

# DESIGNING APPROACH OF AN INTRUDER REALTIME UBIQUITOUS EMBEDDED SURVEILLANCE SYSTEM

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## ABSTRACT

As an essential constituent of many associations' security and safety precedence, video surveillance has established its importance and benefits numerous times by providing immediate supervising of possessions, people, environment and property. This paper deals with the design approach of an Embedded Real-Time Surveillance System Based Raspberry Pi SBC for Intruder Detection that reinforces surveillance technology to provide essential security to our life and associated control and alert operations. The proposed security solution hinges on our novel integration of cameras and motion detectors into web application. Raspberry Pi operates and controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback. This research is focused on developing a surveillance system that detects strangers and to response speedily by capturing and relaying images to admin office based wireless module and thus activate the alert system both at intruder location and office admin. We will use the Smart Surveillance System Using Raspberry Pi presents the idea of monitoring the particular place in a remote area. The system can be administrated by a remote user from any networked workstation. The proposed solution offers efficient stand alone, flexibility to upgrade and cheap development and installation as well as cost effective ubiquitous surveillance solution.

**Keywords:** *Embedded System, Raspberry PI, Surveillance System, Motion Detection*

## 1. INTRODUCTION

In our daily life, surveillance systems based video streaming (VSS) are considered of a very important in many applications. These applications may exist in banks, homes, offices, airports, institutes and fans to maintain our security. VSSs presently are experiencing an evolution where extra and extra analog conventional answers are being substituted by means of digital ones. A comparison of digital video surveillance system versus the established analog system, the aforementioned surveillance system offers higher elasticity in transmission and processing of video content. Beside, Digital solution can effortlessly implement superior features like facial recognition, tracking of objects and motion detection. Numerous famous technology suppliers like Texas Instrument DSPs can be cooperate to build low end to high end surveillance systems in the form of portable realization to plug in realization.

In general, Digital Security Systems can be divided into three modules: preprocessing and decision

making model, capture module of video, module of network interfacing, admin workplace module and alarm or alerting module. The preprocessing module is the main admin module for controlling and activating the sub other modules. The video capture module is usually composed of a set of cameras and a video encoder device. This module works on capturing and compresses the raw video data based on predefine video coding standard. While, network module is responsible for processing the stream of the video codec and passing it to the internet server. Lastly, the admin central office module monitors every video channel and controls the camera's actions.

Nowadays the demands on video surveillance systems are rapidly increasing. Commercial spaces, universities and hospitals, warehouses require of a video capturing system that have ability to alert and record beside live video of the intruder. The current technologies require RFIDs which are costly and hence the security domain in all becomes expensive. Embedded systems invade our daily life as they are used within all kinds of devices such as



entertainment, communication and transportation. Beside fusion with industrial and military integrated solutions. The need for more sophisticated solutions and the availability of increased computational power has an effect on the pristine single purpose systems. Existing solutions have to assist their users for a wide variety of orthogonal designed based on a real time operating system that is raspbian, as an exemplar. In this project video surveillance system is presented based on a single board computer represented by Raspberry PI as an embedded solution.

This project describes the use of low cost single – board computer Raspberry Pi with wireless internet. This work is focused on developing a surveillance system that detects stranger and to response speedily by capturing and relaying images to admin office based wireless module and thus activate the alert system both at intruder location and office admin. The adopted system of surveillance is based on a networked single board computer, raspberry pi, motion section and videoing system which presents the idea of monitoring a particular place in a remote area. The system can be administrated by a remote user from any workstation. The new technology is less expensive and longer life of remote battery powered units. The project aims to develop a surveillance embedded system which captures and hosting, real time intruder images and arises of alerting alarms. The proposed system has potential benefits for various security applications such as, but not limited to, securing remote area, estate departments, warehouses and surrounding fence. The proposed solution offers efficient stand alone, flexibility to upgrade and cheap development and installation as well as cost effective surveillance solution.

## 2. RESEARCH MOTIVATION

Nowadays, the security has gained much attention of worldwide organizations and governmental institutes. The integration of image, video and warning activities into a surveillance system is becoming more attractive to build an efficient surveillance system. This research is motivated by the following:

- Remote and scattered valuable and sensitive locations such as labs and offices inside university campus need efficient monitoring and warning system.
- A semi autonomous surveillance system based on human monitoring assistance is not optimum.

