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# A Novel Video/Photo Recorder Using an Online Motion Sensor-Triggered Embedded System

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**Abstract**

In recent years embedded systems have gained more importance. These systems are especially dedicated to specific tasks which are handled by highly optimized solutions. One of the interesting areas of embedded systems use is multi-media. Producing, processing, streaming various multimedia types and interacting with the physical environment is very common today. Similar to these studies, controlling and observing the specified area by multi-media tools are the necessities for many reasons such as security. This paper presents a method of video and photo recording of any moving object by using open source operation system (Raspbian- a distribution of Linux) and software (Python – a high-level programming language). The system is triggered by a motion sensor and it collects visual data from a specified area for limited duration. The collected data is published on internet via dedicated web site.

**Keywords:** Photo and Video Recorder, Open Source Platforms, Embedded Systems

## 1. Introduction

Embedded systems provide highly optimized solutions for many tasks. The most important advantages of embedded systems are fair price, small size, reliability [1]. Therefore, embedded systems are used in many key areas such as automotive electronics, avionics, railways, telecommunication, health sector, security, consumer electronics, fabrication equipment, smart buildings, logistics, robotics and military applications [2].

One of the interesting fields of embedded systems used is multimedia. Producing, processing, streaming various multimedia types and interacting with the physical environment is very common today [3-7]. Also there are many academic studies based on embedded surveillance systems [8-9]. These studies captured images and video mostly with ARM core microcontrollers [10].

In this study a novel video/photo recorder is designed for motion catching and independent of cabling (communicates with Wi-fi). This study shows how to use together an embedded microcomputer (Raspberry Pi), a camera (Pi Camera), and a motion sensor for this specific task.

The system works by itself but with a web interface many control abilities are possible. A user can for example, change operation modes, length of video recordings and access files from system memory. The operation system that works on embedded microcomputer is a distribution of Linux, Raspbian. Python programming language is used as operating system and controls the camera. The developed program in Python operates the camera. The other tasks of the program are saving the records on the system and communicating with dedicated web page. The web page interfaces the records to the users and gives opportunities to make some adjustments on the system with cooperation of the microcomputer.

## 2. Methodology

### *2.1 System Structure*

The video/photo recorder system consists of two primary components. One component is the application platform based on Raspberry Pi. Inside the Raspberry Pi two sections work together. The I/O section manages the data communication between Raspberry Pi and the camera, and the Pyroelectric Infrared (PIR) Motion Sensor. The second section of Raspberry Pi processes the data and interfaces with the web server, internet and user. Here some adjustments are made on Raspbian OS and router that Raspberry Pi works with.

The second primary component of the recorder system includes the external hardware of camera and PIR motion sensor, activated when motion is detected. Overview of this structure is shown in Figure 1 below.

 

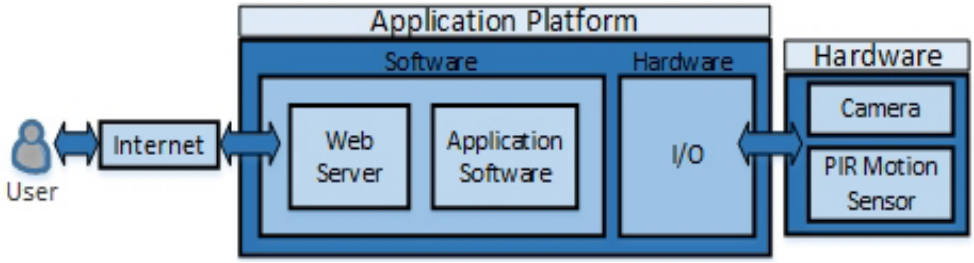


Figure 1. System Structure.

*2.2 System Components*

The system consists of multiple components. A microcomputer (Raspberry Pi), Pi Camera and PIR Motion Sensor are the primary components; and an LCD Monitor and keyboard-mouse group are used for designing and programming procedure.

2.2.1 Raspberry Pi

Raspberry Pi is a small size microcomputer which has many advantages for various applications. It works at 700 MHz by booting from a SD Card, consuming less than 500 mA at 5V with no peripherals attached.

