IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 10 (October. 2018), ||V (IV) || PP 51-58

Iot Based Security System for Monitoring Surveillance Area by Using Raspberry Pi with Android App Alerts

Vasudev Emmennavar[1], Dr. U. B. Mahadeva Swamy[2]
[1](*Dept. of Electronics and communication, Sri Jayachamarajendra College of Engineering, mysuru, Karnataka, India*
[2](*Associate Professor, Dept. of Electronics and communication, Sri Jayachamarajendra College of Engineering, Mysuru, Karnataka, India*
Corresponding Author: Vasudev Emmennavar

Abstract: - People are surrounded by a wide variety of electronic gadgets, sensors and devices which range from mobile phones, routers, home automation systems and many more. They are all embedded systems, be it a small device or a big one. Internet of Things is an approach of transferring information from one entity to the other inter-connected to a network through a wireless connection to a remote device. It is an area of interest which is growing very fast. It can be as simple as communicating a small message between two devices or as complex as sending information from a spaceship connected to a space station using embedded systems through cloud services. The proposed work aims at using sensors and IoT based Security System to monitor a secured area remotely for any activity that might occur. The application polls the surveillance area continuously and once an activity is detected, images of the particular activity are captured using a camera connected to a Raspberry Pi Board. This application uses OpenCV, computer vision library and detects the motion. The captured pictures are uploaded to a dropbox and simultaneously the GSM interface alerts the user using the android application through a voice output that some activity has occurred and needs user's attention. The Android app plays a voice output as "Caution camera image is captured".

Keywords: - *Embedded systems, OpenCV, Internet of Things, Raspberry Pi, Android application, GSM.*

Date of Submission: 20-10-2018 Date of acceptance: 03-11-2018

I. INTRODUCTION

Around 40% of the world population has an internet enabled devices today. According to a study, around 6.4 billion connected things are in use worldwide in 2016, which is up to 30 percent increase from 2015, and will reach 20.8 billion by 2020 [4]. The internet of things is growing exponentially across various dimensions into different industries. India is one of the progressing countries where Internet of Things is picking up its pace across different technologies like Digital India.

There is a lot of scope for Internet of Things in India and government has rightly recognized it and working towards it. The government has taken action and framed a draft policy to fulfill a vision of developing a connected, secure and a smart system based on our country's needs. Indian Government's objective is to create an IoT industry of USD 15 billion by 2020. Internet of Things offers better control of statistics.

Internet of Things [4] has a lot of applications in various fields like security systems to monitor a surveillance area like forest to track the movements of animals or poachers, women safety, intelligent parking system, smart-home systems to automate waste management, smart lighting, water management, medical applications for monitoring patients health condition, etc.

The proposed work targets on integrating IoT into electronic devices that can be helpful for humans in day to day activities. It can help in sophisticating and automating things which can help in taking away the burden from doing it manually.

The agenda is to monitor a restricted surveillance area without human intervention or polling. Presently, there are CCTV cameras and security systems to monitor the restricted areas continuously. The problem with the current systems is that humans should keep polling to see if some unusual activity is going on. To avoid the polling, we can design a system which does this automatically [1] and alerts the user when any such activity occurs through a text message, voice output, image, etc.

The objective of the proposed work is to develop an IoT based Security System for monitoring surveillance area that uses a Raspberry Pi, a camera to capture the images, a GSM interface to alert the user, power supply for the system, dropbox account to save the images to be viewed by the application user whenever alerted by the system about some activity occurrence. Here we make use of software technologies like OpenCV,

Python which is a scripting language and Android which is a front end interface for the user to track the activity of a particular area remotely.

II. SYSTEM DESCRIPTION

The proposed design is mainly composed of a Raspberry Pi development board, VGA monitor, GSM, Raspberry Pi Camera, Dropbox storage and an android application in a smartphone device. The block diagram of the proposed work is shown in the figure 1.

The proposed system is 3-tier architecture – application interface, processing interface and database interface as shown in figure 2. The 3 tier architecture makes use of a client-server paradigm where a user interface forms a client side and the image capturing and processing comprises of the server side.

