Surveillance Camera Using Raspberry Pi and Simulink

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Abstract: **With the availability of low-cost hardware accompanying higher processing speed, there's been a significant increase in the use of image processing for various applications to solve real life problems. This paper highlights the use of image processing in surveillance and security systems. Raspberry Pi, a low-cost single board computer with built-in Wi-Fi is used in the project. The Camera Module for Raspberry Pi helps to capture high definition images and videos. MATLAB and Simulink Hardware Support Packages is used to create algorithms for both Raspberry Pi and Android hardware. The video captured from the camera is transmitted to the android phone using UDP. A motion detection algorithm is created using Image Processing Toolbox in MATLAB. A message is sent to the ThingSpeak cloud channel and received on the phone. The android phone plays an audio when the motion is detected. The camera module has been given one degree of freedom to give a visibility of 180º.**

Key Words: ***Raspberry Pi, MATLAB & Simulink Support Packages for Raspberry Pi and Android, Image Processing and Computer Vision Toolbox***

I INTRODUCTION

We A long time ago, surveillance techniques were used only in shopping malls and centers. Now-a-days, we can notice closed-circuit televisions almost at any place you visit, from a tiny grocery store to residential buildings and holy places. These places guarantee greater public security at a fraction of the cost. Traditionally big organizations have always had the benefits of video surveillance manned by security professionals. In the past times, the capturing and transmission used to take time. But, modern technologies let users to check and reply to alarms immediately. In our busy lives we don't have much time to monitor and keep a watch on every little action taking place or done by people. In the 21st century of so much advanced technology and people's busy lives, we need to think smartly to make our life better, easier and secure, so rather than sitting at once place for longer and keeping a check, why not carry the security in our pocket?

We all know that Surveillance is being a great need nowadays. Not only in the field of theft but also for monitoring processes in industries. There are many surveillance systems available in the market. Wired as well as wireless surveillance systems both cost a lot. Therefore, we have attempted to build a simple and cheap wireless surveillance system using Raspberry Pi 3B+ and a Pi camera module. The main aim of this project is to provide a cheap option of a wireless surveillance system to small scale as well as large scale industries.

The Raspberry Pi 3B+ is a great microcontroller with wireless connectivity like Bluetooth and Wi-fi. It also has an option of an Ethernet cable to transfer data via a LAN connection. It also has an on-Board HDMI port for wired display support and 3.5 mm Jack for audio input and output. The Pi camera module is easy to operate and can just be mounted onto the Raspberry Pi directly via a thin flexible cable. The interfacing of the Raspberry Pi 3B+ is done using the Raspbian Operating System(OS). The Raspbian OS creates ease in the interfacing of any sensor with the Raspberry Pi 3B+ board. We have programmed the chip to the MATLAB Simulink Model and can easily be optimized according to the users need.

II. LITERATURE SURVEY

This paper is based on the concepts of IOT basically, intrusion or motion detection in a particular area covered by the PIR sensor and can detect the changes in motion. The output of the alert is wireless as well as wired. The user gets an e-mail and also an SMS for the same and along with a buzzer alarm mounted on the board. The project is good enough for securing theft protection and intrusion detection. It is a completely automated system and does not require any kind of major setups. The major advantages of the project are that it has wireless connectivity and as well as it gives the user alert in different forms. PIR sensor is not that reliable source of information in different lighting conditions as it consists of an IR transmitter-receiver pair to get the obstacle detected. The drawback of the system is that it cannot stream live videos nor can store them in particular storage despite the capability of the Raspberry Pi 3 Model of storing the data as well as transferring it to the remote device through any channel (LAN cable, WIFI, Bluetooth, etc.). The Raspberry Pi Model 3 could have been used more extensively or in a better way to get surveillance as well on a remote device along with motion and face detection. This project is apt only for home use and not good for industrial use (nor large scale neither small scale). [1]

