INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

A novel approach to design smart home architecture in energy efficient way based on IoT

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ABSTRACT

PIR motion sensor and camera is used in this project. Whenever an intruder enters the house the PIR motion sensor detects the motion and which turns on the camera and thus image is captured here the camera is not 24*7 on it turns on only when motion is detected thus by saving the battery of camera also at one time only one sensor is activated not all sensor which also increases the battery life of sensors.

Keywords: *PIR, Webcam, RPi*

1. INTRODUCTION

Due to the change in the scope of applications of internet shifting towards making "Physical World Smarter", there is no doubt that people will witness a shift in the number of connected devices soon. It is estimated that in the next five years fifty billion devices will be online. Wireless networks are the most important for the success of the IoT infrastructure. Sensors should be able to communicate without the constraint of physical wiring thus making them more independent. The things on the internet should exhibit power efficiency apart from excellence.

The sensors are expected to be active only when necessary that is to read, send data or to make a decision and be lying dormant for the remaining time thus implementing power efficiency. Atmel, Texas Instruments, Free scale, STMicroelectronics are offering such microcontrollers that make application building very fast. An important factor that affects IOT infrastructure is the architecture While 32bit cores, low-cost microcontrollers have the advantage of being more compatible with a large number of open-source software still they have high power consumption. Many companies are working towards the manufacturing of microcontrollers exhibiting inherent energy efficiency which will help in the overall architecture of IOT in the bigger picture. In this model, we are using PIR motion sensors. PIR sensors detect humans being moving around 10 m from the sensor. Here we are using PIR sensors because they are flat control And minimal effort, have wide lens range and are simple to interface with.

2. DATA COLLECTION

PIR motion Sensors are used to collect data. Data is collected in form of photos. PIR sensors are used to detect motion. This detected motion is taken as input and the Camera turns on. As the camera is turned on the image is captured and stored in the buffer. Data is collected in raw form. Data is collected by Sensors and Camera, which are interlinked with each other.

The system starts due to the data collected by PIR motion sensors. The PIR sensors detect motion in a range of 10m. Hence any human presence in a range of 10m can be detected by these sensors. Slightest motion in a range of 10 m can be detected by PIR which is the building block for the system. Now, this data collected by sensors is taken as input to the next part of the system which is the camera.

The camera is the second part of the system which is the user interface. The PIR data as given above is beneficially used to operate the camera. The operation here means that the data collected by the PIR sensor i.e. motion is used to effectively switch on and off the camera. Whenever human presence is detected by sensors the data is passed on to the camera and it eventually turns on the camera.

Humans are the final beneficiary of the camera. Images are taken by a camera with the help of data from sensors. The data for humans is in the form of the images taken by the camera. The data can be used for analysis purposes.

3. WORKFLOW

Raspberry Pi 3B model is used for this project. The R pi consumes 5V and 2 Amp of power to operate in any case. The jumper wires available in three configurations viz. male-female, female-female, and male-male are essential in order to connect the sensors to the raspberry pi. For convenience, breadboard can be used as a middleware between raspberry pi pins and PIR sensors. Turbochargers are used for R pi. The PIR sensors which are used consume 5 mA to 20mA for operation.

As and when Raspberry Pi has the necessary connections which include the sensors and the camera connected to it the

power button is switched on. The PIR sensors detect the motion in their vicinity of 10m and as coded in raspberry pi the camera is switched on. There are many sensors connected to the raspberry pi and each sensor goes into sleep after the specific time as specified in the code. The time of inactivity need not be same for each sensor, it may differ. The sensors are very easy to integrate into the system it does not take much effort to add the number of sensors. The output of the sensor is motion detection and this output is given as an input to the camera. The camera clicks the pictures as soon as the motion is detected by the sensors. The images are stored in the buffer. These images are made available to the consumer with the help of a web application which is completely secure due to login functionality. Thus allowing easy access to the security only to the desired ones.

4. SYSTEM ARCHITECTURE

The system architecture comprises five basic components: 1. PIR motion sensors 2. Raspberry Pi 3B 3. USB Web camera 4. Jumper wires 5. Display unit.