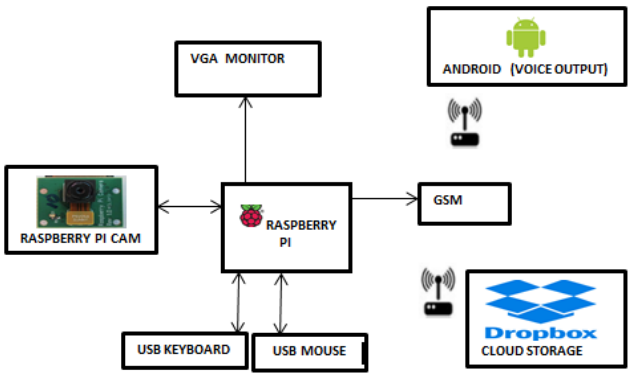

Fig.1. A schematic block diagram of the system

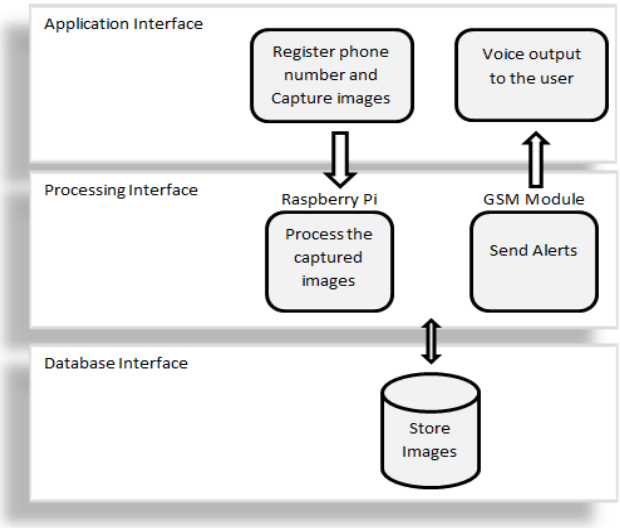

Fig.2. 3-Tier Architecture of the system

2.1. Application interface

A Raspberry Pi camera is used as an input for capturing images of a surveillance area. The communication between the camera and Raspberry Pi board is wired. The camera is connected to the Raspberry Pi board through a Raspberry Camera Serial Interface (CSI) Port. An android app is also used as a Graphical User Interface (GUI) which allows the user to provide the phone number to be registered into the database. The registered phone number will receive the alerts through the android application in the form of a voice output whenever any kind of motion is detected in the monitored surveillance area.

2.2. Processing interface

The processing interface is used as a controlling unit of the system. It mainly consists of a Raspberry Pi Board Model B, a GSM Board and a Power Supply of 5V. It is the brain and heart of the monitoring system acting in the backend. The images captured by the Raspberry Pi camera are used as input for the Raspberry Pi Board which preprocesses it by applying Gaussian Blur to remove noise and calculates delta deviation. Based on the results obtained it is decided if the motion is detected.

Whenever a motion is detected by the system, the GSM interface is signaled by the Raspberry Pi Board. The GSM module sends an alert to the registered phone number on the android app.

2.3. Database interface

The database layer forms an important interface to store the images captured by the camera whenever a motion is detected in the surveillance area. Dropbox is used as cloud storage. It is interfaced to the Raspberry Pi Board through a wireless connection. Upon the motion detection, when the user receives the alert through the android application, he/she can log into the dropbox server using the login credentials to check the images captured by the camera and take actions if required.

III. SOFTWARE SPECIFICATION AND DESCRIPTION

Below is the brief about the specification of the software used for designing, compiling and debugging of the proposed system.

3.1. OpenCV

Open Source Computer Vision Library (OpenCV) [6] is open-source software. It is a computer vision and machine learning software library. It provides an interface and infrastructure for various image processing applications.

3.2. OpenCV-python

Python [10] is a general purpose scripting language which is very popular nowadays due to its simplicity and efficiency to represent a complex and difficult structure. Python can be easily extended and interfaced with C++ which allows us to write a C++ [7] code and wrapped with python modules.

