual surveillance system. Experiments on Weizmann & Self developed database shows that this method has more discriminative ability with relatively robust and low computational cost compared to other motion detection algorithm. Also, this system is easier to implement, making it suitable for online applications.

Keyword: - Video surveillance, Movement Detection, Optical Flow, Template Matching.

1. INTRODUCTION

The importance in location and tracking of persons has increase in recent year with many applications like safety, defence, human computer interaction, supervision, and many others. Human detection is a tough problem in many higher-level visions processing applications. High intra-class unpredictability of the humans due to variations in gestures, expression & shapes makes the detection method very difficult [1, 2]. The background litter, dissimilar illumination conditions and variations in weather conditions makes it further difficult. Object tracking technique must resolve the task of matching the target object in successive frames. Typically, the tracking procedure begins with locating the first instance of the moving object, then identifying that picture object constantly in succeeding frame sequence. Visual tracking is a lot difficult process, owing to factors such as sudden object motion; object overlapping; camera shift & illumination changes [5].

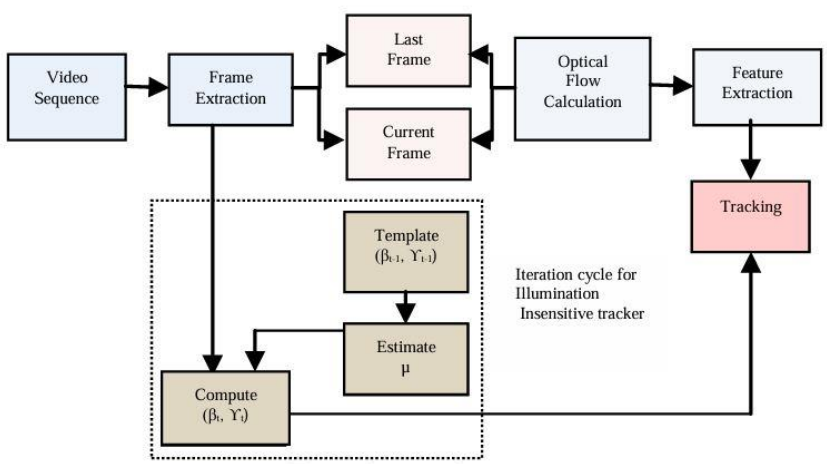

Fig.1: System Overview

Visual surveillance in vibrant scenes has extensive variety of possible applications, such as a safety guard for communities and important buildings, traffic surveillance in cities and highways, etc. A typical surveillance application consists of 3 functional blocks: movement detection, object tracking and behavior analysis. The aim of the surveillance applications is to detect, track and classify targets. The existing methods of Visual surveillance for object detection & tracking can be grouped into 3 major 5], and characteristic point-based models [7, 8]. Also most of the programmed surveillance system uses optical flow method for object detection. This works on the principle that Optical flow [10, 11] cannot be calculated locally, because merely one sovereign dimension is accessible from the image sequence at a point, whereas the flow rate has two factors a second constraint is essential. Smart programmed tracking system should be able to sense modification caused by a new object, whereas moving background regions, such as clouds, rain or a flag waving in the wind, should be recognized as an element of the background. Optical flow; It computes an independent estimate of motion at each pixel; this usually involves reducing the intensity among consequent pixels summed over the image. It is supposed that these variations are because of motion and not due to other effect, for example lightening effect. The illumination can vary in an interior and an outside image sequence. The elucidation in an interior sequence can vary as the radiance varies as a minimum 3600 times per minute by reason of indoor lighting; on the other hand, the image taken by a camera is 25 ~ 30 per second. As a result, illumination has a consequence on the captured image sequence. The elucidation in an open-air sequence also changes for a variety of reasons for example the sun light change & this variations are extremely quick compared to indoor sequence.

2. RELATED WORK

There is an enormous literature on video surveillance for human motion detection & tracking. In our recent work [12], we have proposed an adaptive threshold initialization system to segment objects from a video based on the supposition that the moving objects are visually separated without overlapping regions. Avidan uses a neural network i.e. Support Vector Machine (SVM) classifier offline and continue it within the optical flow framework for object tracking. Collins et al. use inconsistency ratio of interested object & background classes to decide discriminative characteristics for object tracking. Jepson et al. [23] uses Gaussian mixture model of pixels to represent objects via an online expectation maximization (EM) algorithm to handle target appearance variations during tracking. Ross et al. uses online multiple instance learning algorithms to successfully track object in real where occlusion & illumination changes are problem.

Hager and Belhumeur 1996 proposed a tracking technique to handle the appearance changes due to lighting and pose change using parametric models as these methods uses only generative representations of target objects and do not consider the background into account, they are less successful for tracking in messed up environments. Classifies the techniques of human action recognition into global and local representation. Bao, and Ravi et al, have proposed methods to forecast few actions like walking, standing, running, sit-ups, and others using features from raw accelerometer data and a variety of different learning algorithms. On the other hand, they do not use this information for indoor positioning. Because this method concentrates on intra-image lighting variations & spatial compared to sequential, inter image lighting changes, it is a dissimilar group of lighting compensation.

