Survey on Wireless Intelligent Video Surveillance System Using Moving Object Recognition Technology

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Abstract

Video cameras are becoming a ubiquitous feature of modern life, useful for surveillance, crime prevention, and forensic evidence. We cannot solely rely upon human efforts to watch and shift through hundreds and thousands of video frames for crime alerts and forensic analysis. That is a non-scalable task. We need a semi-automated video analysis and event recognition system that can provide timely warnings to alert security personnel, and that can substantially reduce the search space for forensic analysis tasks. This survey describes the approach of wireless intelligent video surveillance system using moving object recognition technique.

Keywords: Wireless, Video surveillance, moving object recognition

1. Introduction

Intelligent video surveillance systems deal with the real-time monitoring of persistent and transient objects within a specific environment. The primary aim of this system is to provide an automatic interpretation of scenes and to understand and predict the actions and interactions of the observed objects based on the information acquired by video camera. The technological evolution of video-based surveillance systems started with analogue CCTV systems. These systems require number of high resolution cameras, high performance network and large amount of space for storage purpose. So these systems are high cost video surveillance systems. So we require a low cost video surveillance system for security purpose where there is limited amount of memory space and average performance network available. Massimo Piccardi (2004) reviewed about eight background subtraction techniques used for object tracking in video surveillance ranging from simple approaches, used for maximizing speed and restraining the memory requirements, to more complicated approaches, used for accomplishing the highest possible accuracy under any potential circumstances.

All approaches intended for real-time performance. The techniques reviewed are: Running Gaussian average, Temporal median filter, Mixture of Gaussians, Kernel density estimation (KDE), Sequential KD approximation, Co occurrence of image variations and Eigen backgrounds technique. Amongst the methods reviewed, simple methods such as the Gaussian average or the median filter offer acceptable accuracy while achieving a high frame rate and having limited memory

The main stages of this type of video surveillance system are: moving object detection, recognition and tracking. For moving object detection there are several types of background subtraction techniques available. Background subtraction is a widely used approach for detecting moving objects in videos from static cameras.

2. Motion and Object Detection

Most visual surveillance systems start with motion detection. Motion detection methods attempt to locate connected regions of pixels that represent the moving objects within the scene; different approaches include frame-to-frame difference, background subtraction and motion analysis using optical flow techniques. Motion detection aims at segmenting regions corresponding to moving objects from the rest of an image. The motion and object detection process usually involves environment (background) modeling and motion segmentation. Subsequent processes such as object classification, tracking, and behavior recognition are greatly dependent on it. Most of segmentation methods use either temporal or spatial information in the image sequence. Several widely used approaches for motion segmentation include temporal differencing, background subtraction, and optical flow.

Temporal differencing makes use of the pixel-wise difference between two to three consecutive frames in an image sequence to extract moving regions. Temporal differencing is very fast and adaptive to dynamic environments, but generally does a poor job of extracting all the relevant pixels, e.g., there may be holes left inside moving entities.

Background subtraction is very popular for applications with relatively static backgrounds as it attempts to detect moving regions in an image by taking the difference between the current image and the reference background image in a pixel-by-pixel fashion. However, it is extremely sensitive to changes of environment lighting and extraneous events. The numerous approaches to this problem differ in the type of background model and the procedure used to update the background model. The estimated background could be simply modeled using just the previous frame; however, this would not work too well. The background model at each pixel location could be based on the pixel's recent history. Background subtraction methods store an estimate of the static scene, accumulated over a period of observation; this background model is used to find foreground (i.e., moving objects) regions that do not match the static scene. Recently, some statistical methods to extract change regions from the background are inspired by the basic background subtraction methods as described above.

The statistical approaches use the characteristics of individual pixels or groups of pixels to construct more advanced background models, and the statistics of the backgrounds can be updated dynamically during processing. Each pixel in the current image can be classified into foreground or background by comparing the statistics of the current background model. This approach is becoming increasingly popular due to its robustness to noise, shadow, changing of lighting conditions, etc. (Stauffer & Grimson, 1999).

Massimo Piccardi (2004) introduced a technique of background subtraction in a video surveillance. It involves comparing an observed image with an estimate of the image if it contained no object. The technique simply involves subtracting the timely updated background template from the observed image.

The process of background subtraction is shown in following flow chart. The background subtraction technique can adapt to slow changes such as illumination changes by recursively updating the background model.

The background subtraction technique is shown in figure 1. Let $B(x)$ represents the current background intensity value at pixel x and $I(x)$ represents the current intensity value at pixel x, then x is considered as a foreground pixel if:

$$| I(x) - B(x) | = T(x)$$

While B(x) is initially set to be the first frame and T(x) is initially set to some empirical non-zero value, both B(x) and T(x) are updated over time

3. Automatic Video Surveillance

Real-time segmentation of moving regions is an elemental step in several vision systems including human-machine interface, automated visual surveillance and very low-bandwidth telecommunications. A typical method used is background subtraction. Numerous background models have been brought in to handle different problems. Pixel based Multi-color background model proposed by Grimson et al (2000) is one of the successful solutions to these problems.

However, this method suffers from slow learning at the beginning, especially in busy environments and it couldn't differentiate between moving objects and moving shadows. P. KaewTraKulPong et al (2001) introduced a method which improves this adaptive background mixture model. By reinvestigating the update equations, we utilize different equations at different phases. This allows our system learns faster and more accurately as well as adapt effectively to changing environments.