3.3. Android operating system

Android is an open source operating system designed for smartphones and tablets which provides a graphical user interface for the user interaction.

3.4. Raspberry Pi operating system

The Raspbian [9] is Linux kernel-based operating system. Raspbian is compiled for the ARMv6 instruction set [9] of the Raspberry Pi making it work but with slower performance. It provides some available deb software packages, pre-compiled software bundles.

IV. HARDWARE SPECIFICATION AND DESCRIPTION

Below is the brief about the specification of the hardware used for designing the proposed system.

4.1. Raspberry pi

Raspberry [2] Pi 2 Model B is a computer which is as small as a credit card. It uses ARM technology and is very cost effective, produces less heat and also it is energy effective.

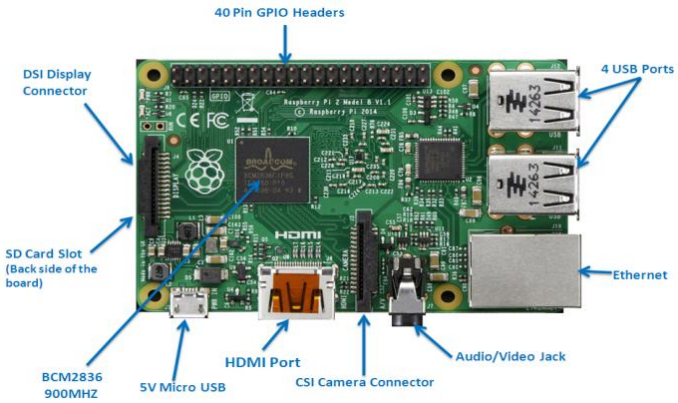

Fig.3. Raspberry Pi 2 model B Board

4.2. Raspberry pi camera

The Raspberry Pi Camera [9] is a product of Raspberry Pi Foundation. It works well compared to USB Camera and provides a high quality images.

4.3. GSM board

The GSM SIM 900A board is just like a mobile phone which allows the user to send and receive text messages, calls. It has RX and TX pins which are used for the serial communication with the Raspberry Pi.

V. ALGORITHM AND IMPLEMENTATION

Figure 4 shows the general algorithm depicted in the form of flowchart to monitor the surveillance area. The images captured by the Raspberry Pi camera are used as input for the Raspberry Pi Board which pre-processes the frame by using OpenCV technology and converts it into the grayscale. It is then followed by applying Gaussian Blur [3] to remove unwanted noise to get a good quality image. Now average background frame is set and the next image that is captured is preprocessed and the current frame is then compared with the average background frame to calculate the delta deviation. If the delta change is greater than the threshold, then it is considered to be some sort of motion detection.

When a motion is detected by the system, the images are uploaded into the dropbox and the GSM module interfaced with Raspberry Pi Board through General Purpose Input/Output (GPIO) pins using a wired connection alerts the authorized person through an android smartphone in the form of voice output.

The surveillance system is implemented on a Raspberry Pi Board which runs on Raspbian OS using OpenCV Module with Python scripting language. OpenCV module provides a huge amount of libraries for image processing.

