VIDEO SURVEILLANCE USING RASPBERRY PI ARCHITECTURE

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***Abstract*- This project is about a remotely monitor surveillance area using Raspberry Pi architecture. Raspberry Pi B+ model is a credit card sized single board computers developed in the UK by the Raspberry Pi Foundation, which provides all the basic features of a computer. Its core architecture is built from ARM11 (Broadcom BCM2835 SoC). This project deals with Raspberry Pi processor, stepper motor, webcam, PIR sensors and GSM module. Raspberry Pi which is heart of system collects surveillance data through interfaces like webcam, PIR sensors. The video stream is locally as well as remotely visualized. Role of a stepper motor is 360^0 surveillance. Further, SIM900A module is used to interface GSM/GPRS functionality with Raspberry Pi processor. The alert notification is sent to user, when Raspberry Pi detects living body or motion of living body in surveillance area. Raspberry Pi transmits the real-time video through internet as well as it sends notification message to the user though GSM module. The Raspberry Pi having these all interfaces using communication ports like GPIO, Ethernet and USB.**

***Keywords*- Raspberry Pi, GSM module, Stepper motor, webcam, PIR sensors, GPIO, Ethernet and USB.**

I. INTRODUCTION

An automated wireless Video surveillance solution using Raspberry PI is proposed in this project. The proposed solution can be applied in to the border surveillance and various security systems. A wireless video surveillance system basically consists of three processing blocks

- The video capture and processing.
- The video compression and transmission in wireless networks.
- Surveillance area monitoring and controlling from remote location.

Live video streaming refers to sending video signals real time over the Internet. Stream video can be clearly visualized on webpage due to Raspberry Pi, which is having picture quality configurations. Also Video Surveillance over wireless sensor networks has been widely adopted in various cyber-physical systems including border security, traffic analysis, healthcare systems in hospitals, public safety (bus, mall etc.), wildlife tracking and environment/weather monitoring etc.

II. BLOCK DIAGRAM

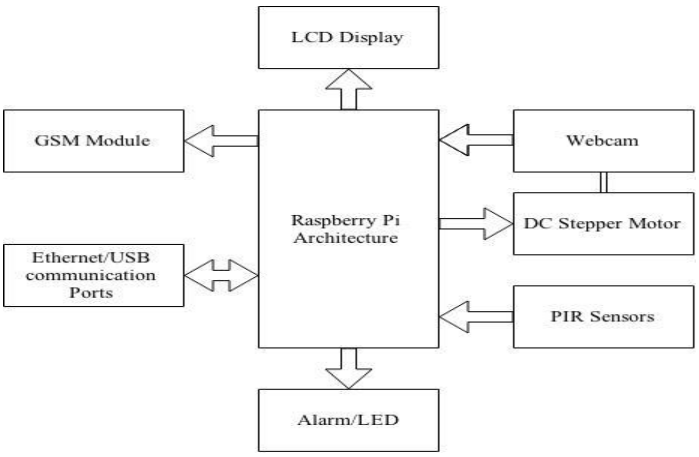

Fig. 1. Block diagram of proposed system

Fig. 1 shows the block diagram of video surveillance using Raspberry Pi architecture. System consists of Raspberry Pi, PIR sensors, GSM module, stepper motor, LCD display, alarm and webcam. Raspberry Pi board is used for video processing and sending the data to the authentic person over the internet. With the help of processor we will make all the data compatible to send over the wireless medium that is internet. RS232 (MAX232) is used to communication between the Raspberry Pi (ARM11 Processor) and GSM module. GSM module is used to send the notification through GSM/GPRS standards. Webcam is mounted on stepper motor; webcam is having the role of video or image capturing. Because of stepper motor surveillance in all

direction is possible. Also motor driving circuit is used for motor operation. Need of PIR sensors are for motion detection in surveillance area. LCD display and alarm is used to give surveillance notification locally. Because of wireless medium we can send the data anytime anywhere.

Fig. 2. System Design

Fig. 2 shows, the system design of whole project. The webpage is accessed by calling IP address of Raspberry Pi processor. The authentic person can only access the data only, because we provided the security through the username and password to access the webpage. HTML webpage can open at any device which is having the internet connection to it. The operating system is not obstacle in this case, because HTML webpage is supported by all most all operating systems.