- Costly solution is emerging for multi location surveillance system deployment.

This research is focusing on the design and implementation of cost effective solution that capable to handle in an efficient way the intruder detection and determine its identity and location. And thus, the surveillance system will be investigated the functionality of the embedded system platform used and qualitative its performance. As well as, Supplementary code has to be deployed on the system to identify the objects and to manage camera configuration besides analyzing of data of whole system cameras. This proposal addresses the problem into two divisions. The first part is the extra software to be implemented on the system in order to identify objects, configure, and manage the cameras. While the later part is concerned with the enhancing security of the system throughout, improving system awareness of the vision area. Security is important because of the sensitive nature of having cameras in a home (or other premises) due to the expectation of Introduction privacy of people who are in the home with the home owners' permission. Most of camera based surveillance systems are video streaming system that depends on guards or security officers who keep watching all the time the monitors. Thus, as humankind's nature, the system may miss important monitoring issues such as an intruder or abnormal activities due to tiredness or amusement. The issues arise with monitoring systems are commonly fused with video streaming and sometimes with intruder warning. For remote and scattered offices and laboratories, such as a university campus, need a hybrid system of all time video monitoring during working hours in addition of warning and image identified system at nighttime or holidays for any intruder.

## 3. AIM AND OBJECTIVE OF THE RESEARCH.

The purpose of this research is to design and implement cost effective solution that capable to handle in an efficient way the intruder detection and determine its identity and location. As well as investigating the existing features and limitations of an embedded real-time surveillance system based on SBC using the raspberry pi platform. To accomplish this goal, this research work opted into the following objectives:

- To design and develop a cost effective surveillance management system based SBC that can be deployed efficiently in remote and

scattered locations such as universities and rear areas.

- To investigate the performance of the surveillance system based SBC using Raspberry platform.
- To implement fast and smart intruder warning system for the university campus.

4. PROJECT SCOPE.

According to our survey, the surveillance system does not in cooperate immediate alerting in case of any unauthorized entry into the universities. This research is focused on developing a surveillance system that detects stranger and to response speedily by capturing and relaying it to admin office based wireless module and thus activate the alert system both at intruder location and office admin. The system will be composed of Raspberry PI and motion detection sensor, camera and wireless modules to design and implement of a distributed surveillance system which presents the idea of monitoring the particular places in remote areas. The system can be administrated by a remote user from any workstation within the network.

5. BRIEF METHODOLOGY

For an embedded real-time surveillance system to be used as an effective monitoring and alert system, it has to have at least three functions, which are detection, picture taking and alert mechanism. The embedded real-time surveillance system mainly consists of two parts as follows.

5.1 Design Hardware.

The entire system modules consist of five parts, Raspberry Pi entrenched Linux as SBC controller, the PIR sensor, the Wi-Fi adapter, the camera and the power supply.

- **Raspberries** are a tiny SBC that have capability of doing different functionalities such as, not limited to, embedded monitoring and control, scrutiny systems, wireless networking and traffic control and military applications. The Raspberry Pi various components are shown in Figure 1, and their functionalities are as below;
- SD Card is the storage space, memory unit that is used for Operating system, booting task. The size could be 8, 16 GByte.
- Micro USB Power Port which offers 700mA at 5A.

- RCA Video Out this port carry out video and audio signal to external monitor also it known as A/V jacks.
- Audio Out is used with the HDMI port to get stereo sound where analogue RCA connection is needed.
- Ethernet Port for connecting the internet. It is a way to contact various worldwide servers for updating, getting new software and communication.
- HDMI OUT to connect the SBC with HDTVs and monitors. HDMI stands for High Definition Multimedia Interface.
- BROADCOM BCM 2835: System on chip of a 700 MHz Processor. It has a Video core IV GPU.
- GPIO port offers the admin to communicate with the real world via input or output of signals.

