Real Time Video Surveillance Architecture for Secured City Automation

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Abstract - *In recent trends city automation is trending around the globe. The project presents a multilevel surveillance security system, which does not require human-to-human or human-to-computer interaction. The project aims at using Raspberry pi which controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback. The purpose of the project is to provide security automation in the city via camera based object tracking, motion detection when an intrusion happens along with pollution detection monitoring system. This system also tracks any object in real time meaning we will be completely aware of precise location of the object to see its movement in real time. Raspberry pi a single board computer that carries motion detection algorithm with python as default programming environment. A camera module connected to the Raspberry Pi will record all the happenings in the monitored area and live streaming can be viewed from any web browser, even from mobile in real-time. To use the storage efficiently, we apply the Motion Detection algorithm. In this algorithm the media is recorded and stored on a local disk only when motion is recognized, the motion detection is achieved by using IR sensor. In normal scenario, for a video of 5seconds, it requires 11MB of storage whereas for motion detected media a reduced storage of 3MB was achieved. Monitoring the surrounding and providing an alert via GSM module in case of pollution and fire accidents. In object tracking we feed the data set for the objects we wish to track, the program extracts the features of the captured image. When the features match with the given data set a luminous highlighting helps to track the path of the object within the camera coverage.*

***KeyWords*: Video Surveillance, Motion Detection Algorithm, Object Tracking, feature detection, Pollution Detection and Monitoring.**

1. INTRODUCTION

Smart cities requires high end surveillance, the cameras play very essential role in this. Generally smart cities requires automated surveillance for intrusion detection, monitoring the environmental pollution , tracking the suspected objects as well as detecting faces of people and giving the personnel concerned an alert message in case of any untoward incidents. The integration of these systems can be done in a Raspberry pi which is a credit card size single board computer.

A camera module connected to the Raspberry Pi will record all the happenings in the monitored area and live streaming can be viewed from any web browser, even from mobile in real-time. This system tracks any object in real time meaning we will be completely aware of precise location of the object to see its movement in real time. The Motion Detection algorithm is also used to reduce the storage for live camera streaming, by allowing the system to analyze the images only when the movement occurs. Monitoring the surrounding and providing an alert in case of pollution and fire accidents. Huu-Quoc Nguyen, et.al [1], proposed a low cost real-time system monitoring using raspberry pi. This paper provides the implementation of low cost monitoring system based on Raspberry pi which follows motion detection algorithm scripted in Python as default programming environment. We have inferred that this algorithm can be enhanced by considering motion detection conditions for fixing the threshold value and providing an alert whenever motion is detected.

Sampa Jana, et.al. [2], proposed an object detection and tracking technique using raspberry pi this object detection and tracking algorithm is based on the color of the object. The input to camera is interfaced to the Raspberry pi 3 which will detect the object and tracks it in its direction. We have inferred that optimization could be implementing the algorithm with additional modules for real time monitoring system. Post optimization the algorithm is expected to function with increased tracking speed.

The paper is organized as follows: Section 1 gives the Introduction to the Surveillance systems in Smart Cities, Section 2 provides the System Architecture for the proposed methodology, Section 3 gives the Description of the various hardware modules and Software used, Section 4 explains the Working methodology of proposed system, Section 5 gives the Results and Discussion on the paper and finally Section 6 gives the Concluding remarks for the paper.

2. SYSTEM ARCHITECTURE

The proposed system for Surveillance as shown in fig.1 is intended to track the path of any object of interest. Object tracking involves locating objects in the frame of a video sequence. The three main steps in video analysis are detection of moving objects, tracking of such objects from frame to frame, and analysis of tracked objects to recognize their behavior. To detect human face in live streaming and capture the images during the real time video surveillance

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when movement is detected. This is achieved by activating the IR sensor when button is pressed. The system also provides alert to the authenticated person and fire fighter via GSM module in case of presence of excess smoke and fire accidents. The advantage of using fire alert in the proposed system is, it will reduce the possibility of delayed report to the fire brigade.

