# Smart Surveillance System Safeguard Security Company Using Raspberry Pi

**Peace Muyambo**

**Abstract:** The internet of things is becoming more popular in recent years due to technological advancement. This has given rise to new technologies such as the internet of things, which make extensive use of the internet to achieve things that were previously very expensive or unworkable. Several researches have been conducted to come up with efficient and effective way of getting things done. This also involves technologies such as closed-circuit television, which have improved vastly due to the adoption of Internet of things. Physical items are no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. With the advent of the internet and advances in technology also came mobile phones. These devices are becoming smarter and smarter and are becoming integrated with the internet. There have also ben advances in computer vision technology, which allow computers to perceive the world through cameras. This research focuses on taking advantage of these technologies to produce a low cost surveillance system for Safe Guard security company (Zimbabwe) that is aware of its surroundings and will only capture footage when there is something taking place in the surveillance area. The system will also alert the guard/user of unauthorized human activity in the surveillance area.

**Key words**: Android, Webcam, Mobile application, Internet of Things, Raspberry pi, Device, Amazon web services.

## 1.0 INTRODUCTION

Over the past few years, we have seen in Zimbabwe the advent of surveillance cameras in retail shops and learning institutions, necessitated by the rise in break into premises and other types of burglary in such places. Often, there is no one on the scene to take note of the crime as it takes place. It is often realised long afterwards that there was a break in. there are also other places where people are not allowed to loiter, and it might often be difficult or impractical to have a person manning the place at all times. In such cases, a surveillance camera can be used, but it also requires a human to monitor the footage in real time. Security guards are often a solution to such problems, but often times they fall asleep and leave the surveillance system unattended. This leads to a third solution, of recording footage such that when a security breach occurs, we can then go back to the footage and see what happened and who did it. This also does away with hours and hours of useless footage, which leads to spiralling storage costs. Smartphones are becoming increasingly available to the ordinary citizens of Zimbabwe, making them a primary means of communication. In addition, a large number of people carry their phones with them all the time, making it very easy to get a message across using mobile phones. Internet costs have also gone down over the past few years, making it accessible to the wide populace. It is against this background that we can create a smart surveillance system that can send notifications when a security breach is detected.


- *Peace Muyambo*
- *Department of Software Engineering, Zimbabwe Open University Email: muyambopeace@gmail.com*


## 2.0 JUSTIFICATION

With the evolution of Internet of Things (IoT), it is an opportunity, which opens up fascinating prospects and interesting application possibility. IoT has countless possibilities, where one is only limited by imagination. Many things, which were previously not possible or too expensive to undertake, can now be done using IoT. The proposed system is also aimed at reducing the cost of surveillance. The combined cost is dramatically reduced. Installation cost of the hardware using Pi camera modules cost just under $30 in Zimbabwe. Users prefer to use a cellular phone, which is always in closer proximity unlike using a laptop or going to a central control panel. It is also more comfortable for them since they are already used to their phones and the learning curve is not too steep. In addition, using a phone, a user is able to know of a compromise as soon as it happens. Most people always have their phones nearby and so can always know when something has happened. Embracing the challenge of integrating software and hardware furthers the cause of the Zimbabwe Agenda for Sustainable Socio-economic Transformation (ZimAsset) goals. It opens the gates of the use of technology towards economic empowerment. The project is in a relatively new field, which requires one to explore a lot, which helps to sharpen one's skill. Surveillance has been an important part of security for many years. The technology for accomplishing this has evolved over the years, but the basic principle remains the same. This chapter will mainly focus on analysing how other scholars and researchers have tried to implement the idea of smart surveillance.

## 3.0 EXISTING SURVEILLANCE SYSTEMS

Literature reviewing is a process of understanding a field of study by analysing published and unpublished scholarly and research work. Many surveillance systems are currently available for commercial and research platforms. The following list shows most of research work done

- Different approaches based on Internet of things
- The use of cameras over the years to monitor premises
- Image recognition technologies
- Video containers
- Image processing technologies