In this paper, the use of Raspberry module as video surveillance & burglar alarm is depicted. It Shows how Raspberry Pi B+ module can be used to its full strength to create an advanced video surveillance setup that can detect

any motion in its 360 degrees coverage with sensible use of PIR sensors and servo motors to detect motion and rotate the camera to respective direction of motion as detected by PIR sensors. This project also uses a GSM module that is interfaced to Raspberry Pi such that it can send a notification to the user when any anonymous activity/motion is detected. This surveillance module can have edge over other surveillance cams available by adding other features such a crowd detection, facial recognition, cloud storage of video footage & the most important point to note is to reduce the cost of the setup as compared to other surveillance modules available in the market. Keeping the cost efficiency aside this project is a good example of how video surveillance should be like. the project can be furthermore polished by the introduction of image processing to it. this project can be used in many applications such as border security, traffic analysis, healthcare systems in hospitals, public safety (bus, mall etc.). [2]

This paper deals with just security surveillance in the day to day life. It is a basic project which is based on a Raspberry Pi. The Pi camera module is used as a camera lens for the project. The notifications or alerts are sent via an SMS and it is based on a 3G modem. It doesn't support any other features like live streaming on Android devices or any wireless device. The project can't be used for any industrial purposes. The cost has been increased due to the use of a 3G modem. A GSM module could have done the job well for the project. [3]

III. BLOCK DIAGRAMS AND FIGURES

4.1 Block Diagram:

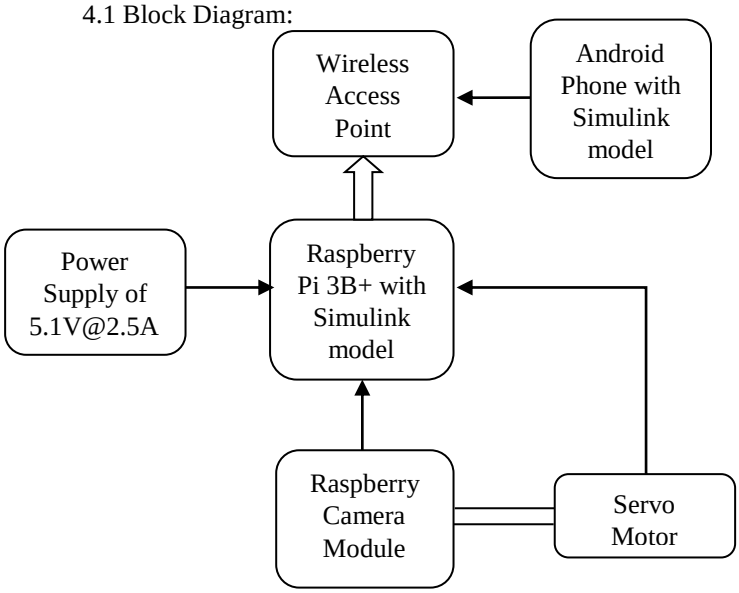


Figure 1: Communication between Raspberry Pi

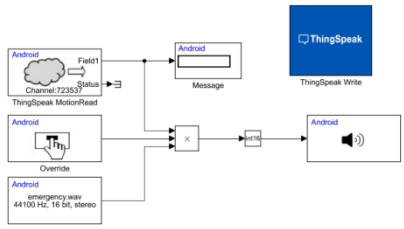


Figure 2: Motion Detect Android Model (Simulink Model)

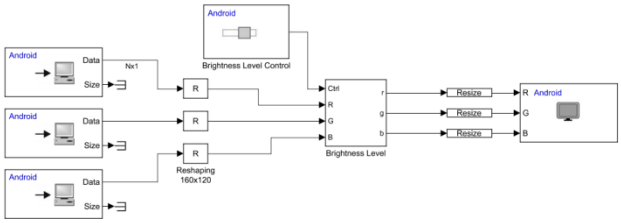


Figure 3: Stream Android Model (Simulink Model)

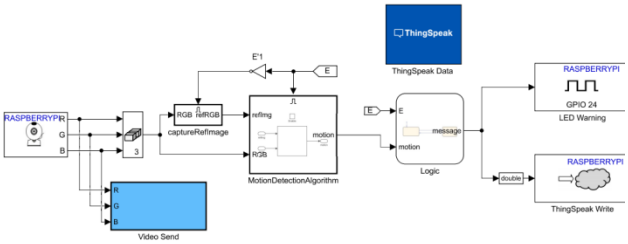


Figure 4: Stream Android Model (Simulink Model)

