IoT Based Occupancy Monitoring and Advance Security System with Intruder Image Capture

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ABSTRACT

In the recent engineering advances the convergence of internet, communication and information technologies will pave the way for new generation. Smart buildings have been equipped with different electronic devices on the basis of Internet of Things (IoT), therefore they are becoming smarter than before. This article surveys the work on occupancy monitoring, energy saving system and security requirements through IoT which is an essential part of smart building. Moreover, we analyze the main parameters that should be considered to be included in any building energy management. This proposed occupancy monitoring develops effective data fusion techniques for improving occupancy monitoring accuracy using multitude of sources. To demonstrate the feasibility and effectiveness of this system, devices such as IR sensors and camera can be integrated with the smart building system.

KEYWORDS: *Internet Of Things, Raspberry Pi, Smart Buildings, Energy Efficiency*

I. INTRODUCTION

Buildings used for both commercial and residential purpose will consume more amount of energy. In some developed countries almost 40% of energy consumption is due to buildings. In order to reduce the amount of energy consumption smart buildings were introduced. Smart building means by using some sensors, camera and data fusion technique occupancy monitoring, energy efficiency will be provided and it will be displayed on the mobile or laptop screen through Internet of Things (IoT).The IoT can be defined as connecting everyday objects like smart-phones, TVs, sensors and computers to the internet where the devices are smartly linked together generating new forms of communication between things and people. By using IOT, we can have real-time access to occupancy counts in different zones of the building. Human interaction is not necessary because the devices are interacting with the machines. Raspberry pi contains ARM processor, the processor interacts with the IOT module. In addition to energy issues, security can also be provided through camera by using multi modal data fusion technique. In this paper we will study of IOT technology that are widely used and enterprise buildings to become intelligent."Internet of Things" describes as a number of technologies and research that enable the internet to reach out into a real world of physical objects. IoT accelerates the sensor advancements, application development, cloud based software infrastructure and wireless connectivity. Why we are using this technology means it can dynamically controls the industry and daily life, the resource utilization ratio will be improved and forming an intellectual entity by combining human society and physical systems.

One example for IoT is smart buildings. It aims to provide that they are energy efficient, environment friendly, easy and comfortable.

Therefore, any solution that can increase the comfort level and provides the mentioned services can be incorporated into smart buildings. We can say that it is a system that allows for the buildings to have a brain so that they can handle human as well as natural disasters properly and maintains the energy expenditure hence it reduces the green house gas emission.

Smart system controls the building functions as heating, ventilation and air conditioning, security and lighting have historically operated as standalone entities. This isolation is beginning to give way to a more effective environment. Building managers finds motivation in several factors for example they view a more integrated approach a way to save energy costs. The smart devices are more efficient and intelligent in how they share the data with building automation systems and the cloud. The cloud provides administrative user interface and the data analytics function. The next section discusses why high security application system is a problem worth solving and the last section explains the power considerations during testing process which plays a key role in deciding the IoT based smart building.

II. Related Work

In many public speeches and in auditoriums one need to continuously watch and control the people entering into that auditorium and the power is wasted when there is no person in the room. To avoid these problem smart buildings were implemented using lpc2148 but the security will not be provided. To overcome this problem our project is implemented with advanced technology. This Paper deals with the design and implementation of building monitoring system using Raspberry pi energy efficiency in building and image capture. For the occupancy collection of data, two IR sensors are used for the detection of existence of the persons entering and to reduce the count at the exit. The sensor is IR pair, Infra Red made of LED and A Photo Transistor. This enhances the occupancy data in the buildings, leading to **the smart** buildings. This data will be displayed on the Phone as well the computer using IOT module. Here **Raspberry pi** acts as heart of our project. The occupancy will be displayed on the LCD interfaced to the controller. The IOT module is interfaced to the controller to send the information of occupancy to the concern person or the authorities of the smart buildings. This project output can be checked at the Android mobile Phone or in the computer. Here we also have a security camera. This can be placed where every second monitoring is necessary. A PIR sensor is placed which can detect human and our controller will capture the image and forwards this to official E-mail. The programming language used in this project is python.