This technology of surveillance has found its use in security systems, environment monitoring. A lot of research work on surveillance has been done across the globe using different platforms mentioned above. The most important aspect in surveillance is to make sure that all unauthorised activity is noticed and stopped before it gets out of hand. Below is different surveillance research work analysed: (Suthagar & Ponmalar, 2016) created a cost-effective method that uses a credit card sized chip RPI. The image is captured and each frame is processed. The image is stored and an email is sent if a human is detected. The system has accuracy rate of about 83%. It uses an enhanced recent model-raspberry pi 2, which has operating speed 900MHz with a pi camera. The image is captured via the pi camera and it is send to the raspberry pi 2 for processing for face and human detection with the help of OpenCV. Then, the face detected is compared with the database, if the human detected is known (visitor) or not (stranger) and based on the output, an audio output is produced and a message is sent to the user. Thus, one can provide a low-cost security system. [1] (Sathishkumar & Rajini, 2015) proposed a system; the home based smart surveillance system, which evaluates the development of a very Low-cost security system using PIR (Pyroelectric Infrared) sensors and video cameras built around the PIC (Peripheral Interface Controller) microcontroller. The human movement is detected using the PIR sensors. In this time, the system triggers an alarm detecting the presence of unauthorized person in a specific interval of time and simultaneously sends a message to the SMS through GSM Modem. When the security system is activated, the CCTV camera is activated. This highly reactive approach has low computational requirement. [2] (Harish S, 2015) makes use of OpenCV library to capture camera images and detect intrusion using image comparison technique. Once the comparison is done and an intrusion is found, it sends the streamed video from server to remote administrator over android phone. Admin can then take appropriate action and alert local security. Smart Surveillance is the use of automatic video analytics to enhance effectiveness of surveillance systems. This system introduces intelligent analysis of single person activity to enhance the security system in home and enriches the current video surveillance systems through an automatic identification of abnormal behaviour of the person. The relevant data is recorded and alert is given to the user by sending MMS, SMS or mail. The user can view the particular video. This system maintains the security situation at home and this reduces the incidence of burglary cases and enhances social stability. [3] (Nagime & Patange, 2016) "The project Smart CCTV camera surveillance system is to enhance the CCTV camera based security systems, which presently exist in different places. The Project Security System by using CCTV Camera is designed using wireless technology. An embedded surveillance system is frequently used in the home, office or factory for image processing of the surveillance system and also for traffic monitoring but this configuration requires a high-performance core, which works against some advantages of embedded systems, such as low power consumption and low cost. Some designs propose the use of different sensors to track the sequence of the human body movement. [4] Other researchers construct an external signal to trigger the embedded surveillance system by means of a PIR sensor, which is triggered when an intruder enters the monitoring area. The system consists of surveillance unit and control unit. This project will work in two modes: Manual mode and automatic mode. In automatic mode PIR sensor will detect person movement and will give signal to the microcontroller to start the CCTV camera by using Relay. IR sensor will track the person movement and give the signal to micro controller. Accordingly, stepper motor will be actuated to rotate the CCTV assembly. In addition, in manual mode we will use keypad for the movement of CCTV camera in manual mode. Control unit consist of micro controller, LCD to see the messages, buzzer and LED for indication, Keypad will be used in manual mode for the controlling movement of the CCTV camera. The MAX232 IC will be used for voltage conversion between RF module and microcontroller."

### 3.1 Overview of Raspberry Pi:

The Raspberry pi is a small credit-card sized computer capable of performing various functionalities such as in surveillance systems. The various functionalities of the components are given below the various components of Raspberry- Pi are • SD Card Slot is used to install OS/booting/long term storage. The total memory of the SD card is about 8GB.

- Micro USB Power Port provides 700mA at 5A. RCA Video Out is connected to display if HDMI output is not used. It is mainly used to carry audio and video signals. They are otherwise called as A/V jacks.
- Audio Out Digital audio is obtained if HDMI is used to obtain stereo audio. Here analogue RCA connection is used.
- Ethernet Port is used to connect to the Internet. It also plays a role in updating, getting new software easier.
- HDMI OUT (High Definition Multimedia Interface is used with HDTVs and monitors with HDMI input. In addition, HDMI-HDMI is used here.
- BROADCOM BCM 2835: It is otherwise defined as System on chip. It is a 700 MHz Processor. It has a Video core IV GPU.