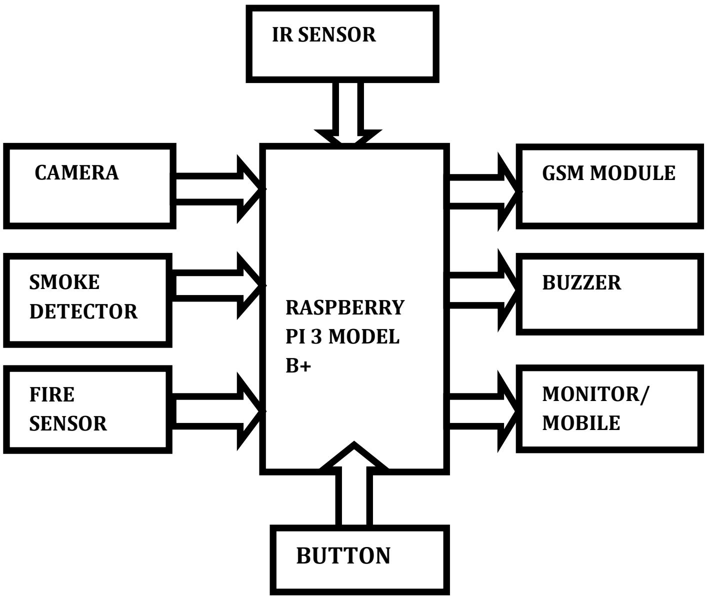

Figure 1: Block diagram of proposed Surveillance architecture

The system consists of various sensors and modules such as camera module, IR sensor, GSM module, Smoke detector, Fire sensor interfaced with Raspberry pi 3 Model B+ . A camera module connected to the Raspberry Pi will record all the happenings in the monitored area and live streaming can be viewed from any web browser, even from mobile in real-time.

ARCHITECTURE:

The following as shown in fig.2, gives the architecture of the proposed system having various layers of hardware integration.

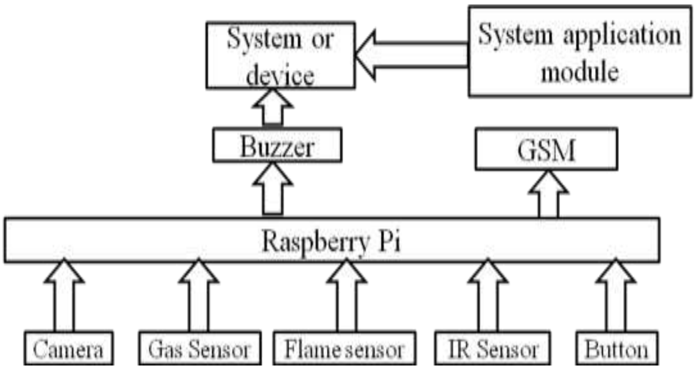

Figure 2: Architecture of proposed surveillance architecture

The top layer includes the output modules such as

- System device(Monitor/Mobile)
- System application module
- Buzzer
- GSM

The middle layer has the single board computer i.e. Raspberry pi 3 Model B+

The bottom layer includes the input modules such as

- Camera module
- Gas sensor
- Flame sensor
- IR Sensor
- Button

The system is developed as a static model for direct implementation in Smart cities.

3. HARDWARE DESCRIPTION

There are many hardware modules and software incorporated in the proposed system. The hardware modules include Web camera, Raspberry pi 3 Model B, GSM modem, sensors like IR sensor, Gas sensor and Flame sensor.

A) RASPBERRY PI 3 MODEL B

The Raspberry pi is a device that is in the size of a credit card, which acts as a computer that can be plugged into TV and a keyboard. The Raspberry Pi 3 Model B was introduced in 2016 which is very fast and efficient in functioning, and it uses SoC BCM2837 with a quad core 64 bit processor and it supports 400Hz Video Core IV which is faster compared to other Raspberry pi versions , it has a RAM of 1GB SDRAM. The advantage of Raspberry pi 3 is it uses inbuilt Bluetooth 4.0 whereas other Raspberry pi versions do not support it. The Raspberry pi 3 has 40 General Purpose Input Output Pins (GPIO). It also has The Raspberry Pi's four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else that you feel the Raspberry Pi needs, but if we want to add even more we can still use an USB hub. It also supports an HDMI port, we could watch Blue Ray quality video. There's no need to connect an external antenna to Raspberry Pi 3. Its radio is connected to this chip antenna soldered directly to the board, in order to keep the size of the device minimum.

B) SENSORS

i) Gas sensor: The MQ-2 gas sensor senses the gases like ammonia nitrogen, oxygen, alcohols, aromatic compounds, sulfide and smoke. The operating voltage of this gas sensor is from 2.5V to 5.0V. The MQ-2 gas sensor has a lower conductivity to clean the air as a gas sensing material. In the atmosphere there are polluting gases, here the conductivity of gas sensor increases as the concentration of polluting gas in the atmosphere increases. MQ-2 gas sensor can be implementation to detect the smoke, benzene, steam and other harmful gases. It has potential to detect different harmful gases.

ii) IR sensor: The Infrared sensor operates by measuring the heat of the object. When the infrared light falls on the photodiode, it measures the output voltage if it is lesser than the input, an object is detected.

iii) Flame sensor: A flame sensor is used to detect the fire. It works by detecting the IR light wavelength between 760nm to 1100nm. The sensor has a Black epoxy receiver. It gives 1 when flame is detected

C) GSM MODEM

A GSM is used for sending messages to the authority under specified conditions, it supports only TTL signals so we use a TTL signal convertor in our Raspberry Pi. When used in outdoor GSM is more efficient than Wi-fi and Bluetooth, because Bluetooth cannot support long distance transmission.

