Design and Implementation of an Embedded Real-Time Surveillance System Based Raspberry Pi SBC

by

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ABSTRAK

Sebagai juzuk penting dalam perkaitan antara keselamatan dan keutamaan keselamatan, pengawasan video telah acapkali mengiktiraf kepentingan dan faedahnya sepertipengawalseliaanke atas harta benda, orang, alam sekitar dan harta. Terdapat banyak kecacatan dalam sistem pemantauan video, contohnya adalah seperti; imej tidak jelas, keabnormalan tidak dapat dikenal pasti secara automatik, banyak ruang stok simpanan yang diperlukan untuk menyimpan maklumat pemantauan, dan harga kekal tinggi secara perbandingan. Projek ini berkaitan dengan pendekatan pembangunan Masa Nyata Pengawasan Sistem Berasaskan Raspberry Pi SBC untuk mengesan penceroboh yang menguatkan lagi teknologi pengawasan untuk menyediakan keselamatan untuk kehidupan kita dan kawalan yang berkaitan di samping memberi isyarat kepada operasi. Penyelesaian keselamatan yang dicadangkan bergantung kepada integrasi novel kami kamera dan pengesan gerakan ke dalam aplikasi web untuk lokasi meresap jauh di samping kos yang berkesan dan bahawa ia adalah mampu untuk mengendalikan dengan cara yang cekap mengesan penceroboh dan menentukan identiti dan lokasi. Raspberry Pi beroperasi dan mengawal pengesan gerakan dan kamera video untuk penderiaan jauh dan pengawasan, aliran video secara langsung dan merakamkannya untuk main semula pada masa hadapan. Kajian ini memberi tumpuan kepada membangunkan sistem pengawasan yang mengesan orang asing dan sambutan cepat dengan menangkap dan menyampaikan imej ke pejabat pengurusan modul wayarles berasaskan dan dengan itu mengaktifkan sistem amaran di kedua-dua lokasi penceroboh dan pejabat pengurusan. Kami akan menggunakan Sistem Pengawasan Smart Menggunakan Raspberry Pi membentangkan idea memantau tempat tertentu di kawasan pedalaman, yang mengatasi keupayaan manusia dari segi rasa mengantuk dan keletihan kerana ia mustahil pengurusan untuk memelihara menonton pemantauan skrin dalam masa yang panjang. Sistem ini boleh ditadbir oleh pengguna jauh dari mana-mana stesen kerja rangkaian. Penyelesaian yang dicadangkan menawarkan pendirian cekap sahaja, fleksibiliti untuk menaik taraf dan pembangunan murah dan pemasangan serta kos efektif penyelesaian pengawasan sentiasa ada.

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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. There are many blemishes in the video monitoring system, such as: image is inconspicuous, abnormalities cannot be identified automatically, a lot of spaces are needed to store the monitoring information, and prices remain comparatively high. This project deals with the development 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 in addition to alert operations. The proposed security solution hinges on our novel integration of cameras and motion detectors into web application to pervasive remote locations in addition to a cost effective and that it is capable to handle in an efficient way the intruder detection and determine its identity and location. 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 admin office. We will use the Smart Surveillance System Using Raspberry Pi presents the idea of monitoring the particular place in a remote area, that to overcome the ability of the human being in terms of drowsiness and fatigue because it impossible the admin to preserve watching the screen monitoring in the long time. 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.

CHAPTER 1

INTRODUCTION

1.1 Overview

In our daily life, video streaming based surveillance systems (VSS) are considered of a very important in many applications. These applications may exist in banks, homes, offices, institutes, and airports, to maintain 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 flexibility 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 can be cooperate to build low end to high end surveillance systems in the form of portable realization to plug in realization.

In general, surveillance systems can be divided into three modules: Preprocessing and decision making module, capture of video module, module of network interfacing, admin workplace, 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. The 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, hospitals, and warehouses require a video capturing system that has the ability to alert and record nearby live video of the intruder. The current technologies 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 the 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 pure single purpose systems. Existing solutions have to assist their users for a wide variety of orthogonal designed based on a real time system that is raspbian, as an exemplar.

In this project a 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. It is focused on developing a surveillance system that detects stranger and to response quickly 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.

This 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.

1.2 Research Motivation

Nowadays, security has gained much attention of worldwide organizations and governmental institutes. The integration of image, video and warning activities into surveillance systems is becoming more attractive to build an efficient surveillance system.