GPIO allows us to control and interact with real world

### 3.2 The Proposed System

It increases the usage of mobile technology to provide essential security to our homes and for other control applications. It has human detection capability that can provide mitigation of potential crimes and unauthorized presence. The credit card size Raspberry Pi (RPI) with Open Source Computer Vision (OpenCV) software handles the image processing, control algorithms for the alarms and sends captured pictures to user's mobile phone via WIFI. The system uses ordinary webcam in place of the pi camera. This has lower cost and works almost equally well. The proposed home security system captures information and saves it on the SD card. The information is then uploaded to Amazon web services, where the researcher has six functions that will take the footage through the verification process. This is transmitted via Wi-Fi. If a human is detected, a notification is sent to the guard or users smartphone via email. The raspberry pi operates and controls the video camera for remote sensing and

surveillance, streams live video and records it during the security breech for future playback. This only happens if the motion persists for more than a minute. When motion is detected, the camera automatically takes a picture and uploads it to Amazon web services, where there is an artificial intelligence engine for classifying images. This cannot be done on the pi because of computational limitations.

### 3.3 Main features of the system

The system will consist of a raspberry pi and a webcam. The system will constantly check a video stream for movement, and when movement is detected, the camera initiates a recording and initiates human detection. If a human being is detected, the system sends a notification to the user and tries to capture the face of the intruder from the video stream. The video stream can also be viewed on the user's phone. Through the web stream.

## 4.0 METHODOLOGY

The smart surveillance system is implemented using:

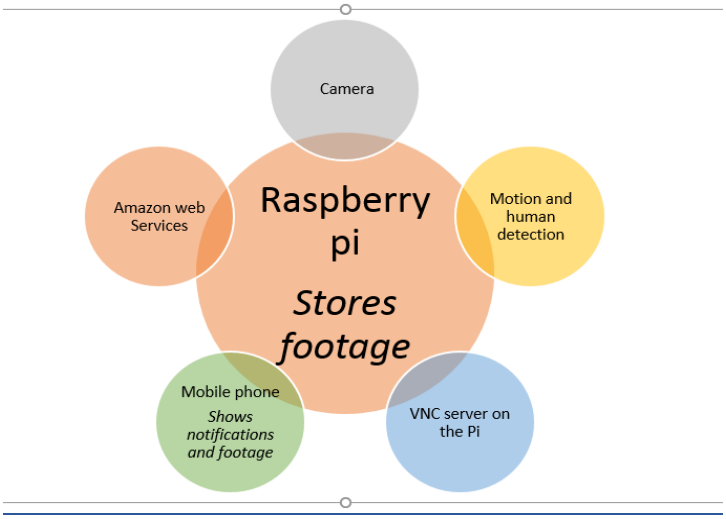
- Raspberry pi credit card sized computer
- Android smart phone
- Pi Camera
- WIFI connection

Control components

- The raspberry pi is the center of the project handles the image stream from the camera
- The pi camera is a hardware component that natively captures content on a raspberry pi
- WIFI provides a communication wireless channel between devices.
- Mobile device uses android version 7.0 Nougat. This ensures timely delivery of notifications through the latest google play services
- Amazon web services handles the uploaded footage

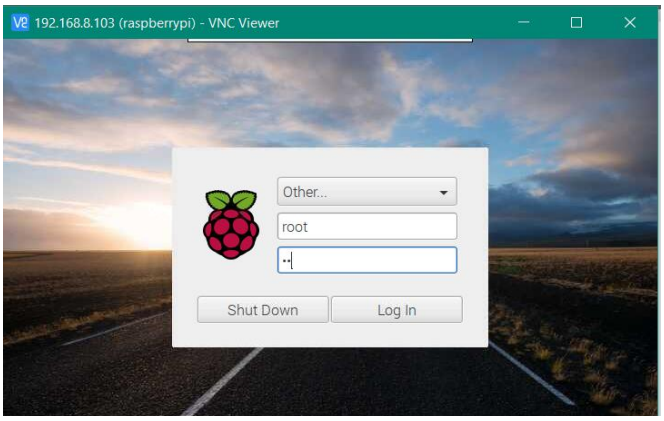
5V DC powers the whole project, and as soon as power is connected, the raspberry pi boots up and starts streaming video. This is achieved by setting a daemon to start all the required services and scripts at boot up.

