Design and Implementation of a Distributed Intelligent Video Surveillance System Based on Android Phone

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Abstract

Smartphones are playing an indispensable role in modern life. With its powerful hardware and high mobility, Android phone become the perfect substitute of traditional intelligent video surveillance system. This paper presents a new intelligent video surveillance system based on Android phone. By using Android phone, this system can be deployed easily and quickly. Therefore this system will have a better performance dealing with contingencies. Compare with the traditional surveillance system, this new one uses Android phone to replace the large and expensive surveillance cameras. In addition, the functions of back-end equipment of the traditional system have been done by Android phone. This schema can significantly increase the mobility and flexibility of the entire system.

Keywords: Android, Surveillance System, Video Processing, Real-Time, Smartphone

Background

With the development of modern technology, distributed intelligent video surveillance system has been put into a high level. Traditional video surveillance systems usually use large and expensive cameras as their head-end equipment. The back-end equipment of the traditional video surveillance system is used to deal with the video processing. Under this circumstance, traditional video surveillance systems have several shortcomings (e.g., over-reliance on monitor environment and poor mobility). In order to solve these shortcomings, several studies have been done to develop a state-of-the-art schema of distributed intelligent video surveillance system based on Android phone. Android is an open source phone operation system based on Linux platform and it is the first truly open and complete mobile software for mobile terminal [1]. Estevez-Ayres et al. [2] have developed a service-oriented video surveillance system based on Android phone. Pang et al. [3] have also conducted an Android Phone Surveillance System. Although, they use the Android phone as the

key component of their systems, the schema of their systems are still same as the traditional ones. On the contrary, our study presents a new system schema that transfers the function of back-end equipment to head-end equipment. Therefore, the head-end equipment is supposed to be intelligent and powerful. In addition, the complicated video processing algorithm need run smoothly on the head-end equipment. Due to its powerful hardware, low cost and high mobility, Android phone becomes the best choice to head-end equipment (i.e., use Android phone as a camera).

The main problem of our study is how to design the video processing algorithm. This new intelligent video surveillance system is designed to be used in various monitor environments. Environmental conditions (e.g., illumination intensity) may be the prior disturbance to the entire system [4]. Thus the algorithm needs to be designed to eliminate the disturbance to ensure the performance of the entire system. Moreover, considering the limited-resource of an Android phone, this algorithm should be an energy-efficient one to support a long-term surveillance period [5].

Objectives

This new intelligent video surveillance system is specifically designed for contingency surveillance, i.e. it is not designed for a permanent use. The objectives that we would like to reach through our study are as follows:

1) High Mobility
   Our study aims to develop an Android phone application, which allows users to monitor certain target sites anywhere and anytime. Using this application, users could also get access to the Real-Time surveillance video by another Android phone through Internet. Meanwhile, because the head-end equipment is replaced by Android phone, users can easily deploy the head-end equipment rather than dealing with a maze of power supply and connection wires of the traditional cameras. In this case, the mobility of the entire system will be increased significantly.

2) Energy-efficient Algorithm
   The key component of the entire system is the video processing algorithm. In order to make it possible to run this new intelligent video system in different monitor environments (e.g., indoor and outdoor), algorithm, which usually run on the back-end equipment, has been redesigned. In addition, considering the limited-resource of Android phone, this algorithm shall marginally occupy resource of smartphones and it will not influence other background applications. This design allows smartphones to run this video surveillance system smoothly.

Methodology

The core of the entire program is the algorithm, which allows this program to detect the invasion within a certain video surveilling area. The major problem of our study is how to design this algorithm and how to ensure the performance of this algorithm. Several methods are used to solve these problems. First, several controlled experiments shall be done to collect data under different conditions. In real surveillance scenario, many environment factors (e.g., illumination intensity) could affect the surveillance performance. In order to make this program easier for police to use, several modes (e.g., indoor and outdoor) have been implemented. Therefore, controlled experiments need to be conducted in these situations to collect relative data for future design. Second, collected data analysis is required. Conclusions of the analysis are helpful to implement a better algorithm. These analyses help us to define the parameters of the algorithm to fit different modes. Third, algorithm is supposed to be designed thoroughly. Because this program is running on a resource-limited Android phone, it is critical for us to design an energy-efficient algorithm to reduce the power consumption. Finally, program debugging has been done to ensure reliability and practicality of this system.

Novelty

In this new intelligent video surveillance system, Android phones are used as remote surveillance cameras and they are also able to process the recorded videos. The function of back-end equipment has been transferred to the head-end equipment. This schema highly improves the mobility of the whole system. Meanwhile, smartphones are the most common portable device in the world now and people are carrying smartphones almost anywhere and anytime. Therefore this new video surveillance system is able to deal with contingencies. Moreover, this new system also allows users to see the monitor target site in Real-Time by another Android phone via Wi-Fi. In other words, by using our application, the Android phone is not only playing a role as a remote surveillance camera, but also as a surveillance monitor.

Recently, several studies have been done to improve the mobility of the video surveillance system. In the service-oriented video surveillance system developed by Estevez-Ayres et al. [2], we can see that they have already replaced the traditional PC monitor by Android phone. Although using Android phone as remote surveillance monitor can increase the mobility of the entire system, the schema of their system, to some extent, still remains the same as the traditional video surveillance system. It will still take a very long time for users to deal with a maze of power supply and connection wires. Similar work can be seen from the Android phone surveillance system developed by Pang et al. [3]. The authors use socket communication to transfer the surveillance video data from cameras to Android phone via server.

However, in this system, the Android phone is still used as a surveillance monitor. As we can see, none of the head-end equipment used by these systems could be able to cope with the contingencies. On the contrary, our system, which is specifically used to solve this kind of problems, fills the blank in this field.

Conclusion and Significance

In daily life, a common requirement for police officer is to deploy a surveillance system monitoring a specific area in emergence. That is to say, police officers have to deploy a temporary surveillance system in a specific area quickly. In conventional way, police officers set several cameras. In the meantime, these cameras need to be connected to the surveillance back-end equipment. It is a very complicated and time-consuming work for police officers to sort power supply wires and data transfer wires. In some extreme conditions, for example, in the forest, it is even impossible to find power to supply the cameras and the surveillance back-end equipment. Under this circumstance, surveillance performance could be highly affected. As we can see, our study is just aimed to solve these problems. Police officers can easily deploy a temporary surveillance system with couple of Android phones. In the meantime, due to the small size and powerful hardware of Android phone, the system can be easily concealed and maintain a high performance.

This new intelligent video surveillance system also makes it possible to monitor target site anywhere and anytime via activating our application on an Android phone. At the same time, if any exception (e.g., burglary) happens, the head-end equipment will immediately send alert message to certain people or police officers. In addition, Real-Time video surveillance is possible if operating our application on more than one Android phone. One is used as the surveillance monitor while others as surveillance cameras.

This system is not only for police, but also for factory and domestic surveillance. Moreover, because of the thoroughly designed video processing algorithm, this system can be deployed in various environments (e.g., indoor or outdoor, day-time or night-time).

References

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