Axel Baumann et al (2008) provided a systematic review of measures and evaluate their effectiveness for specific features like segmentation, event detection and tracking. This review focuses on normalization issues, representativeness and robustness. A software framework is established for continuous evaluation and documentation of the performance of video surveillance systems. A new set of representative measures is projected as a primary part of an evaluation framework.

4. System Architecture

"Architecture" is both the process and product of planning, designing, construction. The system architecture for wireless intelligent video surveillance system based on object recognition technique is shown in figure 2. Firstly Video is captured by camera (mobile).By capturing first N number of images the background template is created. After this when the object is detect the image is captured. This image is subtracted from the background image to get the moving object and finally this separated moving object is send to the destination.

5. Video Characteristics

Video quality is an outgrowth of a few basic characteristics; frame rate, color depth, resolution, and file format. Frame rate is measured in frames per second (fps), with live video feeds requiring a minimum frame rate of 10 to 15 fps. Color depth can be black and white, grayscale, color or true color. Resolution is typically measured in the number of pixels (picture elements) within each picture frame and will need to be considered in relation to the device screens or monitors the video will be viewed on. Higher resolution, higher frame rates and video with color contain much more Information /data and require more network and storage capacity than lower resolution black and white images.

Compression algorithms, often referred to as video formats such as MPEG 4 and H.264, allow video files to be compressed and take up less network bandwidth and less storage space. Each format has different characteristics and care must be taken to select the format most suitable to a particular situation.

Considerations in choosing the appropriate sizing of solution components must include: frame rate, resolution, color depth, types of compression and subject matter for recording.

6. Conclusion

This paper reviews and exploits the existing developments and different types of video surveillance systems which are used for object tracking, behavior analysis, motion analysis and behavior understanding. The moving object recognition technology led to the development of autonomous systems, which also minimize the network traffic. Also, the system can be extended to a distributed wireless network system. Many terminals work

together, reporting to a control center and receiving commands from the center. Thus, a low-cost wide-area intelligent video surveillance system can be built.

Video surveillance systems have been around for a couple of decades. Most current automated video surveillance systems can process video sequence and perform almost all key low-level functions, such as motion detection and segmentation, object tracking, and object classification with good accuracy.

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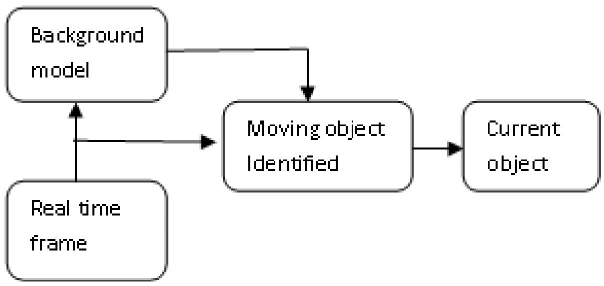

Figure 1. Background subtraction technique

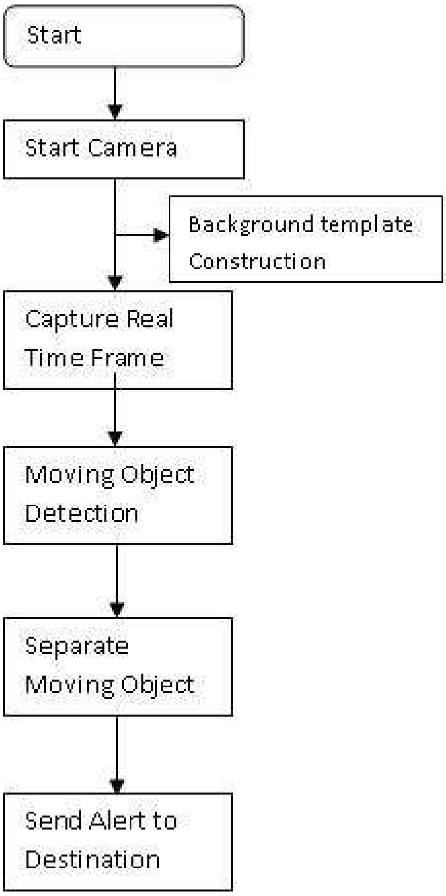

Figure 2. System Architecture

Table 1: Summary of technical evolution of intelligent surveillance systems

1^{st} generation	
Techniques	Analogue CCTV systems
Advantages	-They give good performance in some situations – Mature technology
Problems	Use analogue techniques for image distribution and storage
Current research	– Digital video recording – CCTV video compression
2nd generation	
Techniques	Automated visual surveillance by combining computer vision technology with CCTV systems

Advantages	Increase the surveillance efficiency of CCTV systems
Problems	Robust detection and tracking algorithms required for behavioral analysis
Current research	Automatic learning of scene variability and patterns of behaviours – Bridging the gap between the statistical analysis of a scene and producing natural language interpretations
3rd generation	
Techniques	Wireless intelligent video surveillance system
Advantages	• Easily installable • Hardware requirement is easy due to advance cameras, growing mobile phone market. • Memory size is very small • Least expensive
Problems	– Design methodology
Current research	-Moving object detection -Background subtraction