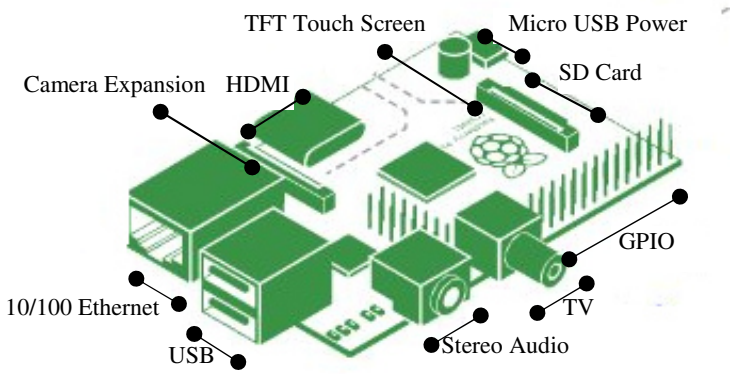


Figure 2. Components of Raspberry Pi Model.

Raspberry Pi has a Dual Core Multimedia Processor which supports Open GL and 1080p H264 high-profile decoding, providing a capability to process multimedia files. Unlike multimedia processors, Raspberry Pi is also used for designing sensors and various applications in embedded field [11-12]. Below, specifications of Raspberry Pi are listed.

Table 1. Raspberry Pi Specifications [13].

| Core Architecture | ARM11 |
|---|---|
| CPU | 700 MHz Low Power ARM1176JZFS Processor |
| Memory | 512MB SDRAM |
| Dimensions | 85 x 56 x 17 mm |
| Power | Micro USB socket, 5V, 2A |
| Video/Audio Output | HDMI |
| GPIO | 27 pins |
| Memory Card Slot | SDIO |

 

### 2.2.2 Pi Camera

Pi Camera is a digital 5 Megapixel camera which supports video and photo recordings. Pi Camera uses for transferring data, CSI interface which is capable of high data rates. Pi Camera generates 'jpeg' formatted images for photo recordings and 'h264' formatted video files for video recordings.

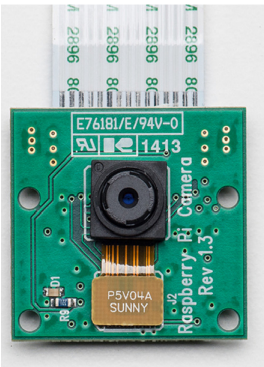


Figure 3. Pi Camera.

### 2.2.3 PIR Motion Sensor

A PIR motion sensor measures the light coming from objects and if it detects a motion, it changes the value outputs from 0V to 5V. Operation voltage is between 5-20 VDC. Sensitivity and the delay time can be adjusted from potentiometers on the sensor. The sensor has 3 pins which are for Vcc, Gnd and Output signals.

Figure 4. PIR Motion Sensor.

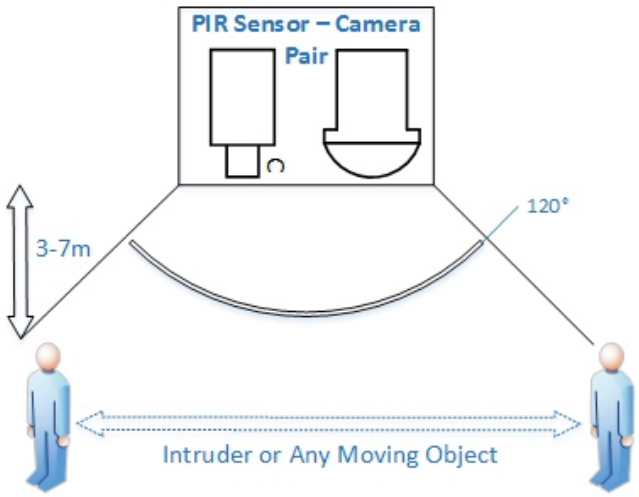


Figure 5. PIR Sensor and Camera Pair.

 

*2.3 Electrical Schematics*

External hardware is connected to the Raspberry Pi. When a moving object is detected an output signal from PIR motion sensor is received by GPIO pins of Raspberry Pi and Raspberry Pi generates a recording. Figure 6 shows the detailed electrical schematics of the system.