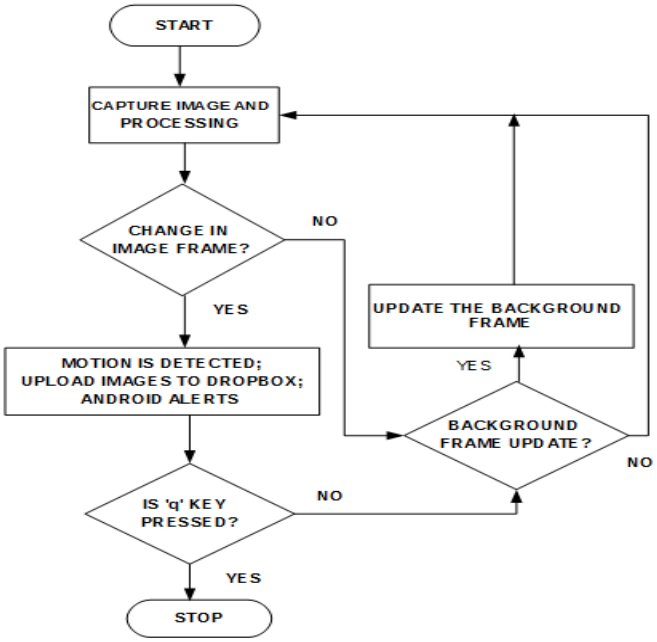

Fig.4. System Flowchart

Below are steps for implementation of the IoT based Security System for monitoring surveillance area by using Raspberry Pi and OpenCV with Android app alerts.

- Install OpenCV Module on Raspbian OS and further install imutils package using pip install imutils.
- To capture images install and enable Raspberry Pi camera module.
- Import the picamera to access the video stream of the Raspberry Pi Camera.
- To upload the images to dropbox install necessary packages.
- Link the dropbox account to the Raspberry Pi Board with necessary functions.
- Import libraries for interfacing GSM Module.
- Raspberry Pi Camera captures the images of the surveillance area.
- The images are then processed by the OpenCV Module in Raspbian OS.
- If motion is detected, the GSM module sends alerts to the android app with the registered phone number and the images are uploaded to the dropbox.
- The android app then gives a voice output “Camera Image is captured” to the user. The camera polls for any other movements.

.

VI. RESULTS

An IoT based Security System for monitoring surveillance area by using Raspberry Pi with Android app alerts is successfully developed using Raspberry Pi 2 model B. The system is tested in different background light conditions and it works as expected. The images are uploaded into the dropbox account which can be accessed by the authorized person at any remote location with the internet connection.

The alerts are sent successfully to the android app. If the phone is in silent mode or screen locked, the alert is considered as priority and the user is informed about the motion detected in the form of voice output.

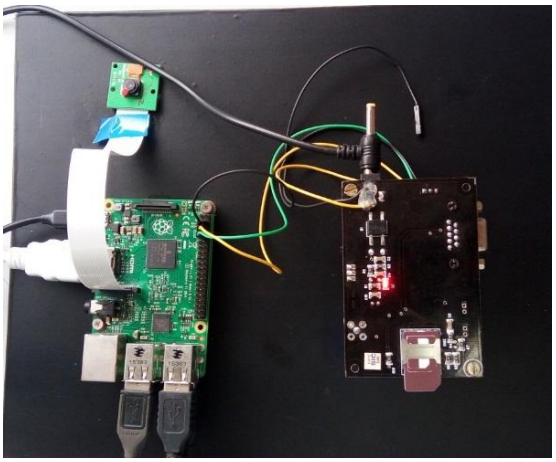

Fig 5 Development Kit

Fig 5 shows the snapshot of development model along with the connections of Raspberry Pi board, Raspberry Pi camera and GSM board.