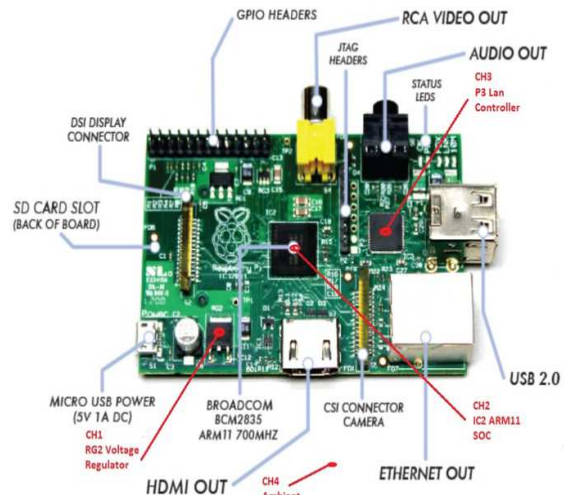


Figure 1 Raspberry Pi

5.1.1 Raspberry Pi camera

The raspberryPI camera, shown in Figure 2, is of a native resolution of 5 mega pixel, and has a fixed focus lens onboard. The camera is capable of 2592 x 1944 pixels static images, still images, It is maintained 1080p30, 720p60 and 640x480p60/90 video. The camera objective is to capture an image, video based on event detection.

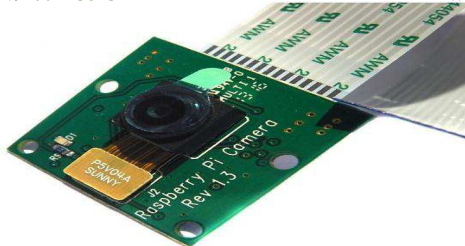


Figure 2: Raspberry Pi camera



Figure 4: Wi-Fi adapter

### 5.1.2 PIR Sensor

One of the key features of video surveillance system is the Motion detection process. Motion Detection sensor can interrupt the Raspberry PI and thus activate the alerting system as well as audio/video streaming and recording tasks. Despite that, to avoid the false alerting, an efficient technique of motion detection should be adopted.

A PIR sensor is used to detect motion by transmitting/receiving infrared radiation, Figure 3. When a motion occurs by an object in the surrounding field of the sensor, it detects a rapid change of infrared energy reflection. Therefore, PIR sensors are widely used in surveillance systems. Applications such as automatically activating lights alerting or start video streaming are examples of event detection tasks based PIR sensors.



Figure 3: Motion detection sensor

### 5.1.3 Wi-Fi adapter:

One of local area wireless computer networking technologies to permits devices, electronics, to have a network is using of Wi-Fi, Figure 4. Mainly Wi-Fi is using the 2.4GHz and 5GHz ISM radio bands. This technology allows various devices, such as personal computers, smartphones, tablet and digital camera to communicate with network resources such as the Internet via a wireless network access point.

### 5.1.4 Battery Pack:

Rechargeable lithium ion battery, Figure 5, USB pack of possibly 10000 mAh equipped with charging circuit, and two boost converters which supply 5VDC over 1Amp USB port. The battery pack may be used when the main electric supply is shut down. It can supply the raspberry pi and keep working for more than 48hours.



Figure 5: Power Supply

## 5.2 DESIGN SOFTWARE

The propose system is based Linux operating system as a software platform. It is mainly composed of several function modules; the main function of each module is as follows.

- System initialization and setting module.
- Daytime monitoring.
- Sensor continuous sampling module.
- Image capture module: activated when the PIR sensor interrupts the system. The module will capture the spatial image and pass it to the main board.
- Image processing module: the objective of this module is to identify the captured object in the monitoring scheme.

- Image transmission module: its used to pass the image to the main admin monitoring system using wireless communication media.

The package will implement using the python programming language and base Linux OS. The Hardware and Software modules above mentioned are fused to formulate the proposed surveillance system that can be deployed in the sensitive area. The system work based the sequence illustrated in the following figure 6.

### 6. STUDY MODULE

The synopsis of the research way adopted is demonstrated in Figure 7, where the direction of thread denotes to direction followed in this research to achieve our aims and the dotted lines represent the other directions that are already considered in previous researches. Figure 7 demonstrates the study module of this research.

### 7. RELATED WORK

Nowadays, researchers and developers have produced numerous surveillance systems that used for remote monitoring, alerting as well as controlling tasks throughout profitable products or investigational research platforms.