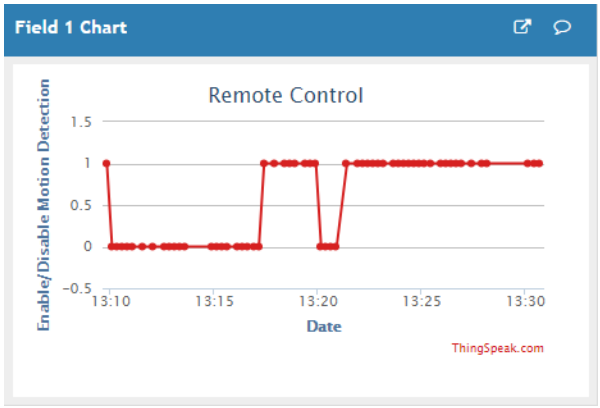


Figure 5:

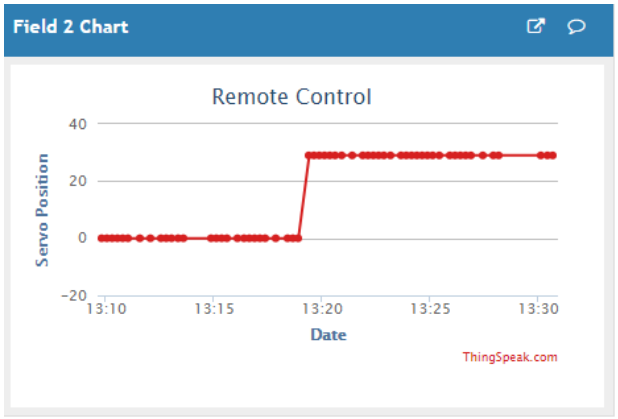


Figure 6:

Figure 9: Raspberry Pi 3B+ Model

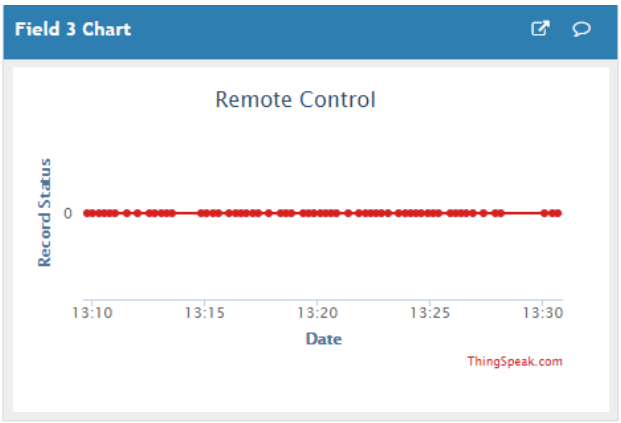


Figure 7:

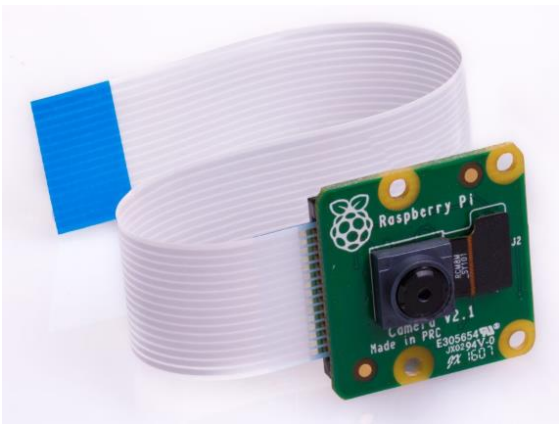


Figure 10: Raspberry Pi Camera Module

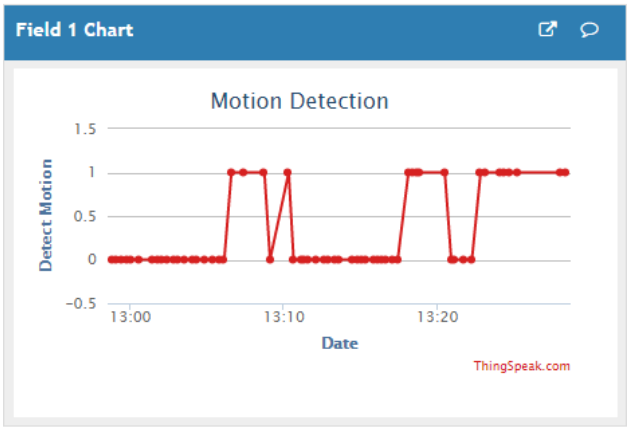


Figure 8:

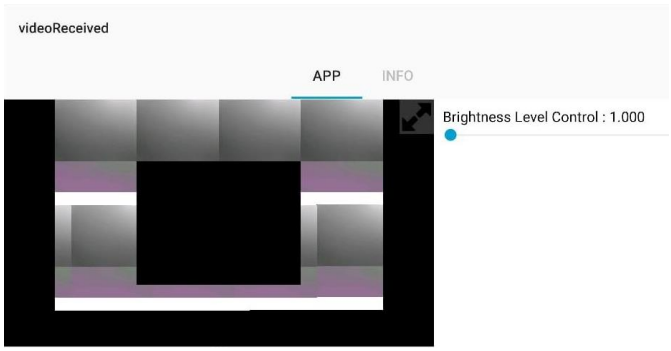


Figure 11:

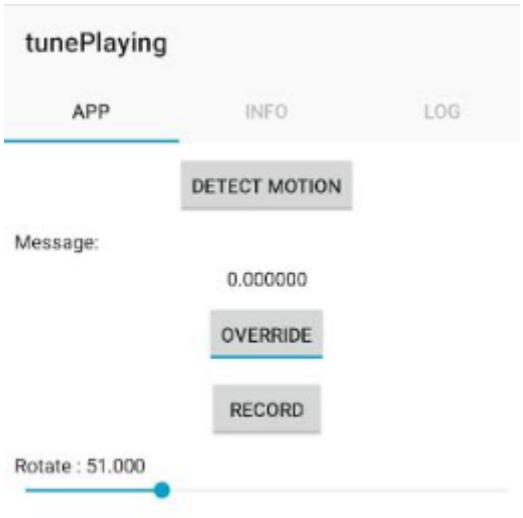


Figure 12:

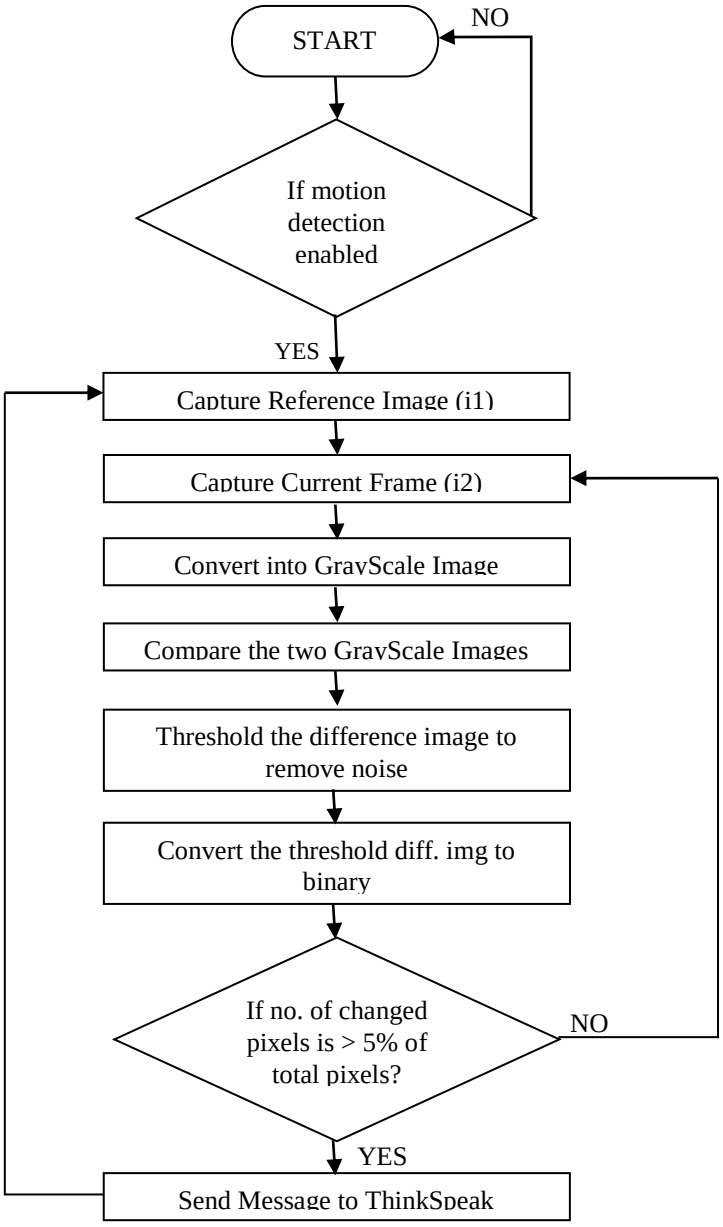


Figure 13:Flowchart for

IV. DESIGN AND IMPLEMENTATION

MATLAB & Simulink Hardware Support Packages for Raspberry Pi and Android allows us to run MATLAB functions and Simulink models on Raspberry Pi and phones running Android OS. We can also use the support packages for Apple iOS devices to generate code for iPhone and iPad. This paper focuses only on the android support package.

Raspberry Pi Support Package:

Once the support package is installed the hardware setup installs some software and files which makes the Raspbian OS compatible with MATLAB & Simulink. Once the hardware setup is successfully completed, we can access MATLAB functions and Simulink blocks from the Simulink library browser. There are MATLAB functions provided for the following interfaces:

- I2C, SPI, Serial, GPIO
- Camera Module and USB Webcam
- PWM and Servo motor control
- Linux System Shell

Some of the Simulink blocks used in the project are discussed below

1. Things Speak read and write
2. UDP send and receive
3. Audio read and write
4. GPIO read and write

(The first 3 blocks are also available in the Android Support Package)

Once the model is completed, Simulink wirelessly uploads the code on Raspberry Pi which runs runs as a standalone program.

Android Support Package:

This support package includes a library of Simulink blocks for accessing the device's sensors, capturing and playing audio and video, creating UI widgets and communicating with other devices through a network interface. Simulink creates and deploy the mobile application which can include touch screen widgets such as sliders, buttons etc. and can communicate with other hardware devices vis TCP/IP, UDP, BLE and ThingSpeak.

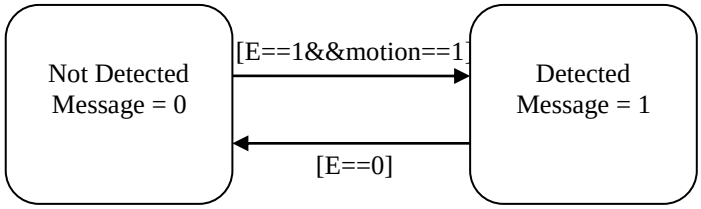
Raspberry Pi Model:

The **V4L2 video capture** block captures RGB image from the Camera supporting V4L2 driver which in this project is the Raspberry Pi Camera Module. The camera resolution is set to 640x480. The block has 3 outputs of dimension 640x480 corresponding to 3 components of an RGB image which is then fed to the **Matrix Concatenate block** and **Video Send** block. The matrix concatenate outputs a 3-D RGB image and the Video Send subsystem sends the image to a remote client which is the android model via UDP(User Datagram Protocol). The video is compressed to 160x120 before transmitting. The **MATLAB fnc block** helps to incorporate a MATLAB function into a Simulink model. Here the MATLAB function named detectMotion is created which outputs the message 1 if the motion is detected. The model also receives two values from ThingSpeak channel to control the camera angle mounted on the servo motor and to enable or disable the motion detection algorithm.