***Figure 1:***




This project will consist of a raspberry pi 3b at its core. The pi will be connected to a camera that continuously monitors a designated area passively through a video stream sent to the pi. The pi will monitor this stream and remains dormant until movement is detected. Movement detection is achieved by using background subtraction and pixel shift count as described in above. As soon as movement is detected, the pi will initiate human detection software. This involves a script that monitors the footage folder. As soon as the file is created, the script runs, uploads the file for analysis and deletes the local copy to save space on the pi. If no human is detected, the pi will remain in its passive monitoring state. If a human is detected, the system will immediately send a notification to the user's phone, starts recording footage. This is saved on the pi then sent to the user's email. The user's email is set to receive push notifications. To save bandwidth, video footage is saved on the pi.

***Figure 2***




### 4.1 Results and Analysis

The researcher performed some test as seen in the screen shots above to see if the system requirements were fulfilled.

1. The system should provide users with a login screen to be used to add users
2. System should allow authorized users to receive notifications
3. The system should allow new users to pair their mobile devices to receive notifications
4. System should save footage to cloud

The above-mentioned requirements were successfully implemented, except for objective one, which can be done only through the backend

***Table 1***

| Feature | Planned product | Current prototype |
|---|---|---|
| **Camera** | X | X |
| **Motion Detection** | X | X |
| **Human detection** | X | X |
| **Live stream** | X | X |
| **Notification** | X | X |

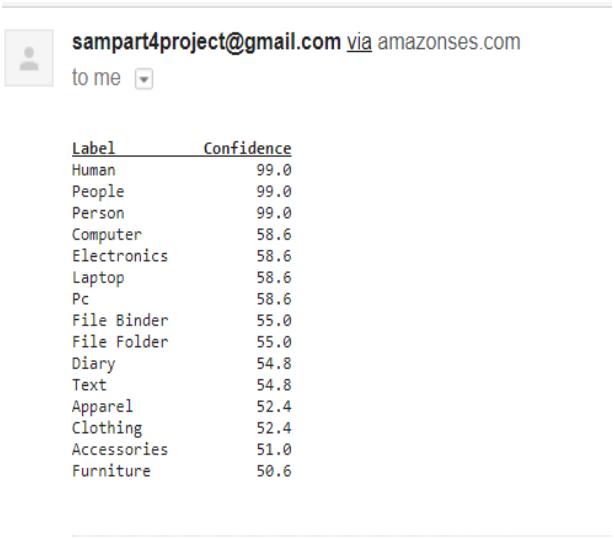
Not all planned features were used due to financial constraints although the main objectives were fulfilled**.** Measurements for detection

***Table 2***

| Subject | Detection | Notification | Number of Attempts |
|---|---|---|---|
| **Stick** | Y | N | 10 |
| **Curtain in wind** | Y | N | 10 |
| **Cat** | Y | Y | 10 |
| **Child** | Y | Y | 10 |
| **Adult** | Y | Y | 10 |

Different test subjects were taken to determine if there were false alarms Confidence levels from footage as calculated by Recognition

***Figure 3***




These confidence levels are used to decide whether there is a human being in the scene, which is assumed so if the number is above 80%

## 5.0 SUGGESTED FUTURE WORK

During the course of the research, the researcher faced challenges during testing phases. The camera used in the final prototype was not the intended module. The official pi camera was in short supply locally and there were serious challenges importing it, hence an ordinary webcam of lower resolution was used. This affected detection quality and not all test areas had internet connection, so the user had to replace the built in WIFI connection with a dongle for GSM based internet connectivity. This drove operation costs up, which is counter to the intended objective of keeping costs down. Another problem also faced was that of pictures being taken too early or too late. This was caused partly by the camera being used that has a low native frame rate and by the placement of the camera too close to the subject. This was solved by placing the camera farther away from the test area.

## 6.0 CONCLUSION

The major issue with the smart surveillance system is that of false alarms. The system might detect subtle movements of trivial things such as cats, leaves in the wind or even clouds. The initial plan was to run body detection using Haar cascades, but this proved to be slow, inaccurate and caused the raspberry pi to overheat due to overwork. This necessitated the researcher to move to neural networks hosted on the cloud. This was a relatively cheap solution where the code is to be hosted on an amazon sever. It is also very cheap as it only cost a dollar to get the service. This greatly improves performance and lifts the burden off the pi, and gives significantly better turnaround times. This method has a disadvantage of relying entirely on an internet connection, and it is incapacitated in case of an internet outage. A mitigation of this is having a backup internet connection that kicks in when the main one has failed. However, this was left as future research.

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