IMPLEMENTATION OF REGULATED SOLAR POWERED IoT BASED SECURITY SYSTEM USING RASPBERRY PI- 3 AND EMAIL ALERT

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ABSTRACT

The need for an effective up to date security system in homes, offices and schools in the face of recent insecurity challenges cannot be over stressed. The traditional security whereby a security personnel checks everyone that enters through a dedicated door could be tedious, time consuming and ineffective. With this method, most times visitors are meant to write their names, phone number and the name of personnel to be visited in a register. This system gives room for manipulation and over familiarity which often results to people bypassing the process thereby, bridging security measures. The present work provides a solar powered security system using raspberry pi-3. The system detects motion, captures images and sends the images to an assigned email address. This makes security information accessible to designated users anywhere in the world.

Keywords: *PIR sensor, python programming language, insecurity, alert system, Fresnel zone.*

INTRODUCTION

Nowadays, Insecurity is a rampant social vice around the globe with third world countries like Nigeria not excluded. In recent times, schools; secondary and higher institutions have received a big blow from the menace. Kidnapping, attacks and killings have been the associated consequence of insecurity in Nigeria [1][2]. These anti-social activities have often been carried out without being captured either in the form of video recording or image captures for any possibility of scrutiny or counter measures to avert future occurrences. In some cases where security measures are put up, irregular power supply has made such measures in effective [3]. This calls for a system that not only provides effective security measures but also do so 24 hours a day uninterrupted hence the need for this work.

An advocate for the use of effective modern technology to tackle insecurity cannot be over-emphasized [4]. Internet of things, IoT, which was first mentioned in 1995 [5] has proven to provide flexible leverage for which security counter measures against insecurity can be tackled head-on. IoT is a technology that provides a platform for 'everything' to interact physically using the internet. IoT provides a platform where sensors, software, electronics and interconnections for the purpose of information giving and sharing for the benefit of man [6]. IoT has received

tremendous attention from security stakeholders giving rise to a better understanding of human physical environment. The present work revolves around implementation of an IoT based security system that incorporates embedded systems. The central controlling unit is performed by the Raspberry pi3 from which other electronic devices are connected. The system incorporates hardware like the pi camera, PIR sensors, and buzzer.

The system works in a way that whenever an object moves within the Fresnel zone of the PIR sensor, an electrical signal at the output of the sensor is detected by the Raspberry pi 3 which consequently activates the camera for image captures. The captured image is then sent to the configured email address accessible anywhere in the world for as long as there is an internet connection.

The raspberry pi 3 is a mini computer whose size is as small as a credit card capable of carrying out from simple tasks to very complex tasks. The raspberry board features general purpose input/output pins, micro SD card slot, USB power port, audio jack etc. as illustrated in figure 1 below.

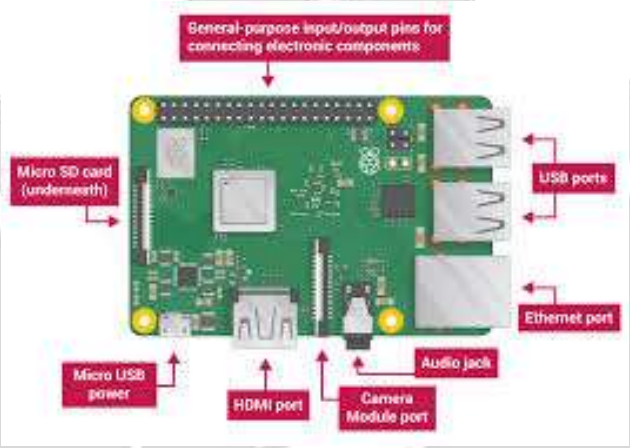

Fig-1. Components making up a typical Raspberry Pi3 board.

The components that make up the raspberry pi 3 are listed and summarized in table 1.

Table-1. Summary of raspberry pi 3 board.

S/N	FEATURES	SPECIFICATION
1	Processor	Broadcom BCM2837B0, cortex-A53 64bit SOC @ 1.4GHz
2	Memory	1Gb LPDDR2 SDRAM
3	Connectivity	2.4GHz and 5GHz IEEE 802.11bg/n/ac wireless LAN, Bluetooth 4.2, BLE Gigabit Ethernet over USB 2.0 (maximum throughput 300Mbp), 4 x USB 2.0 ports.
4	Access	Extended 40-pin GPIO header
5	Video and sound	1 x full size HDMI, MIPI DSI display port, MIPI CSI camera port, 4 pole stereo output and composite video port
6	Multimedia	H.264, MPEG-4 decode (1080p 30); H264 encode (1080p 30); open GL ES 1.1, 2.0 graphics.
7	SD Card support	Micro SD format for loading operating system and data storage
8	Input power	5V/2.5A DC via micro USB connector; 5V DC via GPIO header; power over Ethernet (PoE).