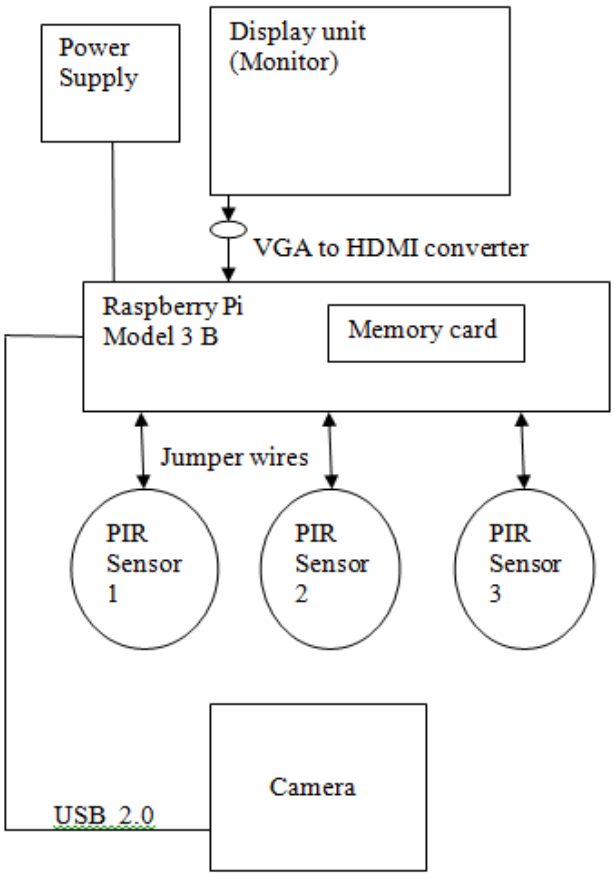

Fig. 1: System architecture

Display unit: Display unit used in the system is a monitor which is used to display the information in pictorial form. The monitor is connected to Raspberry Pi through VGA to HDMI cable. This cable is used as an interface between Raspberry Pi and monitor. The images captured by the camera can be viewed on a monitor.

Power supply: A Turbocharger is used to power on the Raspberry Pi and the charger is connected to a DC Power supply.

Raspberry Pi 3 B: Raspberry Pi is a credit card sized computer. Raspberry Pi 3 model B 1.4GHz 64-bit quad core processor dual-band wireless LAN Bluetooth 4.2/BLE, faster Ethernet and power over Ethernet support. Raspberry Pi is a series of small single board computers developed in the United Kingdom by Raspberry Pi foundation to promote the teaching of basic computer science in schools and developing countries. All models feature Broadcom system on chip (SOC). Processor speed ranges from 700 MHz to 1.4Ghxz for Pi3, onboard memory ranges from 256mb to 1GB ram. The board has 4 USB ports. For video output, HDMI and composite video are supported with a standard 3.5mm phono jack for audio output, the lower level output is provided by a number of GPIO pins which support common protocols like I2C. The B models have an 8P8C Ethernet port and the Pi3 has onboard Wi-Fi 802.11n and Bluetooth

Memory Card: For installation of the image installation of Raspbian, the minimum recommended card size is 8GB. For Raspbian Lite image installations a minimum of 4GB is recommended. Raspberry Pi Model B require full-size SD cards.

PIR (Pyroelectric Infrared Sensors): These sensors allow you to sense motion. A PIR-based motion detector is used to sense movement of people, animals, or other objects. They are commonly used in burglar alarms and automatically-activated lighting systems. Infrared radiation enters through the front of the sensor, known as the 'sensor face'. At the core of a PIR sensor is a solid state sensor or set of sensors, made from pyroelectric materials—materials which generate energy when exposed to heat. Typically, the sensors are approximately 1/4 inch square (40 mm^2) and take the form of a thin film. Materials commonly used in PIR sensors include gallium nitride (GaN), caesium nitrate ($CsNO_3$), polyvinyl fluorides derivatives of phenylpyridine, and cobalt phthalocyanine. The sensor is often manufactured as part of an integrated circuit. An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again.