An embedded home surveillance system which assesses the implementation of a cost effective alerting system based on small motion detection is presented by Padmashree A. Shake and Sumedha S. Borde (2014). They worked on implementing cheap in price, low power consumption, well utilize resources and efficient surveillance system with using a set of various sensors. Their system help to monitor the household activities in real time from anywhere based on microcontroller which is considered nowadays as a limited resource and an open source solution compared to SBC [1]. Khandavalli Michael Angelo and Katakala Karthik, in 2014, introduce us the video capture and motion detection embedded system. This system is based on power full ARM9 processing chip to implement an embedded web monitoring system. They provide a system with high performance embedded processors to process the main controlling, compressing and web processing tasks. It is stable, cost effective, simple and widespread. Despite that,

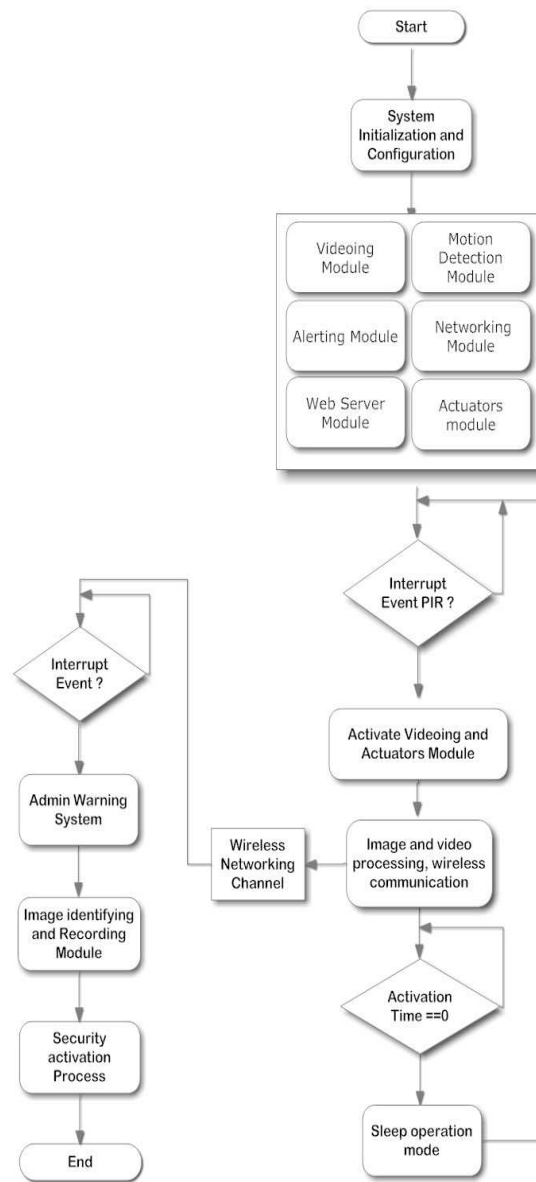


Figure 6: Research Flowchart processes

their work did not considered the reaction process of any unusual events [2].

D.Jeevanand et al. in (2014), works on designing of a networked video capture system using Raspberry PI. The proposed system works on capturing video, distributes with networked systems besides alerting the administration person via SMS alarm as required by the client. Their system is designed to work in a real-time situ based Raspberry PI SBC. The Researchers are provided in their system to work at cost effective and intelligent powerful visioning system to be used like in

