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IoT Based Smart Room For Power Consumption Monitoring And Control

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***Abstract*—** In this paper, a design is proposed for the automation of lights, temperature etc. using IR, PIR sensor etc. and Arduino with Internet of Things for smart rooms. The proposed work uses IR sensors to detect persons entering the room and switch the lights and other appliances on if there are any occupants in the room. The temperature sensor would be used to read the temperature of the room. The ESP8266 NodeMCU microcontroller Wi-Fi module will be the 'heart' of the system to connect all the materials for developing the system. The power consumed by the devices and the appliances will also be calculated and stored using the PLX-DAQ software which extracts the data stored in the memory of the module and stores it in an Excel sheet.

***Keywords*—** IoT, smart room, power consumption monitoring, Android.

I. INTRODUCTION

This is an Internet of Things (IoT) based project work where we developed a Smart Room in which various parameters like temperature, lighting system, etc. can be analyzed and monitored.

Nowadays we're having automation of every little electrical devices in our homes. Internet of Things is the concept of basically connecting any device with an on and off switch to the internet. IOT is more than smart homes and connected appliances; however, it scales up to include smart cities with connected sensors. In this paper, a design is proposed using IR, PIR, LM35 sensors and the ESP8266 microcontroller for automation of lights, reading the room temperature and accordingly appliances can be ON or OFF through the android application built for this system; using Arduino with Internet of Things. Using IR sensor to detect person entering the room to keep count of people entering and switch the lights and other appliances on if there are any occupants in the room. Temperature sensor read the temperature of the room and using ESP8266 NodeMCU microcontroller Wi-Fi module to connect all the materials for developing the system.

Using this system the users can keep track of power consumption of the electrical appliances as the power consumed by each appliance is calculated by the system and can be displayed on an excel sheet or printed out by the users. This system helps in reducing the power consumed as the lights and others appliances will be ON only when a particular room is utilized. For owners and operators of small to large-sized houses, the cost of adding smart-room technologies requires huge investment, making it prohibitively expensive for many. As a result, most small-medium houses owners and operators do not have automated access to data in their houses, thus making it very difficult to realize energy savings, lower maintenance costs, and improve overall house performance. A lower cost alternative is to instrument a house using Internet of Things (IoT) technologies, including low-cost sensors, on-premises gateways, distributed control, and cloud analysis. Instrumentation involves installing an independent collection of sensors (e.g., light, temperature) throughout the house to collect more information on the house's operation, such as utility usage.

Some potential advantage of owning or working in a smart room include:

Self-monitoring: - Smart rooms are designed to constantly gather data and monitor themselves for problems in the structure's facilities. Smart rooms can also monitor system performance to increase energy savings.

Comfort factor: - Smart rooms are set to adapt to the way people live. They have control of heating, lighting, learning the schedules of those who operate these systems in order to optimize comfort.

Section II deals with discussion about the related work, section III methodology of the work proposed work and section IV contains various results obtained from the proposed work.

II. RELATED WORK

Smart Rooms are being implemented by many companies in different houses. This system helps to track the power consumed by that particular house with the help of sensors, and the lighting system with the help of IR sensors, temperature monitoring with the help of the temperature sensor. The services provided by companies in home automation/smart home are expensive, for example, a company known as HomeAdvisor in the USA charge up to an average of $1,045 for the installation, and the monthly maintenance cost is also very expensive. And also doesn't visually show the power that their home appliances have consumed for a period of time. Most IoT projects don't include the power calculation module, like the Home Automation Using Internet of Things in Vinay sagar of MSRIT, Bangalore, India and IOT Based Home Automation Using Arduino by G.Mahalakshmi, M.Vigneshwaran is mostly concentrated on automation but not in calculating power consumed and power consumption efficiency. The data that is uploaded to the server is not been stored; As the definition of I.o.T states that the data that is generated should be stored on the cloud and it should be shared by another device. So, a work must be done on it to store the data that is generated by the sensors. The data that is generated can be viewed from any device which is connected to the same cloud server and retrieve the data from cloud to analyze it and to control the lights etc.; by using a smartphone.