D) CAMERA

The camera used is Logitech c310. It supports high definition quality images and video. It has 5-megapixel snapshots with a built-in microphone with noise reduction and a automatic light correction. It is compatible with 1 GHz processor, 32/64-bit Windows 7/Windows Vista/Windows 8, at least 512 MB RAM and 200 MB hard disk.

1.1 SOFTWARE DESCRIPTION

The software used for the proposed Surveillance Architecture are: Raspbian OS and Anaconda Navigator. The Raspbian OS is installed in Raspberry pi 3 and Anaconda software is used for Object Tracking.

A) RASPBIAN OS: It is a Debian based operating system. This OS is installed in the SD card, which is beforehand formatted using an SD card formatter, once the OS is installed in the SD we can start coding the programs and dumping it in the SD .Then connect the SD card with Raspberry Pi .

B) ANACONDA: It is an open source distributer of Python Programming language, it has 1400 inbuilt packages as Jupyter, Spyder and so on which comes with a virtual environment manager, these can be launched and the programming can be done. We use Anaconda software for object tracking as it supports Graphical User Interface format, so we can perform live video demonstrations. It is supported in all the Operating Systems.

4. SYSTEM METHODOLOGY

1.2 OBJECT TRACKING [2]:

Object detection is the process of locating objects in the frame of a video sequence. The three main steps in video analysis are detection of moving objects, tracking of such objects from frame to frame, and analysis of tracked objects to recognize their behavior.

The location of objects in subsequent frames is computed by object tracking algorithm.The process of object detection and tracking, either by using three-frame differencing or background subtraction approach requires some kind of pre-processing on input and post- processing on the output to get higher accuracy in detection. A flow chart for Object tracking algorithm using the image processing technique is given in fig.3.

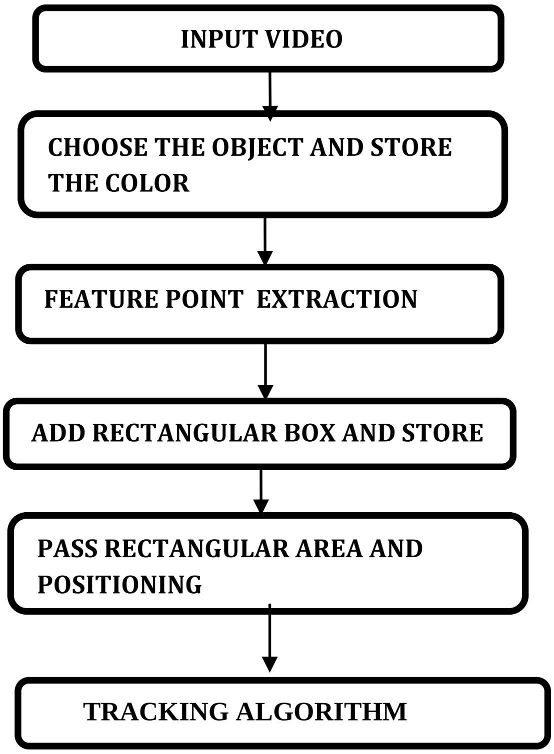

Figure 3: Flow chart for Object tracking Algorithm

The steps in the algorithm are as follows:

Step 1: Get the input video in real time.

Step 2: Choose the color of the object and store it.

Step 3: Extract the feature points from the image.

Step 4: Add rectangular box and store the frame.

Step 5: Pass the rectangular area and positioning of the video given.

Step 6: Track the object.

1.3 MOTION DETECTION [1]:

Motion detection algorithm is used to reduce the storage issues. It is achieved by detecting the motion through IR sensor output and storing the images only when motion is detected.

When the button is pressed, camera will be activated. When the IR output goes high, the media is recorded and stored on a local disk which can be retrieved for future reference. This can hugely reduce the storage issues.

1.4 FLAME AND GAS DETECTION [8] :

The atmospheric conditions are monitored through gas and flame sensors. When the output of these sensors goes high, an alert message is sent to the authenticated person via GSM.

The overall flowchart representing the Motion detection, Flame and Gas detection is shown in fig.4.

The steps in the algorithm are as follows:

Step 1: Activate the flame and gas sensor.

Step 2: Monitor the environment by continuously reading the values in air.

Step 3: Get the input data.

Step 4: Print the values continuously in the screen.

Step 5: Check if the reading has surpassed the threshold value.

Step 6: If the condition is true, then send an alert message via a GSM to the authenticated person.

Step 7: If the condition is false, then go to step 3.

Step 8(motion detection): Set the button and check whether IR output is high.