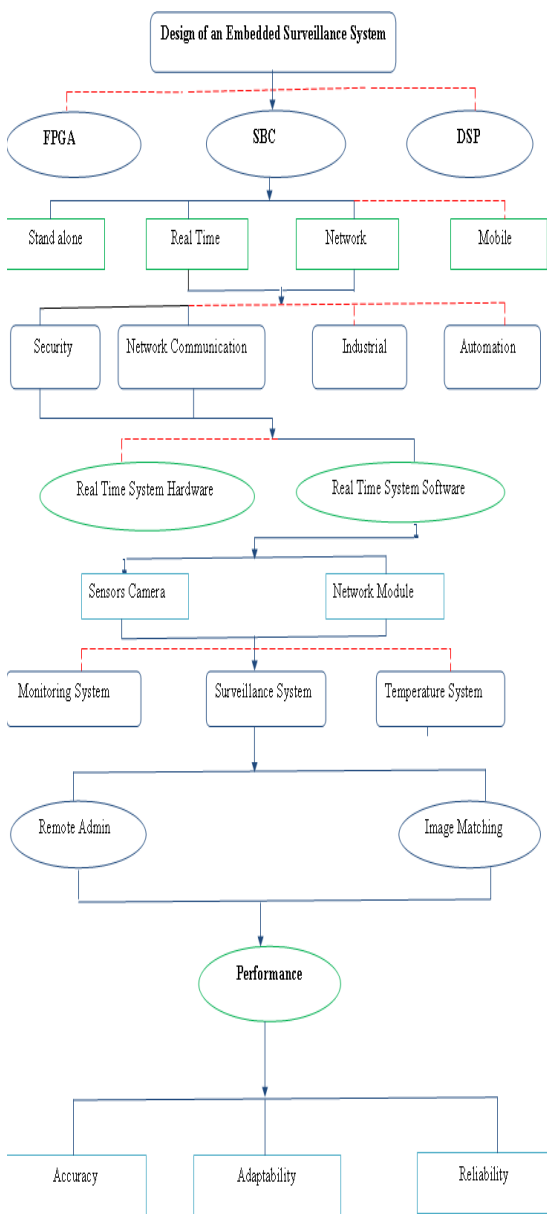


Figure 7: Study Module

residence security systems, tower elevators, and numerous other applications of small power consumption. Contrasting to other embedded systems their real-time application offers client video monitor with the help of alerting module and SBC platform [3]. Sneha Singhd et al (2015), describe IP Camera Video Surveillance system using Raspberry Pi technology. They use this system to low cost to single – board computer Raspberry Pi technology [4]. The system used as a standalone platform for hosting image

processing. The Researchers aim at developing a system which captures real time images and displays them in the browser using TCP/IP. The algorithm for face detection is being implemented on Raspberry PI, which enables live video streaming along with detection of human faces. The research did not include any of surveillance reactions [5]. Mahima F. Chauhan and Garge Anuradha P (2015) offered us to design and develop Real Time Video Surveillance System Based on Embedded Web Server Raspberry PI B+ Board. Their system has low cost, good openness and portability and is easy to maintain and upgrade these are considered for targets researchers thus this application system provides better security solutions. This system can be used in security in banking, industry, environment, in military arts [5].

Jadhav, G. J evaluates in 2014 use various sensors, wireless module, microcontroller unit and finger print module to formulate and implement a cost effective surveillance system. They adopted ARM core as a basis processor of the system. Different sensors used to detect motion in the vision area by using PIR sensor, while vibrating sensor is used to sense any vibration events such as sound of breaking. The intruder detection technique is proposed by using the PIR sensor that Detect and trigger a system of alerting and send short message service throughout GSM module for a specified n phone number. Their work can be featured by adopting by using numerous diverse kinds of demanding database and thus it will be more secure and difficult to hacked [6].

In 2014, Sanjana Prasad et. Al work on developing of a mobile smart surveillance system based on SBC of raspberry and motion detector sensor PIR. Their development boosts the practice of portable technology to offer vital safety to our daily life and home security and even control uses. The objective of their research is to develop a mobile smart phone home security system based on information capturing module combined with transmitting module based on 3G technology fused with web applications. The SBC will control the PIR sensor events and operates the video cameras for video streaming and recording tasks. Their

system has the capability to count number of objects in the scene [7]

Uday Kumar etc al.(2014) work on implementing of a low cost wireless remote surveillance system using Raspberry Pi. Conventional wireless CCTV cameras are widely used in surveillance systems at a low cost. They implement a low cost and secure surveillance system using a camera with Raspberry Pi and the images acquired have been transferred to the drop box using a 3G internet dongle. Their objective to design and implement of a remote wireless image acquisition and monitoring system in low cost and it was successfully implemented using raspberry pi and 3G dongle[8].

## 8. CONCLUSION

The design approach for low cost ubiquitous surveillance system for intruder detection and identifying is presented. The main system blocks of hardware and software modules are specified. This research is focusing on the design and implementation of cost effective solution that capable to handle in an efficient way the intruder detection and determine its identity and location. Most of camera based surveillance systems are video streaming system that depends on guards or security officers who keep watching all the time the monitors. Thus, as humankind's nature, the system may miss important monitoring issues such as an intruder or abnormal activities due to tiredness or amusement. The proposed system will alert the offices only when an intruder is detected, thus the system will easier lift the burden of continuous monitoring of the system while maintains the readiness and revivalism of the office.

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