III. FUNCTIONAL DESCRIPTION

The functions of various components are as mentioned below:

A. *Raspberry Pi*: Raspberry Pi B+ module is capable of performing various basic functionalities of multimedia, gaming and surveillance applications. The functionality of various components of Raspberry Pi is stated as below:

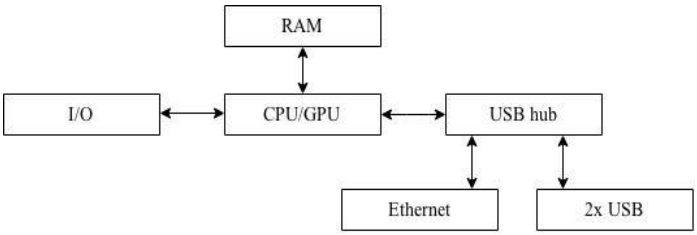

Fig. 3. Block Diagram of Raspberry Pi B+ Module

1) *Micro SD socket*: SDIO (Secured Digital Input/Output) memory card is required to store the operating system and files. The operating system boots from Micro SD card, it is running a version of the Linux operating system (i.e. Raspbian OS). The maximum support of the SD card is about 32GB.

2) *Micro USB Power supply socket*: Raspberry Pi Micro USB socket 5V, 2A. It also creates three different voltages 3.3V, 2.5V and 1.8V for the processor and Ethernet.

3) *Ethernet socket*: 10/100 BaseT Ethernet socket used for LAN network.

4) *Audio output*: 4-pole (TRRS) type connector, 3.5mm Jack, HDMI (High Definition Multimedia Interface), stereo audio and composite video.

5) *Video output*: HDMI (rev 1.3 & 1.4), composite RCA (PAL and NTSC). It is type of electrical connector commonly used to carry audio and video signals.

6) *USB socket*: Four Universal Serial Hub 2.0 connectors are available. The LAN9512, which is basically, turned the 1 USB port on the processor into 2 ports + Ethernet.

7) *GPIO Connector*: 40-pin 2.54mm (100mil) expansion header: 2x20 strip providing 27 GPIO pins as well as +3.3V, +5V and GND supply lines.

8) *Broadcom BCM2835 SoC*: 700MHz low power ARM 1176ZFS application processor is available on board.

9) *Graphic Processing Unit*: Dual core VideoCore IV^{R} Multimedia Co-processor is used, which is having 1080p30 H.264 high profile decode.

10) Power requirements for board are 5V, 2A.

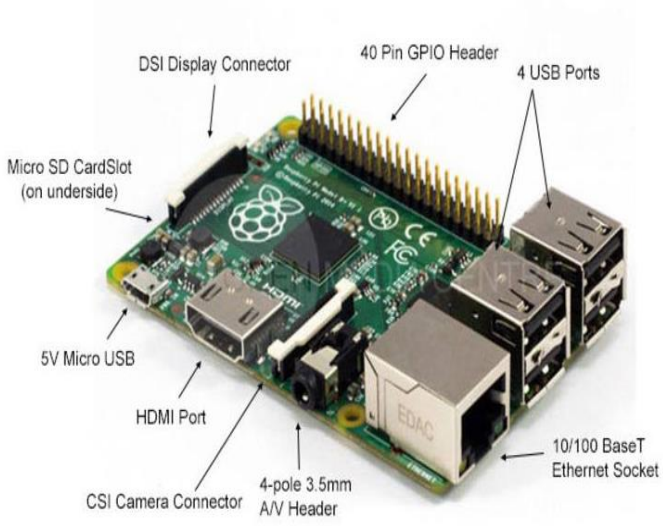

Fig. 4. Raspberry PI B+ module

Raspberry Pi is having the role of video compression. Webcam is having 1080p high definition video/image output.

According to need we can compress the video to transmit over the wireless media. We compressed the video in 320x240 resolution and 15 frames per second by configuring Raspberry Pi module. This resolution and frame rate is selected because of smoothly transmission of data and clearly visualize on webpage.

B. *USB camera*: Webcam is used to capture the video and images of surveillance area. Here, we use Zebion USB webcam.

Webcam having the specifications like 10MP and 1080p maximum resolution.

C. *Stepper motor*: It is used to track whole 360^0 surveillance. Because of this camera will rotate in 360^0. Webcam is mounted on right the top of the motor. Here, we required 2kg torque DC stepping motor. Its power consumption is 12V, 0.5A.

In this project, we used stepper motor rotations in two modes:

1) *Normal mode*- In this mode, stepper motor is in steady position, it will not change its angle until it will not getting any command from user. On webpage two options are available to rotate motor either in clockwise direction or in anticlockwise direction. When you single click on the button motor will change its angle by 45^0.