Jumper wires: A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire or group of them in a cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of the breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. There are different types of jumper wires. Some have the same type of electrical connector at both ends, while others have different connectors. Each cable length about 20cm or 8-inch. The male ends meant for insertion into standard 0.1 inches (2.54mm) female sockets and the female ends are meant for insertion onto standard 0.1 inches (2.54mm) male headers. The cables can be separated to form an assembly containing the number of wires you require for your connection and to support non-standard odd-spaced headers.

Camera: A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and emailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which

connects using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops. Webcams are known for their low manufacturing cost and their high flexibility. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated by spyware. Webcams may be installed at places such as childcare centers, offices, shops and private areas to monitor security and general activity. Webcams have been used for augmented reality experiences online. One such function has the webcam act as a "magic mirror" to allow an online shopper to view a virtual item on themselves. Webcams can be used as security cameras. The software is available to allow PC-connected cameras to watch for movement and sound, recording both when they are detected. These recordings can then be saved to the computer, e-mailed, or uploaded to the Internet.

In this project, we have used a Webcam which is interpolated to 25 Megapixels, 10 level zoom, Night vision, inbuilt sensitive microphone with USB 2.0.

5. RESULT

The system that is invented here is very well serving its purpose of creation for energy efficiency.

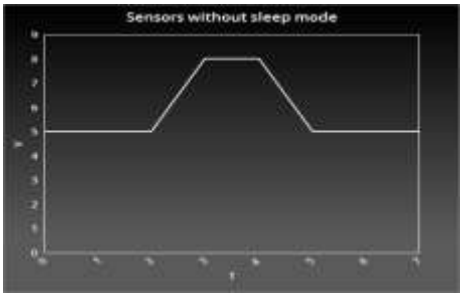

Fig. 2: Sensors without sleep mode
(T = time, V = voltage)

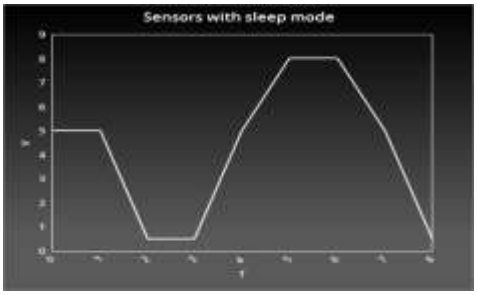

Fig. 3: Sensors with Sleep mode
(T = time, V = voltage)

The comparison between voltages required when sensors are not in sleep mode when in sleep mode and during normal activity period is shown in the above graphs in fig.2 and fig. 3.

Table 1: Voltage Study

Sr. No	Sensor Voltage	Sleep Mode (Yes/No)
1	5V	No
2	5V	No
3	8V	No
4	8V	No
5	0.5V	Yes
6	0.5V	Yes
7	5V	No

Raspberry Pi 3B requires a 5V supplies. The PIR motion sensor requires a 5V-12V supply when any motion is not detected. When any motion is detected it requires 3V. The above table describes the voltage requirement along with the power efficiency which we get because of the sleep mode. For the sensor to work it needs 5V as given in serial no 1 and 2 of the above table. Now referring to serial no. 3 and 4, we need additional 3V as motion has been detected and the sensor is not in sleep mode. Further moving towards serial no. 5 and 6, we can see the drastic drop in voltage required for sensors which fall from 8V directly to 0.5V which is a huge example of saving power consumption.

As per the calculated results, from the analysis done on the implemented system, the amount of energy consumed by each sensor is 5V, and it is the constant voltage supply needed for the sensor to be in the normal state. So, by the calculations done on the power consumed by the sensors and the amount of cost required by each sensor is also a very less amount. For 5V of power required by a sensor, it costs about 0.001*80 = 0.08 Rs. Of cost per hr. Thus, a sensor costs Rs. 1.92 of the amount per day, thus Rs. 57.6 a month. So, by consuming less power, the cost is also reduced.