This research is motivated by the following points:

1. Remote and scattered important and sensitive locations such as labs and offices inside university campus need efficient monitoring and warning systems.
2. A semi-autonomous surveillance system based on human monitoring assistance is not optimum.
3. Costly solutions are 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 investigate 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 divides 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. The second part is concerned with enhancing the security of the system by improving system awareness of the vision area. Security is important because of the sensitive nature of having cameras at a home (or other sites) due to the expectation of Introduction privacy of people 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 the monitors all the time. 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 complex 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.

1.3 Aim and Objectives

The purpose of this research is to design and implement a 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 Single Board Computer (SBC) using the raspberry pi platform. To accomplish this goal, this research work opted into the following objectives:

1. 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.
2. To investigate the performance of the develop surveillance system.

3. To implement fast and smart intruder warning system for a university campus.

1.4 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 quickly 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.

1.5 Brief Methodology

For an embedded real-time surveillance system to be used as an effective monitoring and alert system, it must 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.

1.5.1 System Hardware

The entire system consists of five parts, Raspberry Pi well-established Linux as Single Board Computer (SBC) controller, the PIR sensor, the Wi-Fi adapter, the camera and the power supply. **Raspberries** are tiny SBCs that have the 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 1.1 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 G Byte.

• Micro USB Power Port: offers 700mA at5A.

• 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 the HDTVs and the 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: allows the admin to communicate with the real world via input or output of signals.

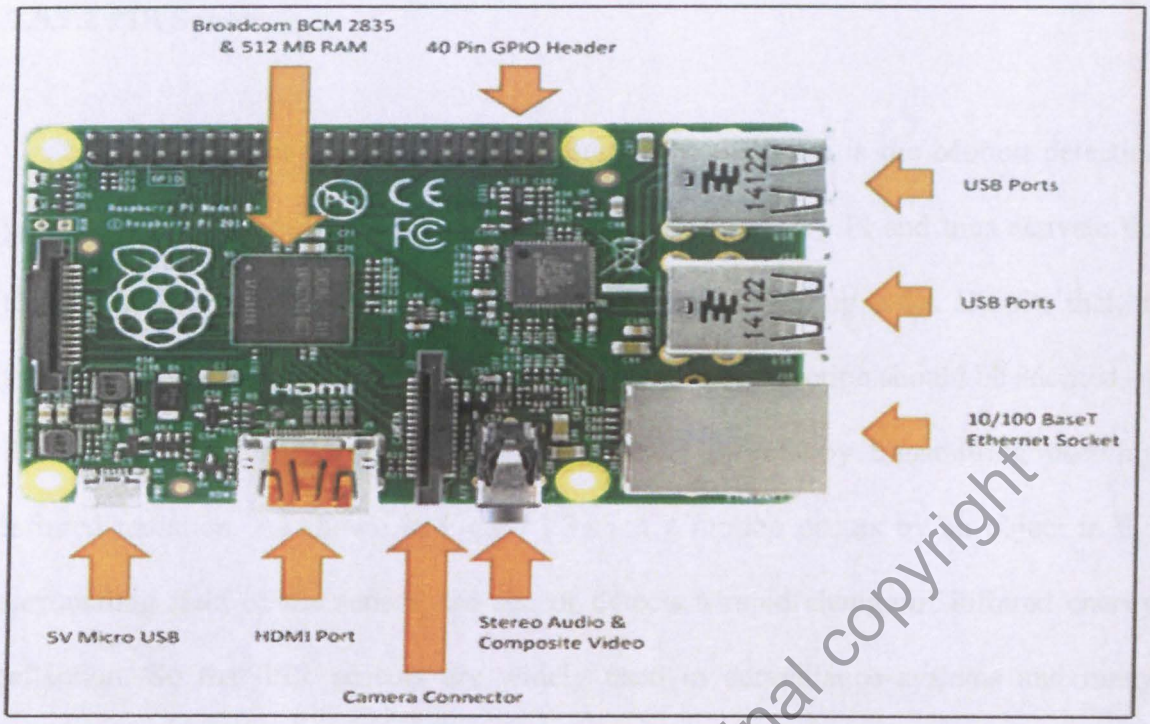

Figure 1.1: Raspberry Pi

1.5.1.1 Raspberry Pi Camera

The Raspberry PI camera, shown in Figure 1.2, is of a native resolution of 5 mega pixel, and has a fixed focus lens onboard. This camera is capable of taking a 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.