2) *Sense mode*- In sense mode, when any of the PIR sensors detect the motion, stepper motor will change its angle by 90^0 towards that PIR. When PIR1 detects the motion stepper motor will change its angle by 90^0 towards PIR1.

D) *PIR sensor*: PIR (Pyroelectric Passive Infrared) used for the purpose of detection of motion; if any movement occurred in surveillance area it will send the data to processor. Raspberry Pi will process on it and send the notification through GSM module, as well as processor will display on LCD display that which sensor detects the motion in that area of surveillance. According processor will take action and camera automatically rotate towards that detected area.

In this project, we used the DYP-ME003 PIR Motion Sensor Module, which is based on BIS S0001IC. BIS S001 is a micro power PIR motion detector IC.

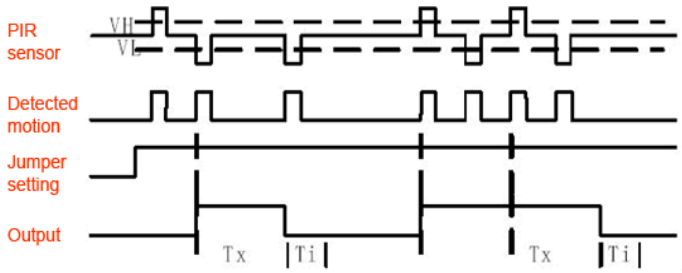

Fig. 5. Working principle of PIR sensor

PIRs are basically made of a pyroelectric sensor, which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for this is we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

E. *GSM module*: This model is purposely used to notify the motion is detected in the surveillance area. When PIR will detect the motion GSM will send the notification message to the authentic person. SIM900A GSM modem is used for this purpose. This modem is works on 900/1800 MHz frequency. The modem is having the RS232chip, which will allows you to connect Raspberry PI processor using MAX232. The baud rate is configurable from 9600 to 115200 using AT commands.

F. *LCD Display and alarm*: In this project, 16X2 LCD display is used to indicate the sensors output. It will show out of two sensors which sensor detected the motion. Alarm is used locally getting the notification that motion is detected.

IV. FLOW CHART

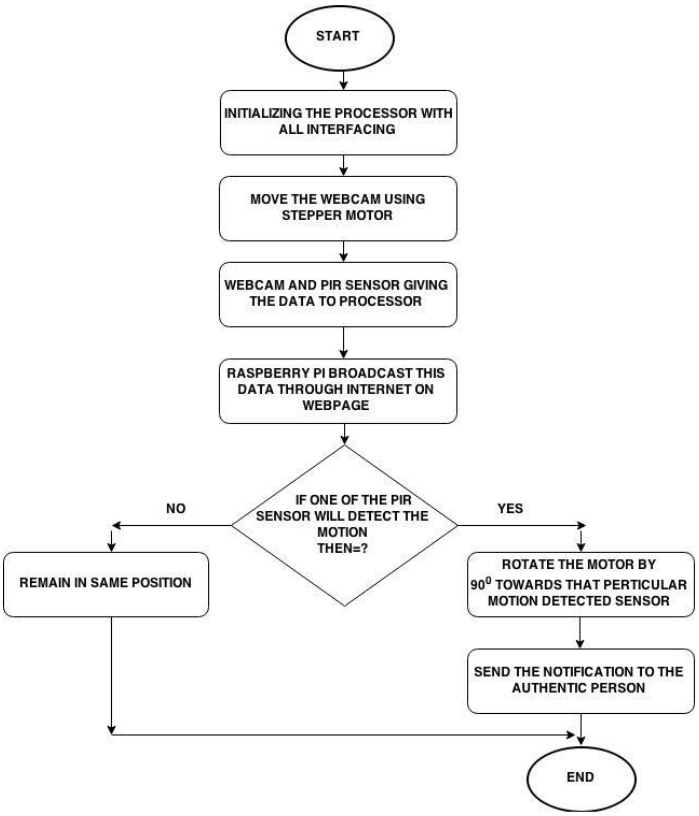

Fig. 6. Flow chart of complete process of project

Fig. 4.1 shows, the total process of project works sequentially. There are basically two modes when PIR detect the motion and another when PIR will be in passive mode, based on that the next procedure will be depending.

V. Raspberry Pi Initial Setup

A. Installation of operating system: To get started with Raspberry Pi you need an operating system. NOOBS (New Out Of the Box Software) is an easy operating system install manager for the Raspberry Pi.