The passive infrared, PIR sensor works on the principle of infrared radiation with the notion that living things emit radiation with wavelength ranging between 0.7 µm and 300 µm. It senses infrared radiation and produces electrical signals [6][7]. The PIR sensor has three pins from which input and output terminals are connected. A 5VDC input is connected between the ground, GND and the VCC while the electrical output signal is obtained between the GND and the designated output terminal.

Fig.2. PIR Sensor

A number of researchers have worked on various security systems using recent technologies like the internet of things. Few of these works are summarized shortly.

[8][10], implemented a raspberry pi based smart surveillance system to prevent intrusion. The system sent both pictures and video to email of the user while [9] in addition to the use of pi -3, added ESP 8266 controller to his system as a means to providing more controls for remote usage. According to [11], security system using PIR sensor with a buzzer alerting system was implemented. The disadvantage of this system is that it cannot be effective in situations where users are far away from where the system is installed. In the case of [12], the developed security system stores the captured image and video to a FTP server using raspberry pi. The merit of this system is that large space could be available for storage. For [13], Arduino based security system that incorporated manual switches in the case the system fails to send an alert to the user was developed. This system still relies on human assistance to attain its full potentials. Many of these security systems were developed with the assumption that power supply is stable. Whereas in developing countries like Nigeria, a good consideration for continuous operation of security system is paramount and should be adequately incorporated during the design process.

METHODOLOGY

The raspberry pi 3 forms the central processing unit for the security system programmed using the python programming language. The board is powered from a 5V 2A DC power supply derived from the regulated solar power energy. The pi camera is connected through the camera slot of the raspberry pi 3. The PIR sensor, LEDs and the buzzer are connected through the GPIO pins. The inbuilt Wi-Fi module is programmed to connect to an access point for internet connectivity while simple mail transfer protocol is used to set up the raspberry pi 3 to compose and send image messages.

When the device is initially connected to the power supply, a red LED is powered on the system initializes to prepare and check all system units and connected devices. It looks for the SSID of the access point that matches the configured SSID on the SMTP as shown in figure 3. Once an internet connection is established, a beep and the blue LED are activated. The PIR senses motion, captures the image. A folder is to be created inside which daily captured images are created, grouped and saved in the assigned email. The solar energy is harvested by the solar panel. The power from the solar panel is connected to the charge controller which ensures that the battery is optimally charged. The output of the battery is sent to the DC-DC converter which produces a 5V 2A to drive the raspberry pi 3. The block diagram of the security system is shown in figure 4.