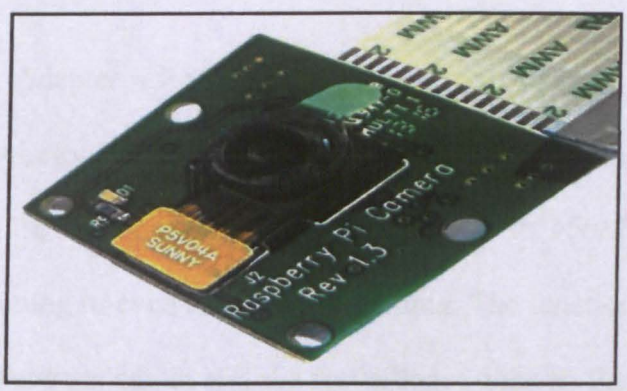

Figure 1.2: Raspberry Pi Camera

1.5.1.2 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 Passive Infra-Red (PIR) sensor is used to detect motion by transmitting/receiving infrared radiation. As shown in Figure 1.3when a motion occurs by an object in the surrounding field of the sensor, the sensor detects a rapid change of infrared energy reflection. So that PIR sensors are widely used in surveillance systems and many applications such as automatically activating lights alerting or start video streaming events, or detection tasks based PIR sensors.

Figure 1.3 PIR Sensor

1.5.1.3 WI-FI MODEM - EDUP EP-N8531

Wireless N USB Adapter EP-N8531 allows you to connect a desktop or notebook computer to a wireless network and access high-speed internet connection. Comply with IEEE 802.11n, they provide wireless speed up to 150Mbps, which is beneficial for the online gaming or even HD video streaming. The function Wi-Fi in this system is communication between admin and the surveillance zone so that can send the

captured images of the intruder to the security admin and download them into the configured Drop Box account.

1.5.1.4 Battery Pack

Rechargeable lithium ion battery, 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.

1.5.1.5 3G Dongle

A dongle is a small hardware device like the size of a flash drive and that plugs into a computer. Wi-Fi dongle is connected over USB port. It has wireless speeds reach to 300 Mbps, the dongle is characterized easily work with IEEE 802.11b/g networks, and some dongles appear as security keys whereas others serve as adapters. Its function in project is transferring the captured images of the intruder and which saved in the SD card for raspberry pi to dropbox and it store into, so that the admin and any staff can see the pictures anywhere. There are some pros to 3 G dongle show below.

1. Dongle is often free when taken with a contract.
2. USB dongles grant internet users greater elasticity with the convenience to access the Internet while away from the home or office.
3. The dongle becomes smaller size, sleeker and faster in transfer data.
4. The dongle runs on the battery of computer, hence do not need to be charged.
5. The dongle can be used in both laptops and computers making its ideal for regular use as well as in contingencies.

1.5.2 Software

The proposed system is a 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 module.
- Sensor continuous sampling module.
- Image capture module: activated when the PIR sensor interrupts the system. This 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 is implemented using the python programming language and base Linux OS. The Hardware and Software modules above mentioned are focused to make the proposed surveillance system that can be deployed in the sensitive area.

1.6 Drop Box

Drop Box is a free service that allows users to access your files and images, documents, and videos from anywhere. They can save a file in their dropbox and they also possible to use the service to share files between more than one user on the Internet and synchronize files between more than one computer or mobile phone. It's used in this project save capture picture of intruder and the recorded video.

1.6.1 Advantages of Dropbox

1. Can be found on all files and control without access to Internet.
2. Can save files directly from computer to the dropbox service.
3. Can get a free extra space from dropbox.
4. Can save all the Firefox browser settings on dropbox.
5. Can transfer files from the Internet directly to dropbox.
6. Can contact two dropbox accounts with each other.
7. Can keep backup copies of dropbox.
8. Can host the sites through dropbox.

1.7 Study Module

The outline of the research way adopted is demonstrated in figure 1.4, 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.