The following Operating Systems are currently included in NOOBS:

- Raspbian,
- Pidora,
- OpenELEC,
- RaspBMC,
- RISC OS,
- Arch Linux.

Steps to install NOOBS:

1) NOOBS is available for free download on the Raspberry Pi website: raspberrypi.org/downloads.

2) Then download [14] and install the SD card formatter software into windows operating system laptop to make the SD card compatible for installing NOOBS.

3) Insert the memory card into memory card slot of laptop, then format the SD card using this software in FAT format.

4) Then download [15] and install Win32diskimager software, this is a Windows program for saving and restoring images from removable drives (USB drives, SD Memory cards, etc.). It can be used to write boot images to a SD Flash device or USB flash device, making it bootable, which is available at:

5) Using this tool, extract the downloaded image into micro SD card. Now, micro SD card is ready to use in Raspberry Pi.

6) But this operating system is not compatible with the new B+ model so using putty, we have to upgrade and update this OS.

7) Now download [17] and install the putty software on to the windows platform. Putty is a free and open-source terminal emulator; serial console and network file transfer application. It supports protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. Using this tool we can configure and setting up the Raspberry Pi easily.

8) Using this tool, we have to upgrade and update the operating system to make compatible with Raspberry Pi B+ model. For that reason two commands are necessary;

1) sudo apt-get update;
2) sudo apt-get upgrade;

9) Using your laptop internet sharing facility you can do this upgrade and update operating system of Raspberry Pi.

10) To use NOOBS on windows platform we have use TightVNC software. TightVNC [16] is a cross-platform free and open-source remote desktop software application that uses and extends the RFB protocol of Virtual Network Computing (VNC) to control another computer's screen remotely [11]. So download and install this software, which is available at:

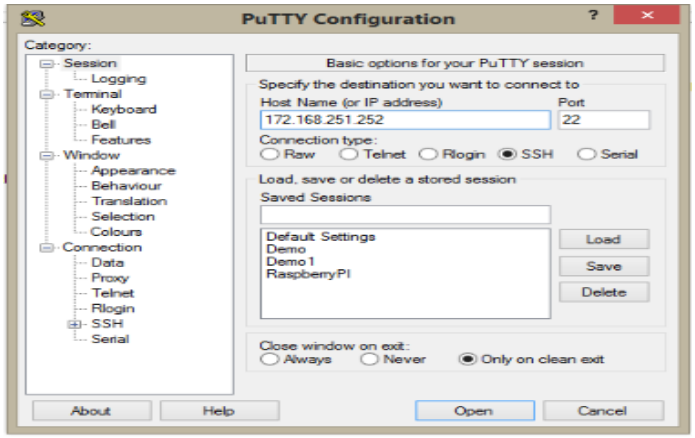

Fig. 7. Putty configuration settings

11) You have to give a command in putty to open TightVNC server, "sudo tightvncserver", after this command it will show NOOBS in windows platform.

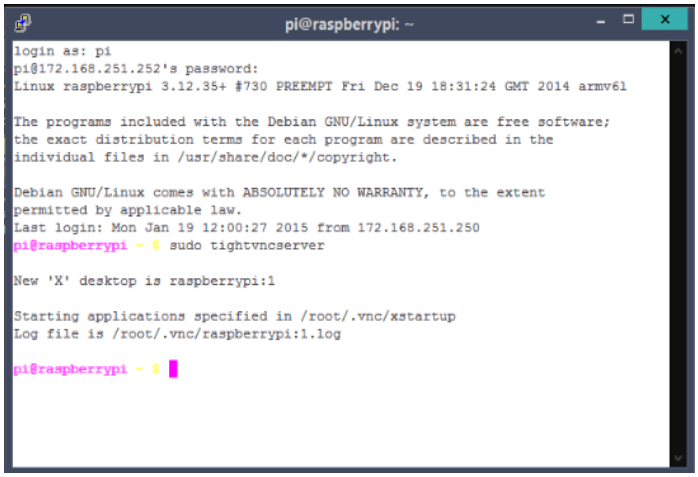

Fig. 8. TightVNC command given in Putty

12) Further interface programming is done through the Genny software which is built in function in Raspbian operating system. LXterminal is use as command prompt in Raspbian OS.

VI. RESULTS

We successfully configured Raspbian operating system, which is freely available. Configuration of static IP for Raspbian

operating system is done through putty software. So this static IP facilitates remote access.

Webcam can rotate from webpage in two directions that is in clockwise and in anticlockwise direction. When single click is done on direction the camera angle will change by 45^0, so after 6 click it will complete whole 360^0 rotation.