III. METHODOLOGY

The outline of the suggested block diagram is indicated done in the figure: 1. those infrared sensors (IR) are low expense analyst sensors that detects a person's entering a room. The PIR sensors will be utilized to identify human body vicinity in less used part of the room so that lights at that part of the room will not be on continuously (it will only be on when it senses movement in its sensing range), which result in a decrease in wastage of electrical power. The temperature sensor will sense the temperature of the room. The IR sensors what's more PIR sensor etc, need aid associated with the ESP8266 NodeMCU. By utilizing a versatile app which will be made What's more controlled towards a web server, the lights and also fans and other appliances might be controlled.

Raspberry Pi can also be used for developing an application but the problem is an operating system have been loaded and when we compare the coding part of raspberry pi with the coding part of Arduino, complexity in raspberry pi is more. The user can easily program his Arduino and can use it based on his requirement. The block diagram that is given above will make it simple to understand the basic concepts that are used in the paper to develop a reliable Smart Room automation system.

In this project with the help of those components and the concepts that is being planned counting of persons is done by IR sensors which are kept in the sides doors i.e one inside and one outside the door when the person is coming to enter the 1st sensor will sense and then the second so we count the no. of persons by incrementing some variable and when the person gets out of the room the 2nd sensors will sense first then the 1st sensor so we decrement that variable, only one person at a time can enter or get out of the room. While the sensors are busy counting the no. persons entering the room as soon as the first person entered the light is on based on that variable from zero get increment then we kept some variable for the light being on till light is off and stop and store the variable in another to get the value of how much time the light is being on. The power consumption is calculated based on those time variables and some formulas that are used in this work. And the last part is that all the values are stored in the real-time database and the power consumed calculations is stored in the PLX-DAQ(Parallax microcontroller data acquisition add-on tool for Microsoft Excel. Any of our microcontrollers connected to any sensor and the serial port of a PC can now send data directly into Excel.) so the admin can look at the excel for power consumption. The values going to the real-time database can also be viewed in a mobile app made for this work.

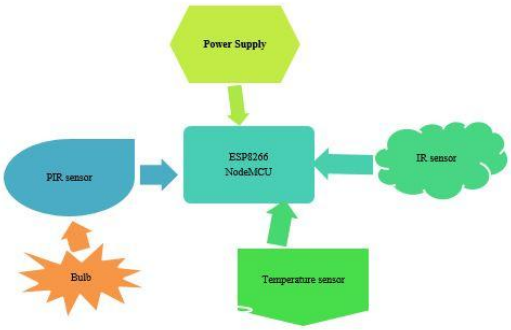

Figure 1. Block Diagram

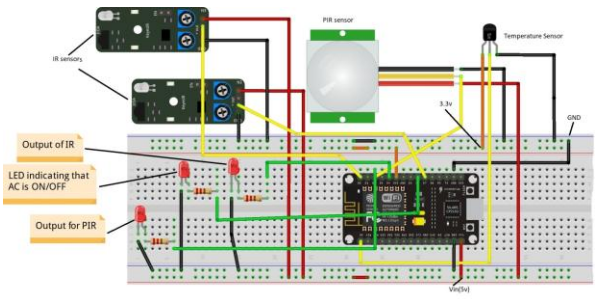

Fig. 2

- Creating a Smart Room using IoT which would help people in
  - Automating lighting system in a room,
  - Temperature measuring,
  - Calculating power consumption over IoT.
- Send notification when temperature is high. And the user can ON or OFF the Fan/AC through the Application developed for this System.
- Counting the number of number of occupants entering a room. And based on the number of people the light will be ON or OFF.
- Storing data (power consumed) in Microsoft Excel and analyze data in an Excel Sheet.
- Using Data Analytics over stored data to build a model which would assist in Power consumption reduction.
- Generation of an e-bill and communicating the same via IoT to the user as an alert if more power consumption takes place.

IV. RESULTS AND DISCUSSION

The output pin of the LM35 will be connected to the A0 pin of the nodeMCU, the voltage from this pin is stored in a variable (‘analogvolts’ in this case) and calculate the temperature based on the formula millivolts=(analogvolts/1024.0) X 3300, the result of this will be in milliVolts(mV).