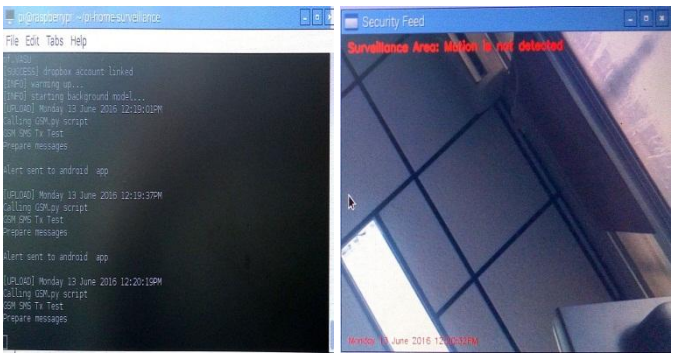

Fig.6. Motion is not detected

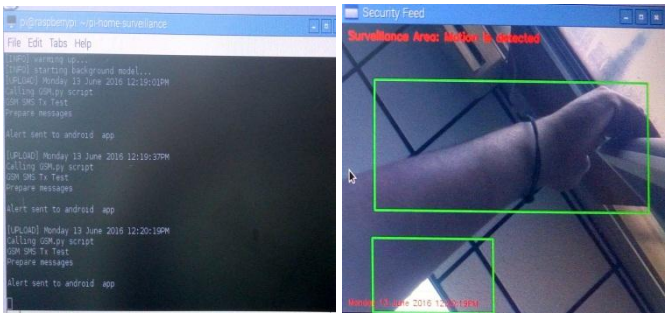

Fig.7. Motion is detected

Figure 6 shows the surveillance area being monitored by the camera. In figure 7, a moving object is tracked and identified; LXTerminal shows the images uploaded to the dropbox. Figure 8 shows the motion detection under different background light conditions. Images uploaded in the dropbox and alert sent to the android app is shown in figure 9 and 10 respectively.

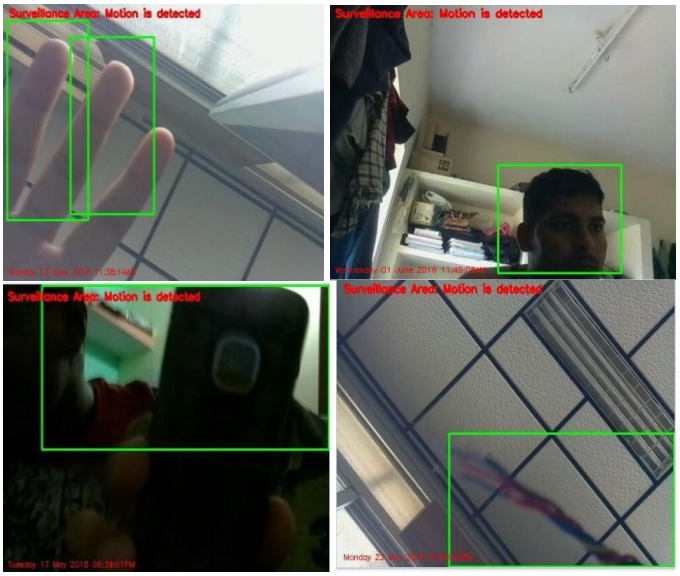

Fig.8. Motion detection under different light conditions

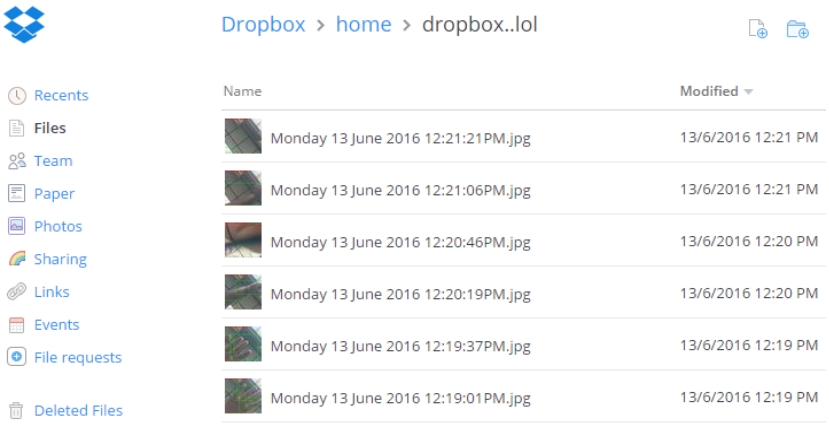

Fig.9. Images uploaded to the dropbox

Fig.10. Voice alert message from Android

Table1. Motion detection accuracy result

Days	Total number of images uploaded	True Positive result images uploaded	False Positive result images uploaded	Accuracy in %
1	19	17	2	89.47
2	17	16	1	94.11
3	15	13	2	86.66
4	20	19	1	95.00
5	6	6	0	100.00
6	25	24	1	96.00
7	30	28	2	93.30
8	12	12	0	100.00
9	21	20	1	95.23
10	14	14	0	100.00

Table 1 shows the test results under varying conditions. On an average the accuracy of motion detection is 94.978%. The proposed work has been tested for reliability under different conditions by positioning the camera at various angles to avoid capturing irrelevant pixels and experimented with different camera lens. The camera was mount in a secure place where it won't be moved unless needed. Under low light conditions, the motion detection algorithm detects the noise produced by the camera and avoids triggering motion detection. A default of 1 second minimum duration has been set to detect the real motion and avoid false positive motion.