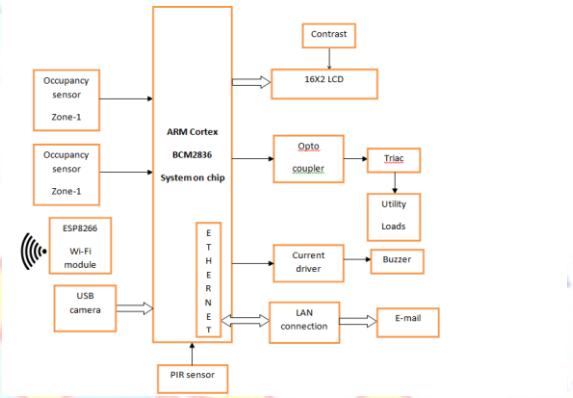

Fig 1: Block Diagram of Energy efficient smart buildings

The project presents a low cost and flexible smart building control and monitoring system using an embedded microprocessor with an IP connectivity for accessing and controlling devices and appliances remotely without using any aneroid application. The proposed system does not require any dedicated server PC with respect to similar systems and it offers a novel communication protocol to monitor and control the building environment with more than just the switching functionality. To demonstrate the performance and effectiveness of this system, devices such as light switches, power plug, camera, IR sensors can be integrated with the smart building system. Building automation or Smart buildings can be described as introduction of technology within the office environment to provide convenience, security and energy efficiency to its occupants. Adding intelligence to building environment can provide increased quality of life and security will be provided. With the introduction of the Internet of Things (IoT), the research and implementation of smart buildings are getting

more popular. Everyday, the Internet of Things helps people, cities, industries and businesses take advantage from data and get improved services, increase their daily experience and live in more sustainable environment popular.

This project will focus on smart phone or a computer enabled systems for the smart building with focus on some of the Raspberry Pi board applications. Although many systems have been researched and proposed, like smart buildings, home automation very few of them have been implemented. This project aims to build on the previous research described to implement energy efficient security system to monitor the occupancy and control the loads within the building. These loads will be controlled via a smart phone running Android OS or a computer. This approach provides an easy to operate, simple and cost effective approach that will benefit to users.

RASPBERRY PI ENABLED SMART BUILDING DEVICES:

A. Raspberry Pi

The microprocessor will interface with the android module to perform the occupancy monitoring and other applications in smart buildings. A simple microprocessor which is ARM will receive signals from the smart phone or a computer and it will be processed. No need to develop any software application to interface raspberry pi with mobile device. A webpage will be created to monitor the occupancy on mobile devices that communicates between pi and devices easily. Integrating the Sensors to a Device: The Raspberry Pi needs to be integrated with the IR sensors and webcam control systems at a low cost with simple installation. After extensive research into the products and some solutions currently available, the following components were chosen to meet our application specific requirements.

Fig 2: Raspberry Pi board

Raspberry Pi is very small sized single board computer developed by Raspberry Pi Foundation. It has a BCM 2836 Broadcom system on chip. The Raspberry Pi board involves an ARM1176JZFS 700 MHz processor and was originally it is made with 256 megabytes of RAM, later upgraded to 512 MB. Some few interfaces and connectors are used to connect external devices. Here we are using a camera connector, Ethernet slot for LAN connection and some ports. There will be two or our USB connectors depending on the board model. It works just like an ordinary pc but requires a keyboard for command entry and a monitor to display. It does not include a built-in hard disk hence an SD card is used for booting and long-term storage.

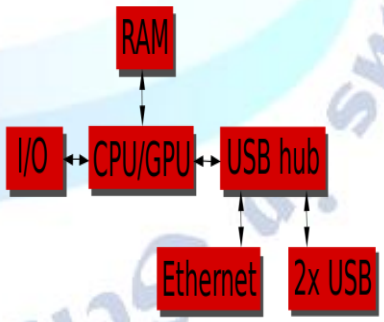

Fig 3: Basic Hardware of Raspberry Pi

The operating system used in Raspberry pi is Linux because the RAM storage is limited to512MB. In raspberry pi, windows or any other operating system cannot be installed within the memory space.Windows operating system occupies more space compared with Linix.

B. IR sensor

IR reflectance sensor contains a pair of matched infrared transmitter and infrared receiver. These devices work by measuring the amount of light reflects into the receiver, because the receiver only responds to ambient light, the device works better when it is well shielded from ambient light and when the distance between the sensor and reflective surface is very small. IR reflectance sensors are often used to detect both white and black surfaces. White surfaces generally reflects well, but black surfaces reflects very poorly. One of such applications is the line follower of a robot.

C. Camera surveillance

A camera that streams the image in real time through a system to computer network. When image is captured by the camera the picture will be saved in the SD card and that can be viewed or sent to other networks via systems such as the internet and email as an attachment. If the internet connection is not available the image can be seen on the monitor which is connected to the Raspberry pi board and later it can be seen in the SD card.