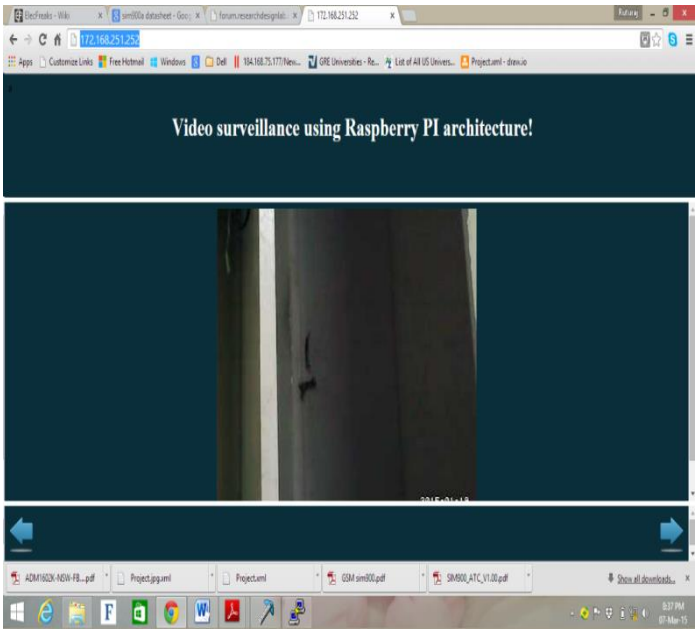

Fig. 6.1: Webpage at the receiver section

The actual project wired connection is shown in fig. 6.2, Raspberry Pi having enough capability for high definition video and image processing and transmission. So, Raspberry Pi interfaces with the GSM module, PIR sensor, stepper motor and webcam in this project.

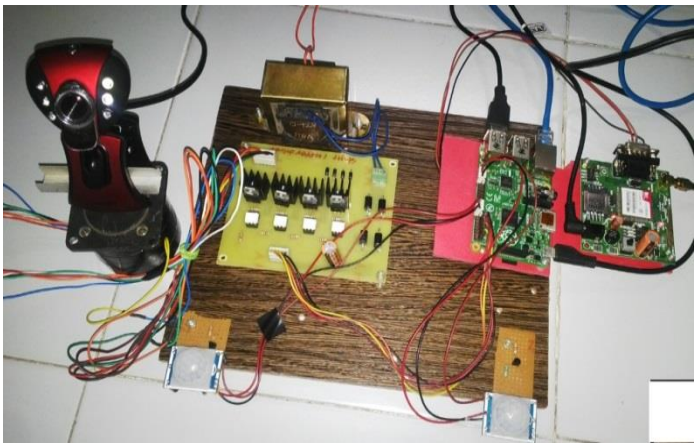

Fig. 6.2: Project Overview

Fig. 6.3: LCD Display showing which sensors detects motion

VII. ADVANTAGES

A. Very small space required as compared to existing available surveillance systems in market;

B. Cost efficient than other surveillance systems;

C. Wireless transmission, so there is minimum data loss or minimum data delay;

D. Whole around 360 degree surveillance area will be under surveillance because of our system;

E. There no any of any fixed surveillance Centre or room, we can observe it from anywhere at any time;

F. It can work on battery power supply, because very less power consumption, only two to three watt power supply will be sufficient.

VIII. APPLICATIONS

A. In hospital for patient surveillance;

B. In city buses or in Wi-Fi enabled trains to reduce the crime;

C. In any big housing apartments, in big organizations or in big institutes;

D. In the companies where surveillance is needed,

E. Also on the international borders for the surveillance purpose.

IX. CONCLUSION AND FUTURE SCOPE

Thus we have designed a smart, compact, cost effective surveillance system capable of capturing video/image and transmit over the internet. It is most important to have reliability privacy and security on both ends, which is achieved in this project. It is provided authentication at the receiver side, hence it can access by the concern person only. Also some addition

options like camera angle control, to view in 360^0. If necessary changes will be done in future, so that it can be also use in drone, international boarder surveillance system or any other military applications. Using digital image processing in this we can develop this same system for various applications.

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[13] http://blog.miguelgrinberg.com/post/stream-video-from- the-raspberry-pi-camera-to-web-browsers-even-on-ios-and-android

[14] https://www.sdcard.org/downloads/formatter_4/

[15] http://sourceforge.net/projects/win32diskimager/files/latest/download

[16] http://www.tightvnc.com/download.php

[17] http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html