The invented system, the connections to the Raspberry Pi acting as the CPU (an interface between the hardware and the software) and the sensors detecting the motions thus making camera capturing the required images only are shown in the below figures.

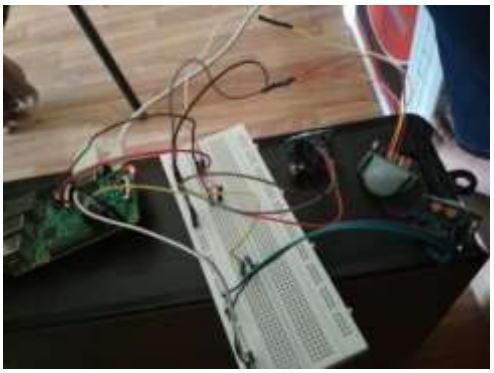

Fig. 4: Prototype of the System

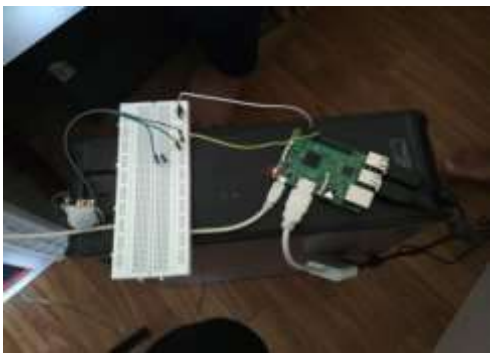

Fig. 5: Connections between Raspberry Pi, breadboard and PIR sensors

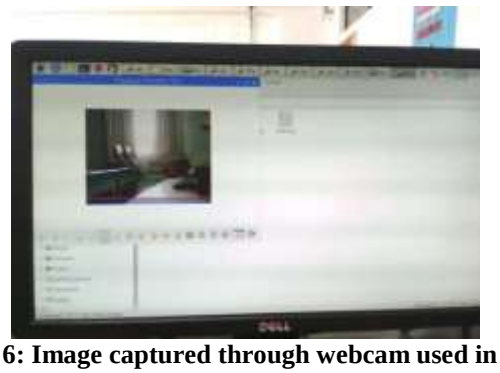

Fig. 6: Image captured through webcam used in the system

Thus, from the above figures it is very well understood that the connections between the hardware, where the Raspberry Pi acting as the interface linking the software and the hardware, causes the PIR motion sensors to sense the movement ahead, thus activating the camera at the same time to capture only the required images at that time only.

6. ACKNOWLEDGMENT

We take this opportunity to express our heartfelt gratitude to our guide, Prof. Parth Sagar, Department of Computer Engineering, for his kind cooperation and capable guidance during the project work, without which it would have been difficult to proceed with. We are also thankful to Prof. Vina Lomte, Head of Department, for her constant encouragement and suggestions. We would also like to acknowledge the authors of the base paper as well as references for their work and inspiration.

7. CONCLUSION

The proposed system is to provide a smart and intelligent energy and security management system. Also, to minimize the power consumption and maximizes utilization of resource by smart real-time tracking. The security mechanism is greatly achieved through the sensors as well as the camera. The sensors for detecting human motions and the camera for capturing the images whenever the sensors detect a motion. So, a great amount of energy is saved as the camera is turned off for most of the time and only turns on while capturing the movement in front.

The main focus of this project is also on saving a large amount of memory required for recording images or videos. Thus, the memory required to save only a bit of required images, captured through some movement will be very less compared to the normal working cameras in real time. So, memory wastage is reduced greatly here. Even the time needed to sort, a huge amount of databases stored in the camera, during an incident would be saved in much greater amount as sorting would be done only in the fewer amount of time. As the camera is not turned on for 24*7, power consumption is also reduced compared to normal working cameras in real time. Security is controlled by the sensors as well as the camera here. In future, the webcam can be replaced with the CCTV so the whole system can be easily implemented outside or within the banks, offices as well as in the home.

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