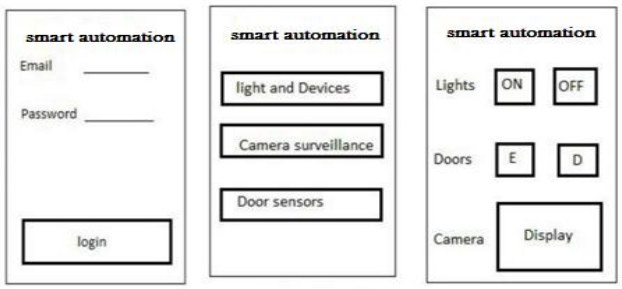

Fig 4: Block diagram for building automation

Web camera is connected to a place which is to be monitored. Image detection process is applied to find out the motion in a particular room. The web camera is kept for this process. Once the person entering door, he will be switching on the web camera device for image capture. This image can be seen in the system which is connected with Raspberry pi board or an email can be sent to the appropriate email address through internet.

D. HTTP (HYPER TEXT TRANSFER PROTOCOL)

The WEB Internet or a WEB is a massive distributed client/server information system which is shown in the below figure. Many applications are running concurrently in the Web, such as web browsing or surfing, e-mail, file transfer, audio & video streaming, monitoring and so on. Here we are using it to see the occupancy monitoring in your mobile or laptop. When you request a web page by typing its address in your web browser the request is sent using HTTP. The browser is an HTTP client, and the web page server is an HTTP server.

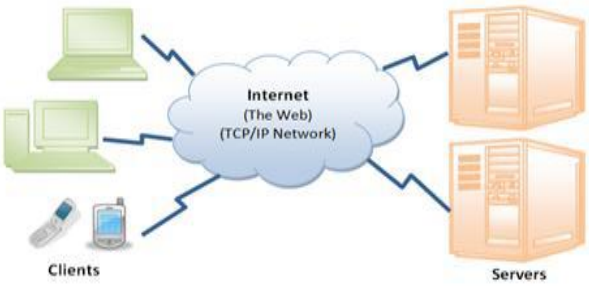

Fig 5: HTTP protocol

III. IMPLEMENTATION

A. INTERFACE:

Once the template was produced, it was time to integrate all the development work to make a complete interface with the components. The python code manages the list of controls and that will be displayed to the user. The software package provide various views to control different aspects of the controls, such as how they are managed or controlled and how they appear on specific client software. Initially we have to install Raspberry pi operating system in the SD card. After the connections, at the login page give login id and password. Check the network connections like internet, Ethernet cable and capture the image through intruder image capture. A GPIO interfacing is also very important, GPIO provides physical interface between the Raspberry pi board and outside world. There are twenty six GPIO pins in pi board and they can be used as switches. We connect the pi board to the loads through this interface. The methodology will be shown with the help of a flow chart.

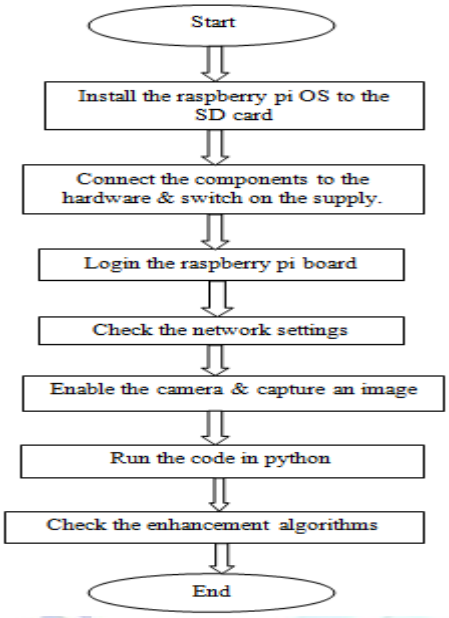

Fig 6: Flow chart of methodology

The proposed method uses the Raspberry pi board as a main controller. To interface camera module, it is attached to the pi board, then starts booting up the board and login page will be opened .Some commands has to be given to install Python. Enable the camera settings on the board in the computer to capture the image and save it on the new folder. Run the python code to check the algorithms and remove the noise present in an image.

B. SOFTWARE:

The flow chart methodology will help to describe the flow of the code. The server and client application is written using Python code as the interface for Raspberry Pi to connect to lights and sensors. The SD card formatter, putty software and Fedora ARM installer are the software's used in this project. The software produced utilizes both the built in functions as well as user defined methods depending on the application. The raspberry pi doesn't contain any inbuilt clock. As for requirement a program running on the Raspberry pi can get the time from the network server or by giving user input at the booting time then only the time will power on or else a real time hardware clock with battery backup may be added.

