Smart City Real-Time Low Cost Surveillance System based on Raspberry Pi

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***Abstract*—Smart cities seek to build the surveillance systems in order to improve the efficiency of urban spaces while reducing costs and resource consumption. There are several defects in the video surveillance system, such as: picture is indistinct, anomalies cannot be identified automatically, a lot of storage spaces are needed to save the surveillance information, and prices remain relatively high. This paper describes the novel design of a smart city low-cost surveillance system based on Raspberry Pi, a single board computer which follows Motion Detection algorithm written in Python as a default programming environment. In addition, the system uses the motion detection algorithm to significantly decrease storage usage and save investment costs.**

***Keywords*—Smart city surveillance; Raspberry Pi; Motion Detection**

I. Introduction

In Smart Cities, closed-circuit television surveillance system has now become an indispensable device [1]. Supermarkets, factories, hospitals, hotels, schools, and companies are having their own CCTV system for 24/7 monitoring. Instead of using the traditional wireless CCTV surveillance cameras, customers can now own their inexpensive security systems with the tiny super computer called Raspberry Pi [2]. IP cameras can serve better as they can send and receive data via computer network and internet based on internet protocol. Also resolution clarity of IP cameras is far better than CCTV cameras. A camera module connected to the Raspberry Pi will records all the happenings in the monitored area and live streaming can be viewed from any web browser, even from mobile in real-time.

There are many problems in the video surveillance system [3], such as: picture is indistinct, anomalies cannot be identified automatically and a lot of storage spaces are needed to save the surveillance information. Moreover, in recent years, Motion Detection [4], [5] has attracted a great interest from computer vision researchers due to its promising applications in many areas, such as video surveillance, traffic monitoring or sign language recognition. To overcome storage spaces issue, we apply the Motion Detection algorithm for live camera streaming, this allows the system to analyze incoming images from cameras, and recognize when movement occurs. And then, the video system can collect and store the most importance items for the administrators review.

The rest of this paper is organized as follows. In Section II presents the proposed system architecture. Section III presents the Motion Detection algorithm. Finally, conclusions and future works are given in Section IV.

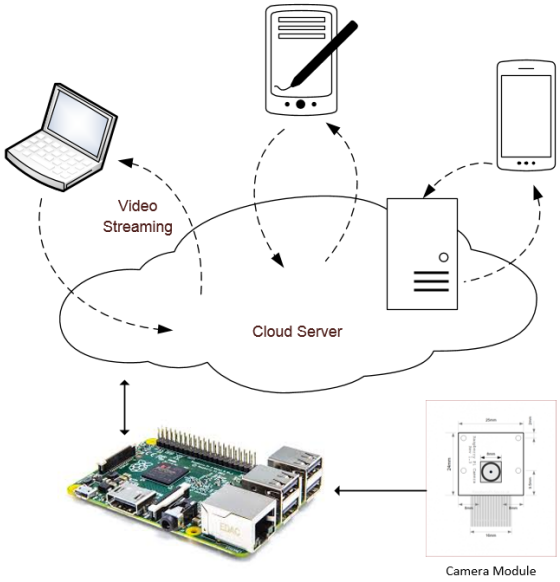

Fig. 1: Proposed Surveillance System Architecture for Smart City

II. Proposed System Architecture

The proposed system is shown in Figure 1. The camera module connected to the Raspberry Pi board can be used to take high definition video, as well as stills photographs.The setup Python script will automatically deliver video data streaming to cloud server. Users will be able to watch the video stream from cloud server on any device that has a web browser. This includes the IPad/iPhone and Android devices.

A. Overview of the Raspberry Pi Model

The proposed system, uses Raspberry Pi Model B+ single board computer and offers these key features:

- Broadcom BCM2835 SoC processor with 700MHz ARM1176JZF-S core
- 512MB RAM
- Videocore 4 GPU supports up to 1920x1200 resolution

- 5Mpix Camera module capable of full HD video @ 30fps
- MicroSD card slot, 10/100Mbps Ethernet port, 4 x USB 2.0 ports, HDMI, audio/video jack, GPIO header, microUSB power port, DSI and CSI ports

During initial setup Raspberry Pi was configured as a miniature desktop with USB configured camera module and an external monitor or mobile for viewing the captured video. The Raspberry Pi runs Raspbian OS and is programmed using GNU Octave and Python, which is an open source. The Dynamic host Protocol is obtained for Raspberry Pi, addressed IP is fetched. After obtaining this the system can be configured and controlled remotely.

B. Connection of Camera Module

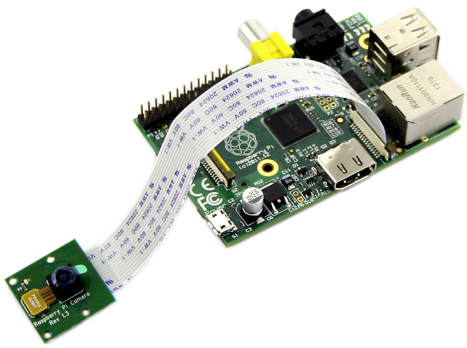

Fig. 2: Connection of Camera Module on Raspberry Pi board

As shown in Figure 2, a 5MP camera module that capable of 1080p video and still image, and it can connect to Raspberry Pi directly with CSI (Camera Serial Interface). And then boot the latest version of Raspbian and we are good to go with the camera. Its a fixed focus 5MP sensor capable of 2592x1944 stills, but also 1080p30, 720p60 and 640x480p60/90.

Cost of the whole system is around $75. Includes the camera module costs, Raspberry Pi board and wifi adapter. So the system cost is less, compared to other alternatives.

III. Basic Motion Detection Algorithm

Motion detection works on the basis of frame differencing - meaning comparing how pixels (usually blobs) change location after each frame. The method looks for a object change in the image:

Algorithm 1 Motion Detection algorithm

```
procedure MotionDetection
    calculate the average of a selected color in frame 1
    wait X seconds
    calculate the average of a selected color in frame 2
    if abs(avgFrame1 − avgFrame2) > threshold then
        motion detected
```

The problem with these motion detection methods is that neither detects slow moving objects, determined by the sensitivity of the threshold. But if the threshold is too sensitive, it will detect things like shadows and changes in sunlight. The Motion Detection algorithm also cant handle a rotating object - an object that moves.

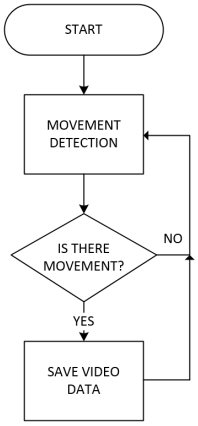

Fig. 3: Flowchart of Motion Detection

Motion Detection flowchart is shown in Figure 3. If there is no motion detected, the program will not save the videos data. Otherwise, if motion is detected, the current frame of detected motion will be processed by Motion Detection algorithm. And then the system will be record full-hd videos, save them on the sd-card packed into MP4 container while the live-preview continues.

IV. Conclusion & Future Work

An approach of the surveillance monitoring system for smart city and the Motion Detection algorithm to decrease storage usage based on Raspberry Pi single board computer was proposed in this paper. In future we plan to implement and improve the Motion Detection algorithm. Because the algorithm depends on threshold value, it's mean the performance of the algorithm can be enhanced by considering certain conditions. If we have a good solutions to get a good threshold value and then the algorithm can detect moving objects precisely, including slow moving or tiny objects.

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