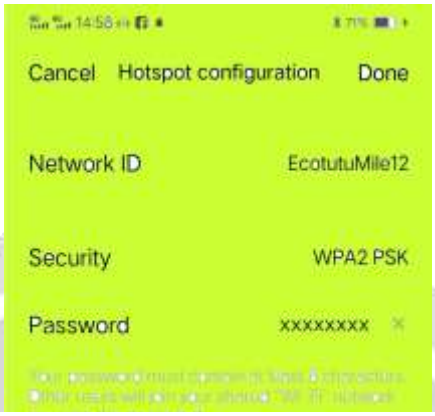

Fig.-3. SSID and password for access point to match raspberry pi 3 credentials

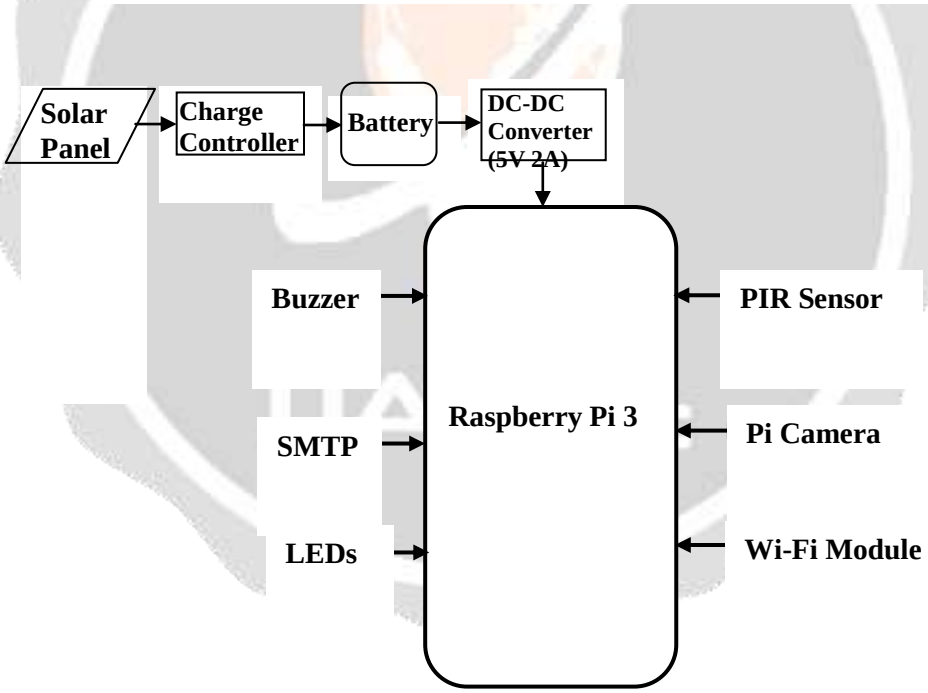

Fig. 4. Hardware Architecture of the security system

Fig-5a. Captured image sample 1

Fig- 5b: Captured image sample 2

Fig-5c: Captured image sample 3

RESULTS AND DISCUSSION

As as the system was powered on, the red light emitting diode, LED, was activated then the system initialized before connecting to the internet. A successful connection to the internet was indicated by the blue LED and a beep made. The system follows the procedure according to the flow chart in fig.6. The system detects motion and captures images which is sent to the assigned email. At first launch of the system, a folder is created in the mail. This forms the parent folder shown in fig. 7a inside which daily folders are created to hold all images captured on daily basis shown in fig. 7b,