3. OBJECTIVES OF WORK

The objective of this work is to design and implement a **smart surveillance system** that leverages **optical flow** techniques to effectively detect and monitor motion in video streams. The system aims to:

Automatically detect motion in a monitored environment using optical flow to analyze changes in object position across consecutive frames.

Track moving objects efficiently and robustly, even in complex or dynamic scenes.

Enhance situational awareness by distinguishing between normal and abnormal movement patterns (e.g., loitering, sudden running).

Improve surveillance accuracy without relying on manual observation, reducing human error and resource requirements.

Enable real-time processing for prompt response to suspicious activities or intrusions.

4. DATABASE COLLEECTION

In our experiment we used two different databases. One is Weizmann database which is publically available and another is our own database this database contains 86 sequences having five & four of classes of actions (Jump, Run, Walk, Side, Hand waving, Jogging) respectively performed by 19 different subjects in two different conditions d1-d2. d1 – Indoor Environment d2 - Outdoor (Playground) + illumination variations

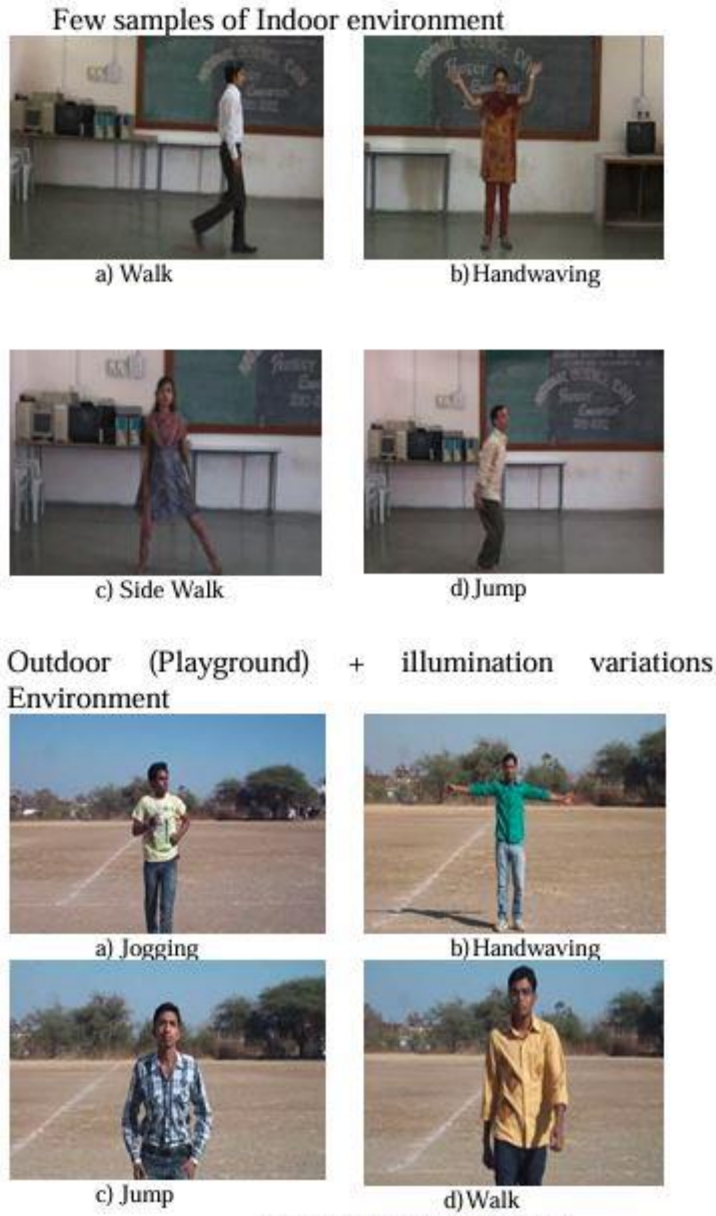

Fig.2: Sample of Own database

5. METHODOLOGY

We propose the method of optical flow estimation for human motion detection and illumination intensity minimization based on template matching technique for object tracking. Human motion detection & tracking algorithms have to deal with numerous problems occurring from the nature of video surveillance like gradual illumination changes, dynamic background, video noise and many others. Our objective is to provide an efficient method to find the moving objects in the video frame as well as to track them. The proposed method is effective in reducing the number of false alarms that may be triggered by a number of reasons. Fig. 1 shows the different stages involved in the proposed system. The algorithm to learn a system for motion detection & tracking can be briefly quoted as follows. 1. Extract the frames from the given video sequence. 2. Take last & current frame and calculate the optical flow in between the 2 frames. 3. Compute the features as optical flow output. 4. Estimate μ from the template of an image. 5. Compute the value of $(\beta t, \Upsilon t)$ for illumination insensitive iteration cycle. 6. Combine the value of step 5 and step 3 to track the given object in a video sequence

A. Optical Flow Calculation Optical flow techniques try to determine the vector field, which illustrates spatial motion of each frame point over period, and gives significant information for motion analysis. For tracking an object or human being in a video sequence optical flow limitation equation can be used.