Step 9: If the output is high then the motion is detected

Step 10: If the output is low go to step 8.

Step 11: As soon as the motion is detected capture the image and give a buzzer alert

Step 12: The saved media can be retrieved.

Step 13: End of working.

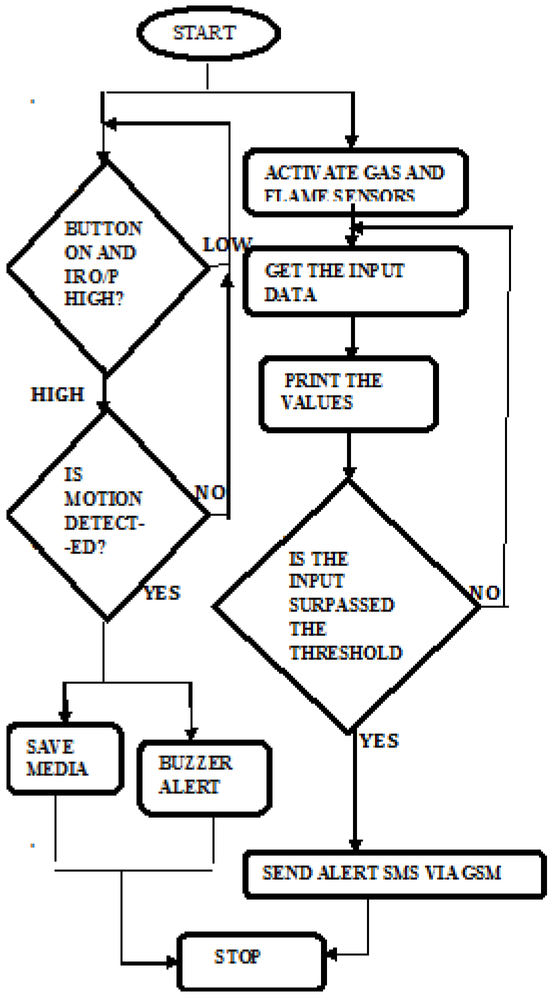

Figure 4: Flowchart for overall system

5. RESULTS AND DISCUSSION

The object tracking algorithm was tested by giving a pre loaded video, we have already given the data set of the car in the XML file , when the input video has a moving object its feature points are extracted and marked as matrix 1, remaining as 0. When these points are as same as the given data set, then the object is detected and is tracked along its path, until the object is in the coverage of the camera. This system can track single moving object as well as multiple moving objects in the single video frame.

The first image shown in fig.5 is the given input video frame, the image shown in fig.6 is the detected and tracked objects as we have given the data set of a car, only a car is detected as its feature points match with the input data set and a luminous highlighting is given to show the tracking.

Figure 5: Input video frame in object tracking

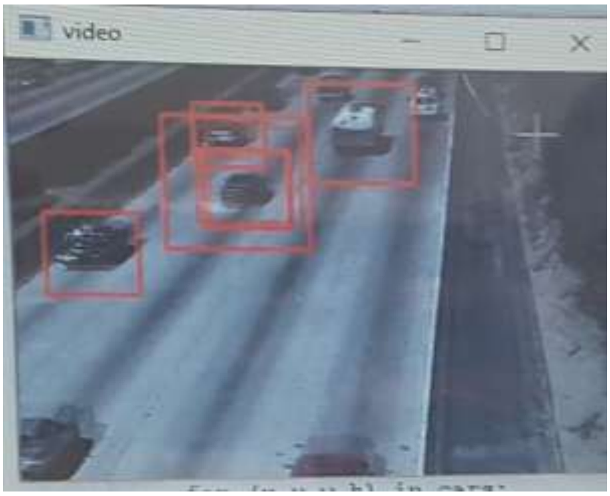

Figure 6: Detected and tracked objects

In the motion detection algorithm, we have incorporated environmental pollution monitoring along with this system, we have set a gas threshold as greater than 700 and flame threshold as less than 800, when either of the conditions satisfy we get alert message as "Fire and Gas Alert" via a GSM module. In motion detection whenever a motion is detected the IR goes high, the camera is activated and the images are captured.

6. CONCLUSION

The project targets its use in most of the public places in case of the intelligent city architecture by providing motion detection, fire alert, authentication and pollution assessment in those places making it smarter. The object tracking technique helps in tracking the path of any object in real time enabling the user to be aware of the precise location of the object. The motion detection is very much useful to efficiently use the memory thereby storing the video only when the movement is detected. In normal scenario, for a video of 5seconds, it requires 11MB of storage whereas for motion detected media a reduced storage of 3MB was achieved. The GSM modem sends an alert message to the authorized persons in case of fire accidents or presence of excess smoke in that particular area. Thus the proposed system provides convenient and reliable security system. In future the idea of this project can be extended for city automation such as smart cities.

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