Table2. Motion detection under different light condition

Outdoor / Indoor	Light Conditions	Total number of images uploaded	True Positive result images uploaded	False Positive result images uploaded	Accuracy in %
Outdoor	Morning, Sunny	15	14	1	93.33
Indoor	Morning, Sunny	18	16	2	88.88
Indoor	Evening	12	08	4	66.66
Indoor	Evening with CFL lighting	08	06	2	75.00
Indoor	Night with CFL lighting	07	05	2	71.42
Outdoor	Evening with street light	25	18	7	72.00
Outdoor	Morning, dull light	05	03	2	60.00

Table 2 shows the test results of motion detection under different light conditions. The accuracy of motion detection is exceptional under good light conditions and in dull light conditions it is slightly on lower side however the images captured are of acceptable quality with good reliability. Overall, under various light conditions we get satiable accuracy.

Table 3 shows cost comparison of various security systems with our proposed system. As compared to the other security systems our proposed system has very low cost and gives good accuracy and reliability. Installation cost of our proposed system is very low, and provides all features of other security systems. Replacement and maintenance is very easy and won't need highly skilled labor to monitor the system

.

Table3. Cost Comparison of different security systems with our proposed system

Sl no	Security System	Price in INR
1	Vimtag VT-361	7150
2	Nest Cam	12772
3	Arlo VMS3130	14119
4	Full CCTV Setup	25335
5	Our Proposed Model	5000

VII. CONCLUSION

It is a very difficult task to monitor an area manually and is often prone to errors. It leads to labor power wastage. There is a lot of innovation in science and technology. Everyone uses a smartphone and this aspect can be used in providing sophisticated, intelligent and sustainable security systems to monitor a surveillance area. It is necessary to monitor certain areas continuously like rare animal and plant species in forest, treasure in a bank, question papers of the examination board or even for the home security to avoid theft and scams. Manual observation is not sufficient to provide security in these situations. The IoT based Security System for monitoring surveillance area by using Raspberry Pi and OpenCV with Android app alerts can be used to monitor these security areas. This system has many advantages like Cost effective with low cost hardware, low power consumption, Minimal maintenance overhead and Simple to use for any layman. This proposed system can be extended in future to predict environmental changes like temperature, pressure, air quality check, gas detection, etc. to avoid hazards and provide safe surroundings.

REFERENCES

[1]. S. Emima Princy, S. Emima Princy, "Implementation of Cloud Server for Real Timedata Storage using Raspberry Pi" 2015 Online International Confernece on Green Engineering and Technologies (IC-GET 2015), 2015.
[2]. Eben Upton, Gareth Halfacree, Raspberry Pi User Guide. United States of America: Wiley, 2014.
[3]. Zoran Zivkovic, "Improved Adaptive Gaussian Mixture Model for Background Subtraction," intelligent and Autonomous Systems Group University of Amsterdam, The Netherlands, ICPR, 2004.
[4]. Nima Bari, Ganapathy Mani, Simon Berkovich, "Internet of Things as a Methodological Concept," IEEE International Conference on Computing for Geospatial Research and Application, Washington DC, USA, pp. 48-55, 2013.
[5]. SIM900_AT Command Manual, Shanghai SIMCom Wirless Solution Ltd.2010.
[6]. Joseph Howse, "OpenCV Computer Vision with Python," Packet Publishing Ltd, 2013.
[7]. Python Software Foundation, https://www.python.org/.
[8]. Internet of Things, http://www.gartner.com/newsroom/id/3165317.
[9]. Raspberry Pi Foundation, https://www.raspberrypi.org/.

Vasudev Emmennavar. " Iot Based Security System For Monitoring Surveillance Area By Using Raspberry Pi With Android App Alerts." IOSR Journal of Engineering (IOSRJEN), vol. 08, no. 10, 2018, pp. 51-58.