C. HARDWARE:

The next step was the integration of the electronic components into Raspberry Pi which are required for our application and setting it up for remote access. A monitor and keyboard should be connected to pi board externally because it doesn't have any inbuilt display. They are connected through cables. When the power is ON system will automatically boot the Raspberry Pi. The integrated hardware with software for client side in android is shown in the figure. The microprocessor in the Raspberry pi kit will sends the information either it may be occupancy monitoring or image to the mobile through the internet.

Here we use a D-Link router that has an ISP connection to provide internet. The connection to the D-link is a local area network connection and it provides a Wi-Fi connection to share the internet to different users. The hardware interaction from computer to Raspberry pi takes place through Wi-Fi wherein all devices are connected to the RPi through Ethernet. The Camera, door sensors and lighting devices are controlled by the pi board.

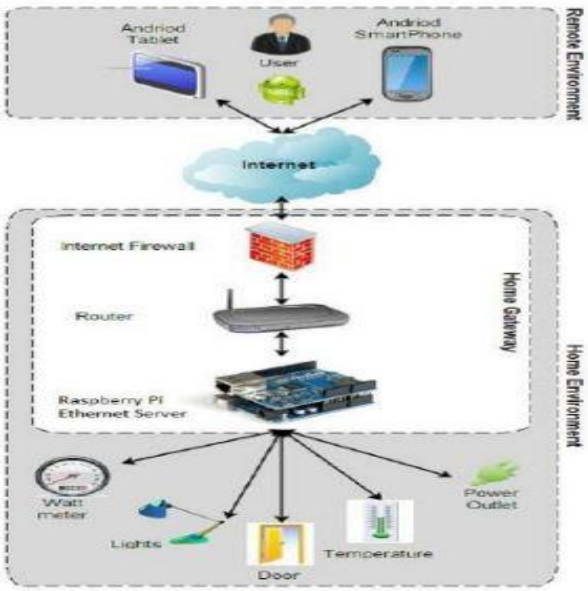

Fig7: Hardware block diagram

IV. RESULT AND COMPARATIVE ANALYSIS

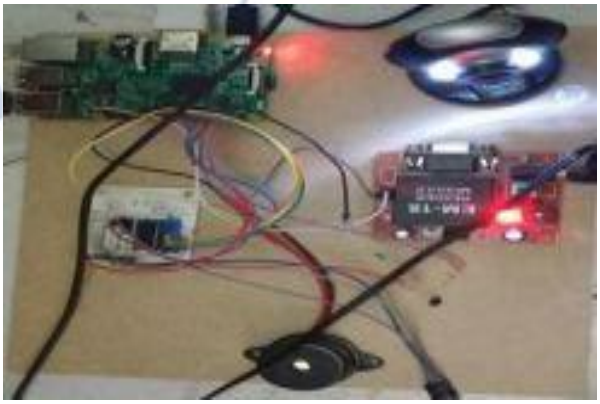

Fig8: Hardware implementation

The existing occupancy monitoring approaches in terms of used infrastructure and the techniques applied. A combination of Wi-Fi, internet, sensors, camera and other resources at the same time is implemented correctly. The analysis of this circuit helps us to determine the future trends smart buildings. With the development of Internet of Things technology there will be a great potential to increase their communications in occupancy monitoring.

We analyzed the total energy consumption of the building and compared it with energy consumption only related with the HVAC system. By this way impact of thermal comfort on the total energy consumption of this building could be estimated. By taking this into account the distribution of individual HVAC appliances in the building as well as the monitoring data about what individual appliances have in operation at each time, we can get the general picture of the minimal occupancy level how many people are in the building at specific hour. Using these data we analyze the impact of both parameters on the total energy consumption relates with thermal comfort in the context of a University building.

V. Future Work

Although the final products is very successful at accomplishing the objectives, it must be kept in mind that they are simple prototypes and more work would need to be done to create a marketable product. Several areas still has to be improved such as size of the devices, the cost of the devices, the power sources used and the range of communication. Currently, the Raspberry device is too large to fit easily into a pre-existing wall switch electrical box. There are several ways this can be improved in future work. The use of surface mount components would dramatically decrease the overall size of the components and also these components are also often less expensive as they require less material to produce. This will helps to reduce the overall cost of the devices as well as the size.

VI. Conclusion

The occupancy monitoring in energy efficient smart buildings with security system using Internet of Things has been presented in this paper. The proposed method was successfully designed, a system that communicates with a mobile device such as a smart phone or laptop via Raspberry Pi to get the information about occupancy monitoring through door sensors and a camera to stream live image and sent as e-mail. Our research shows many types of applications for implementing smart buildings and the applications are not limited to those discussed in this paper. This would help reduce the overall cost of the devices as well as the size. But still the size of the circuit has to be reduced. Currently for the prototype, a generic breadboard style board was used.

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