Algorithm

When the detect motion is enabled by the user, the Motion Detection Algorithm subsystem is enabled and the captureRefImage subsystem is disabled. The reference image is then fed to motion detection algorithm. The detectMotion function takes current images to compare it with the reference image. The images are converted into 2-dimensional grayscale image using the function **rgb2gray**. **Image differencing**technique is used to determine the change between two images. I1gray and I2gray are the grayscale image of I1 and I2. The absolute difference between I1gray and I2gray stored in diffgray gives the change in each pixel value of the consecutive image. Due to noise most of the pixels differs in their value. To reduce noise, thresholding is used. Only those pixels are considered whose value differs by more than 35. Logical indexing is used to find the values of pixels which are less than 35 and are replaced by zero.>>diffgray(diffgray < 35) = 0;

The difference grayscale image is converted into binary using **imbinarize** and stored in bindiffgray. In this image the changed pixel value after thresholding is set as 1 and others by 0. To further reduce the noise, sum of total changed pixel is calculated using **sum** function. If this this value is greater than 5% of the total pixels in the image, a message is sent to the ThingSpeak channel and the GPIO pin is set to 1.



The logic chart contain two states as shown in the figure. When a motion is detected i.e. motion=1,

The state changes from not detected to detected unless the detect motion is disabled by the user from the phone.

Android Model

The android model receives the RGB colour matrix separately via 3 UDP receive block and displays it on the android screen using Android Display block. The image is resized to 320x240 before displaying it on the screen.

The detectMotion android application is used to notify when a motion is detected. A buzzer is played on the android phone when the message received is equal to 1. It contains 3 buttons whose function is described as below:

1. DETECT MOTION: To enable or disable the motion detection algorithm.
2. OVERRIDE: To disable the buzzer sound.

The camera pan value and the record status value is sent via ThingSpeak channel to the raspberry pi. The android model

receives the message ,1 = motion detected, 0 = motion not detected. If the motion is detected, an audio is played on the android phone.

GUI Components
Brightness Level Control: Used to increase the brightness of the image.
Camera Pan: Used to change the orientation of the camera mounted on servo motor. Its value varies between -90 to +90.Record Button: On pressing the record button, the camera feed starts recording and the video is stored on raspberry pi.
OVERRIDE: To disable the buzzer sound.

V. CONCLUSIONS AND FUTURE SCOPE

Thus, we have successfully designed a smart, compact, cost effective surveillance system capable of streaming live video and transmit it over the internet. It can be viewed on any android device. We have given the user an option for enabling an disabling the motion detection whenever he needs. The user receives alerts in the form of buzzer on hi Android device which he can override whenever needed. The camera is mounted on a servo which can be rotated 180 degrees which increases the field of view. The angle can be adjusted on the Android phone as well.
This project can be upgraded for sending an email or SMS alerts when motion is detected. It can have the face detection algorithm for the user convenience as he can understand that the motion was done by someone familiar.

VI. APPLICATIONS

1. It can be used in hospitals for patient's surveillance
2. It can be used in any public transport to reduce the crime rate
3. In industries for machinery surveillance as well as theft protection
4. It can also be used on International borders for enemy intrusion
5. In home surveillance

VII. REFERENCES

[1] R.Rani, S.Lavanya, B.Poojitha(. 2018),"IoT BASED HOME SECURITY SYSTEM USING RASPBERRY PI WITH EMAIL AND VOICE ALERT".

[2] Shete, Ruturaj & Sabale, Mayuri. (2015),"VIDEO SURVEILLANCE USING RASPBERRY PI ARCHITECTURE".

[3] Shivprasad Tavagad, Shivani Bhosle, Ajit Prakash Singh, Deepak Kumar. (2016)," SURVEY PAPER ON SMART SURVEILLANCE SYSTEM".

[4] https://maker.pro/raspberry-pi/tutorial/how-to-connect-a-raspberry-pito-a-laptop-display

[5] https://www.instructables.com/id/Raspberry-Pi-as-low-cost-HDsurveillance-camera/

[6] https://randomnerdtutorials.com/video-streaming-with-raspberry-picamera/

[7] https://www.raspberrypi.org/forums/viewtopic.php?t=64480

[8] https://raspberrypi.stackexchange.com/questions/26912/rapberry-picamera-module-vs-usb-camera

[9] https://www.hackster.io/middleca/sending-photos-and-video-over-theinternet-db58