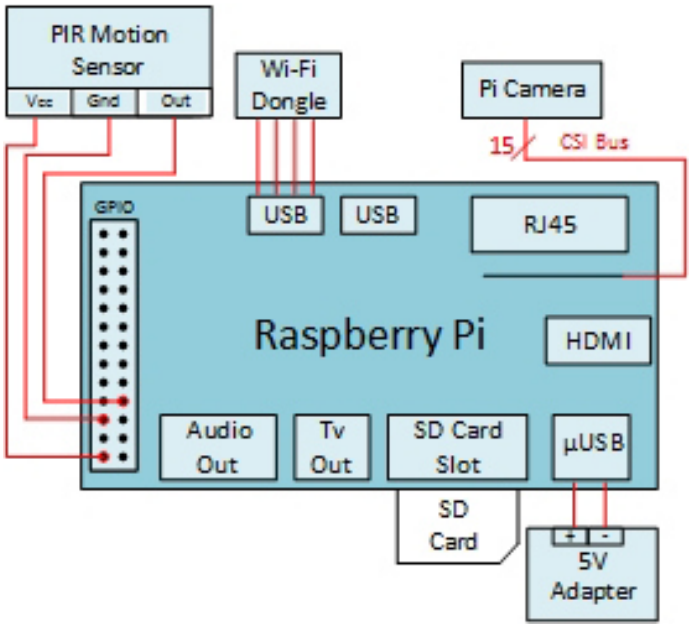


Figure 6. Electrical Schematics.

*2.4 Software Development and Algorithm*

One of the important issues of the project is developing the necessary software. The main goal of this software is management of the components and the communication with web interface. The software in question is developed in Python programming language which works properly on a Raspbian operation system (At first, Raspbian operation system should be installed and executed on Raspberry Pi). Below main algorithm of the software is shown.

 

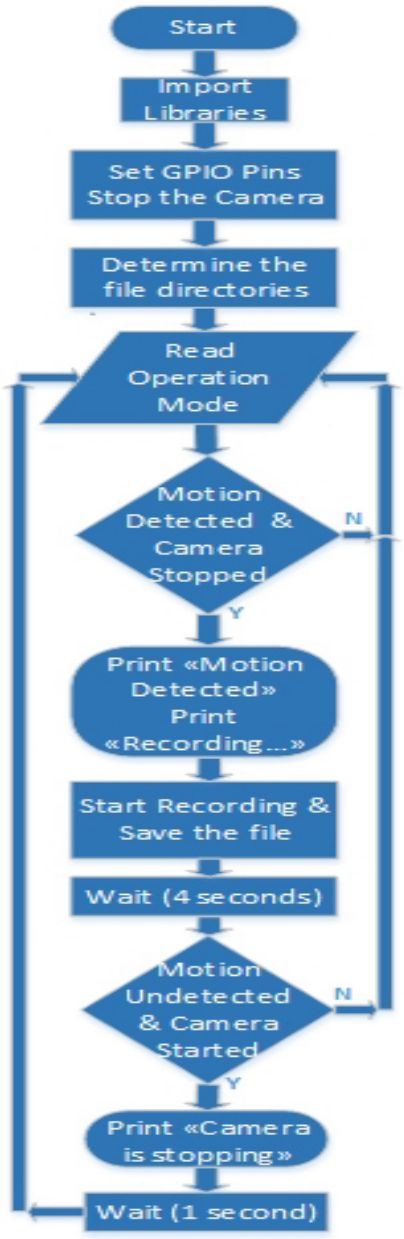


Figure 7. Algorithm of Python Software.

*2.5 Web Interface*

Web interface of the system is designed as a simple and fast web page. The web site design is based on HTML and JavaScript together and changeable operation modes.

2.5.1. Adjustments on Router and Raspbian

A major aim of the project is to enable the user to connect a web page using same IP address. Therefore, a rule to the router should be added. By this way, the requests coming from outside the local network, will be directed to the Raspberry Pi. The table below shows the details of the added rule.

 

Table 2. The rule on the router.

| Port Forwarding | | | |
|---|---|---|---|
| **IP Address** | **Start Port** | **End Port** | **Protocol** |
| 192.168.0.19 | 80 | 80 | TCP and UDP |

Raspbian OS is capable for serving the interface with the web page. To realize this, the settings which are written below, should be changed on IPConfig file of Raspabian OS.

Table 3. Raspbian Settings.

| |
|---|
| Auto lo |
| Iface lo inet loopback |
| Iface eth0 inet dhcp |
| Address 192.168.0.6 |
| Netmask 255.255.255.0 |
| Network 192.168.0.0 |
| Broadcast 192.168.0.255 |
| Gateway 0.0.0.0 |
| Allow-hotplug wlan0 |
| Iface wlan9 inet manual |
| Wpa-roam /etc/wpa_supplicant/wga_supplicant_conf |
| Iface default inet dhcp |

2.5.2 Designed Web Page

The web page is designed for changing operation mode of the system and also for sharing the recorded files on the internet with the user.