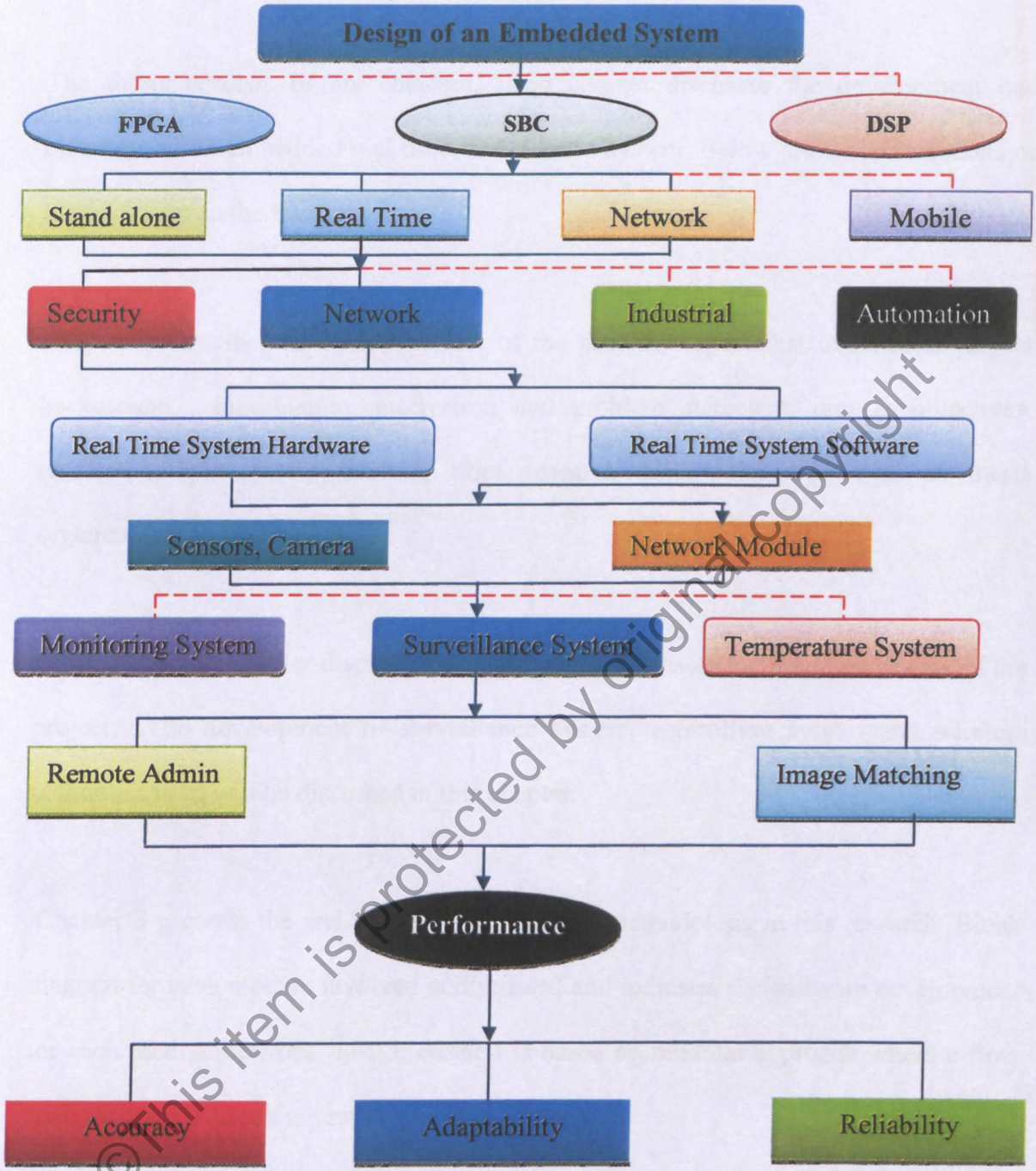

Figure 1.4 Research Study Modules

1.8 Thesis Organization

The thesis consists of six chapters. Each chapter discusses the development and operation of an embedded real-time surveillance system. Below are the elaborations of every chapter in the thesis.

Chapter 1 describes an overall review of the project. Aspect that included is project background , introduction, motivation and problem statement, aim & objectives, research scopes, study module, brief research methodology as well as thesis organization.

Chapter 2 in this chapter displays introduction and discusses the literature review of the project. The development of surveillance system, controlling system and wireless communication will be discussed in this chapter.

Chapter 3 presents the architecture and proposed methodology in this research. Block diagram for each module involved is discussed and indicates the software development for each module network. The discussion is based on modular approach where a flow chart diagram is used for simple approach explanation.

Chapter 4 this chapter will show the result and will explain it in detail.

Chapter 5 concludes the outcome of the project. The recommendation on this project is included in this chapter for future works to enhance system performance.