B. Illumination Insensitive Template Matching For eradicating the effects of lighting variations, a method is to determine lighting compensation factors for the present template, in order to regulate its gray level values regarding the standard template.

To suppress time wasting process of computing the matrix on the left, we exchange the standard template with the present template and hence get the motion compensation factors β and γ for adjusting the standard template to the present template. As a result, the matrix has to be calculated just the once. In order to still adjust the current template, In this paper, based on reference, after selecting the illumination compensation parameters for template matching algorithm & combining this information with the centroid estimation as discussed in the above section advantages of both the model can be maximized, and it can optimize the tracking result of the object.

6. EXPERIMENTAL RESULTS

The proposed method is compared with the simple optical flow with adaptive threshold initialization [12] for the condition of detection precision and computational time. The experimental conditions are summarized in Table I. The optical flow method uses segmentation of boundary. To improve final estimation of optical flow field borders in successive images are matched, and a set of point limitation is derived.

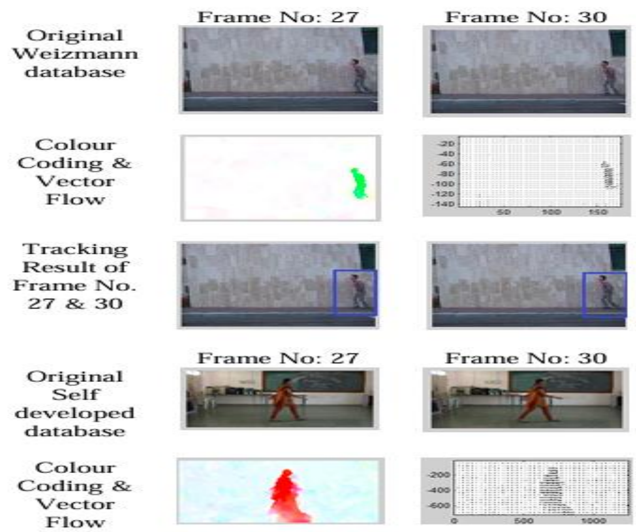

Table 1: Experiment Conditions

Sequence	1280 x720 pixels, 24 bit color 30 fps, 90 frames Motion JPEG
CPU	Corei3, 2.13GHz
RAM	4GB
OS	Windows 7.0
MATLAB	Version 7.10.0.499 (R2010a)

The proposed method can locate and track moving object and is examined for steady & moving camera. Figure shows the result for human motion detection & tracking result moving camera & dynamic background. From the result obtained it is clear that, algorithm achieves accurate target tracking not only in steady but also in dynamic conditions. The algorithm implemented has attained extremely competent & efficient results in messed up backgrounds and lighting variations. This shows the effectiveness of algorithm.

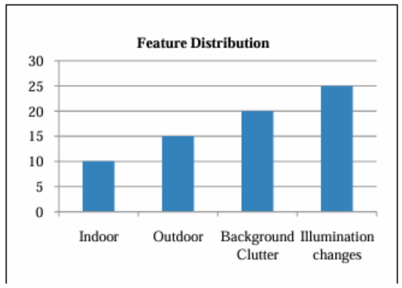

Fig.6: Range of deviation of feature distribution for different environment

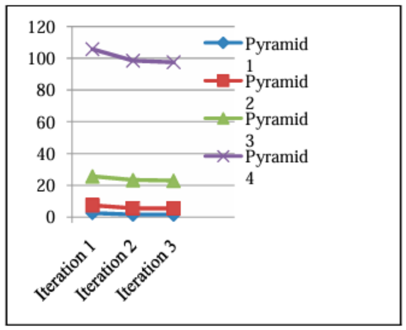

Fig.7: Norm of optical flow increment Vs No. of iterations for Optical flow calculation

From Fig 6, the number of features variation is very high if there is large change in the illumination of the image, as the pixel intensity changes to a lager extent compared to other environment conditions. Fig. 7 shows the representation of norm of optical flow for the different number of iterations.

7. CONCLUSION AND FUTURE WORK

This paper has proposed the robust human motion location and tracking which overcomes the difficulty of wavering camera and altering lighting conditions. The system uses efficient technique of optical flow calculation which calculates the value of change in pixel in between two frames. Further module of template matching eliminates the problem of illumination & dynamic environment conditions. The results of experiment carried out shows that the method is accurate & fast with all kind environmental conditions. Our future extensions include further study on occlusion handling problems, which will be of interest to social studies and can be used for realistic crowd simulation.

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