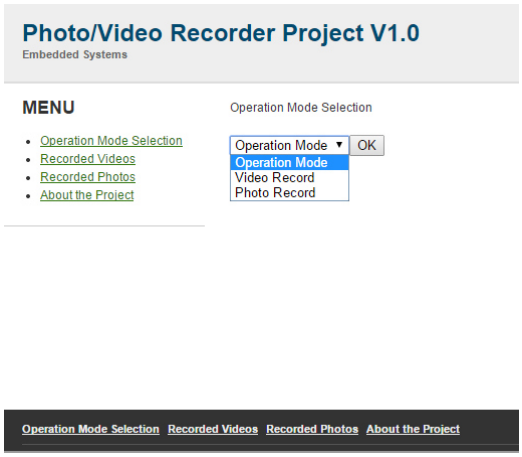


Figure 8. Web Interface.

After the operation mode is selected, the data is written to a text file which is readable by Python software. In this way any change will effect directly the Python software.

When the user tries to reach recorded files, web site connects to the related directories in Raspberry Pi and offers

 

the file as a downloadable option.

## 3.Test Regime

*3.1 Test-1*

Operation mode is selected as "Video". At the experiment environment, an object is moved in front of the system and by this way, the system is triggered and starts recording. After short time, the user connected to the Raspberry Pi's IP, 46.196.67.172 and downloaded the 'h264' formatted file out of the local network.

This test is for confirming the connectivity of Raspberry Pi out of local network and refresh rate for new **video** files. The new recorded file was available for downloading in 0.3 second after the file is recorded.

*3.2 Test-2*

Operation mode is selected as "Photo". At the experiment environment, an object is moved in front of the system and by this way, the system is triggered and started recording. After short time, the user connected to the Raspberry Pi's IP, 46.196.67.172 and this time downloaded the 'jpg' formatted file out of the local network.

This test is for confirming refresh rate for new **photo** files. This time new recorded file was available for downloading in 0.2 second after the file is recorded.

*3.3 Test-3*

This test is performed for confirming a specification of the system. This specification is about deleting and refreshing the directory after 24 hours.

On the date of 05.07.2014, the system has been triggered several times for each operation modes. On the web site, these files were shown for the user. Right after 24 hours, on the date of 06.07.2014, the system is checked for old files and it is noted that there is no old file in the directories.

## 4. Conclusions

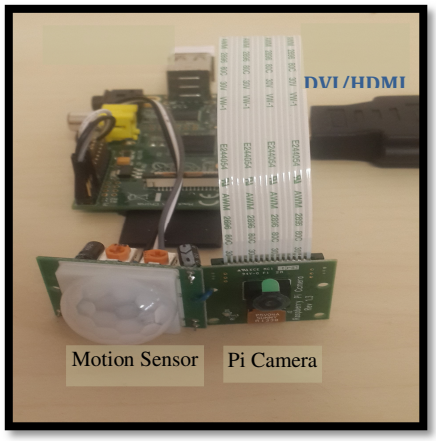


Figure 9. Completed Recorder.

The aim of the study was to design a video/photo recorder which is triggered by a motion sensor on an embedded microcomputer. This aim has been achieved with respect to design considerations. At the last stage, recorder has the following specifications:

- **Low cost:** The cost of the system is limited to a low level.
- **Small Size:** Size of the system is 15 cm x 7 cm.
- **Low Power Consumption:** System requires very low energy inputs. In the idle mode it consumes 1.5 Watts; at the operation mode it is 3 Watts.
- **Mobility:** The recorder system is designed for mobile use. But it needs a robust mechanical case. Including internet connection, there is no need to locate the recorder in stable place.
- **ARM Architecture**
- **Open Source Platforms (Raspbian and Python)**
- **Accessibility:** The recorded files are reachable from anywhere which has internet connection.

 

Synergy of embedded systems and multimedia technologies is expanding day by day. This study and other related studies offer many advantages for future works. The next step after this study can be by identifying moving objects or target tracking of objects. The possible studies can be more interactive with the physical environment with using more effective sensors. The designers can implement the recorder on a mobile robot. Such a type of mobile robot can be used for many applications like geographical mapping. Also supporting these applications with internet technologies is enriching the possible studies in this field.

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