- 1024 is 2^10, value where the analog value can be represented, the maximum value it can be represented is 1023. The actual voltage obtained by VOLTAGE_GET / 1024.
- 3300 is the voltage provided by the nodeMCU.
- And ultimately the temperature can be obtained by the formula Celsius=millivolts/10
- 10 is constant. Each 10 mV is directly proportional to 1 Celsius.

For the Fahrenheit value, the normal Celsius to Fahrenheit conversion formula is used. And if the temperature is high(i.e. more than the value specified in the condition, a notification will be sent to the user's phone). The user can ON/OFF the Fan/AC from the App.

For the PIR sensor code, declare the initial state of the sensor as LOW and a variable for storing the state of the sensor when it detects movement, to determine whether the state of the sensor is HIGH or LOW. If the state of the sensor is HIGH the output pin of the sensor will be high and eventually the LED will be ON, otherwise it will be LOW, and the LED will be OFF.

IR sensor code(counting people entering)
Declare variables for storing states of both the IR sensors. If the state of the first sensor is HIGH then followed by the second IR as HIGH then the variable ‘count’ will be incremented(i.e. increment the number of people entering), and if the second one is HIGH followed by the first sensor then the ‘count will be decremented.

The variables ‘k’ and ‘p’ in the program above is used so that if only one sensor is HIGH then ‘count’ won’t be incremented or decremented respectively, in other words only if both the sensors are HIGH but with a little difference in time that they would be HIGH(not at the same time) then ‘count’ will be incremented or decremented. A variable for holding the amount of time period the LED is ON is also declared.

Calculating power consumed.
Calculation of power is based on the variable (‘timer’) that holds the amount time period (in terms of Seconds) an LED is ON as mentioned earlier. If the value of ‘timer’ is less than 59(seconds) that value is moved to the variable ‘x’ and similarly if ‘timer’ is more and 60 (1 minute or more) and 3600 (1 hour or more) then these values will be moved to their respective variables for calculation as shown in the different statements in the code.

Serial.println(“DATA,DATE,TIME,”);
Serial.print(pow); these two lines is for sending the data to the Excel sheet.
DATA: To notify the port that is used for extracting the data from the module to the Excel sheet that data will be extracted.
DATE, TIME: To display the date and time when the data is extracted.
Serial.print(pow); To display the calculated power.
The outcome of this paper for each parameters has different utilities like the following:

IR sensors is used for sensing the occupants entering in a room and with the help of the firebase we can sends the data to the mobile application made for this system and for this high network connectivity is needed for accurate results. And as soon as the persons is inside a room the lights will be automatically on, and the lights will off when the no of occupants becomes 0. PIR sensors is used for detecting the persons when someone is entering in a room the sensor will sense and the lights will on. Temperature sensor is used here for sensing the humidity of a room when the temperature is above a limitation number given the AC/Fan will be on by the users by collecting temperature data of that room through firebase in the App.

Excel sheets will display the power consumption as soon as the lights is on values will be incrementing to tract the time for how long the lights is on and by opening the excel sheet it will display the power consumption in a day or week or months. Data model will help in prevention of over usage

Electronic bill communicated as an alert will help the user to keep a check on the system as to make lesser use of energy if it is not required thereby preventing wastage.

V. CONCLUSION AND FUTURE SCOPE

The world is undergoing a dramatic transformation, rapidly transitioning from isolated systems to ubiquitous Internet-enabled 'things' capable of generating data that can be analyzed to extract valuable information. Commonly referred to as the Internet of Things (IoT).A Smart Room is an intelligent space that optimizes efficiency, comfort, safety for people, and asset performance within the house. Moving forward, the IOT will drive nearly every house system to have built-in, secure, interconnected intelligence. Similarly, the supporting network and cloud infrastructure are enhanced to better protect data, manage devices, and perform data analytics.

The system will be made in such a way that it can count accurately even if more than one person enters the room at a time. Sensors with high responsiveness will be used in the later implementation of this work. Hence, accurate computation can be done. The power consumed by the electrical appliances will be calculated in monetary terms.

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