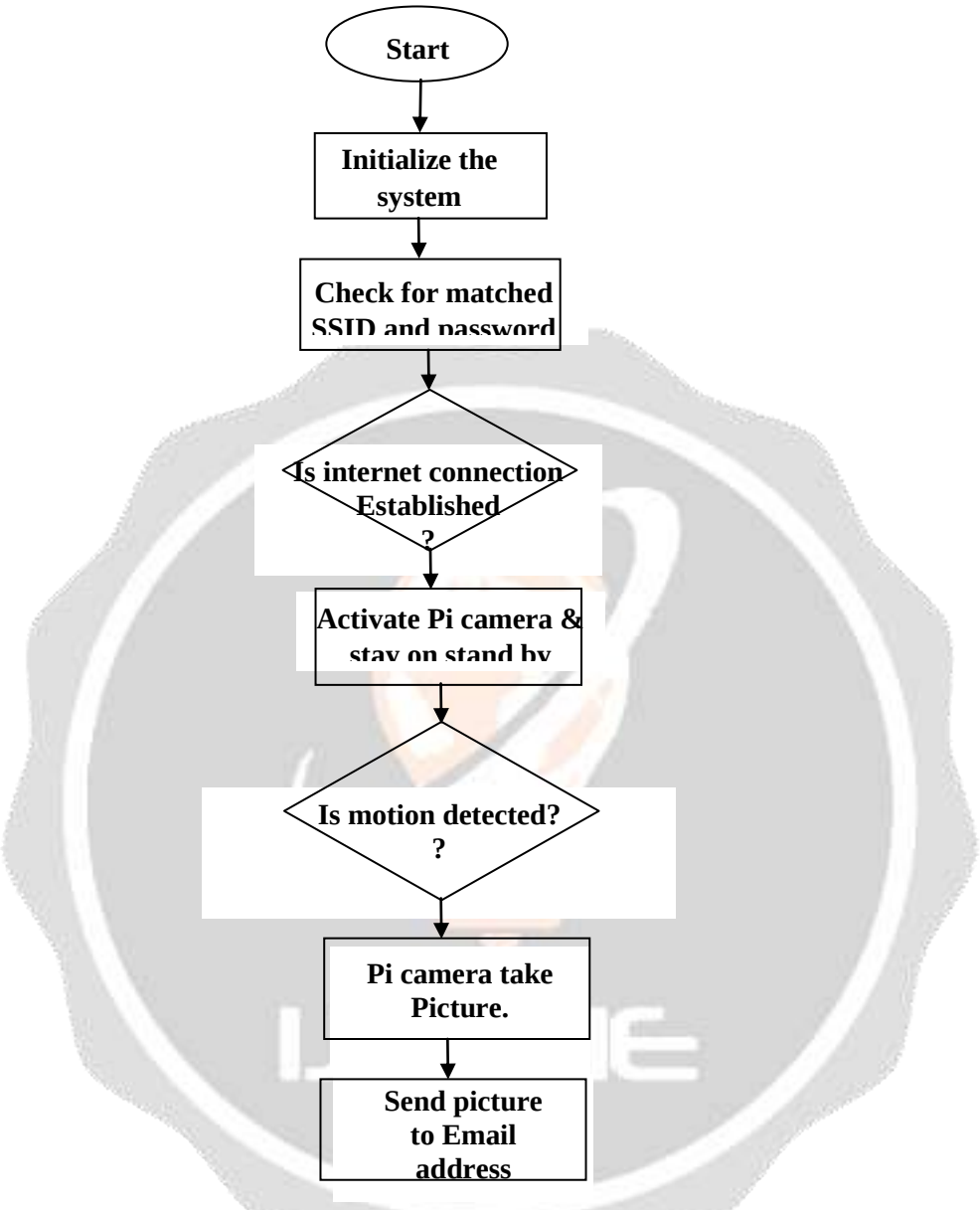

Fig.6. Flow chart for the security system.

Inside daily folders, each picture captured by the Pi camera is stored accordingly as shown in fig. 7c.

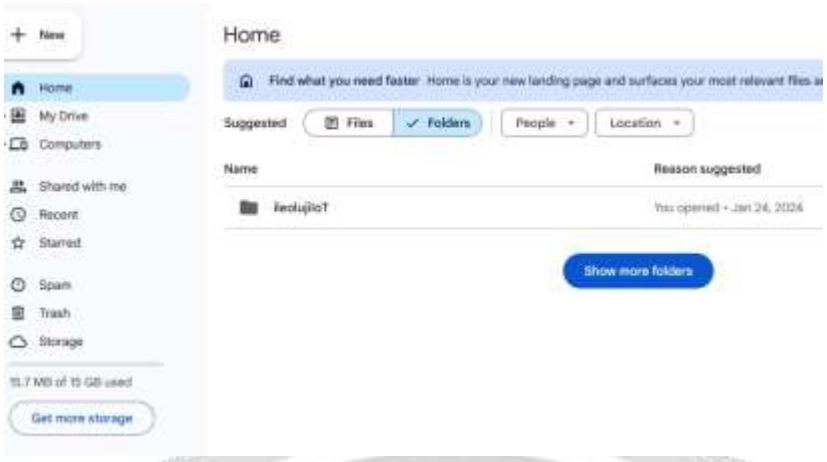

Fig-7a: Parent folder created on Google drive

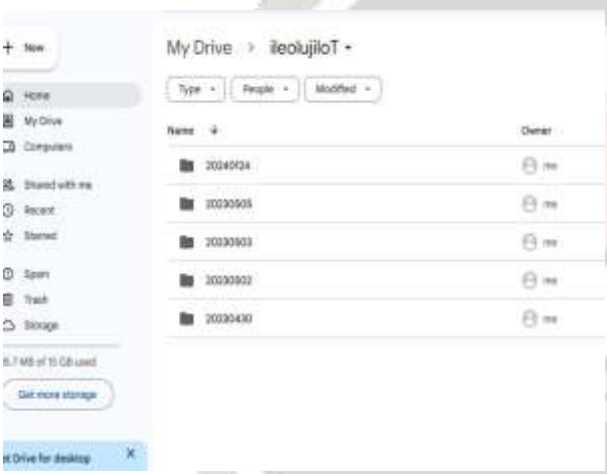

Fig-7b: Folders created for daily pictures captured by the Pi camera.

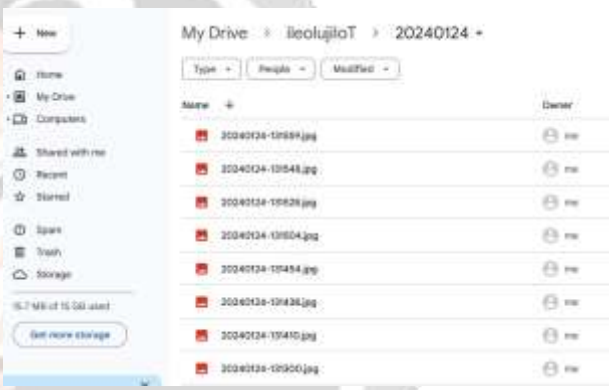

Fig-7c: Each pictures captured by the Pi camera.

CONCLUSION

The design which involved a solar powered security system based on Raspberry pi 3 works by detecting movement, taking picture and sending the captured image to an assigned email address. The performance of the system based on designed objectives was tested and the results were satisfactory, the design is recommended for use in homes, schools, offices and industries to enhance security system of where it is installed. This work however, is meant to be used for the benefit of Federal Polytechnic, Ile – Oluji, Ondo State, Nigeria in ways that promote technology use in the fight against insecurity in Nigeria.

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