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Smart Energy Meter Monitoring System

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ABSTRACT: The significance of energy management is growing, and it has become a demand for people to reduce their energy expenditure because energy prices have been a major component in household budgeting in recent years. Therefore, a smart energy meter monitoring system is crucial for most modern households, enterprises, and many other institutions. In our research, we will be developing a smart energy meter monitoring system using IOT technology that can reduce electricity consumption by managing lighting systems and detecting the meter's location. In addition, there will be a prepaid feature that enables the user to pre-set the amount. The customer will get a notification about the surplus energy usage, consumption details in periodic intervals, and remaining balance in the account to alert the customer.

1. INTRODUCTION

Everything runs on energy. In reality, we tend not to think about how often we use things. Nowadays, electricity is a big issue that individuals must deal with. Typically, a person has no idea how much energy he consumes and only receives a bill at the end of each month. As a result, he may use a large amount of electricity and waste a significant amount of money. People should be aware of the concepts of electricity so they can prevent wasting energy and save money. [2] In this research, we will create a Smart Energy Meter Monitoring System that can help users avoid wasting electricity and save money without putting in a lot of work by displaying the current readings and the remaining balance, the consumer will have a better understanding of their energy usage and be able to manage it if it is high. IOT technology has enhanced our living experience in several ways, making smart energy management easier and more important than ever before. [3]

2. LITERATURE SURVEY

Islam, M. R., Sarker, S., Mazumder, M. S., & Mehnaj proposed that the system has the ability to reduce customer suffering and raise user awareness of excessive power use as well as defective home appliances. Customers may simply View total pulse, total units, and total power expenses with this method. The system architecture is separated into three key elements. They are the customer's energy meter region, cloud server region, and customer application interface. The data stored in the cloud has great importance for future energy meter data mining.

Prabaakaran, K., Ovaiz, M., Vivek, J., Harshith, B., & Lokesh, P. presented a paper titled "Implementation of smart metering based on the internet of things," "describing sophisticated billing methodology and individual load consumption without the need for extra sensors, and the meter warns the user by continually anticipating energy use."

Hariharan, R. S., Agarwal, R., Kandamuru, M., & H. A. G. (2021). demonstrated an energy consumption monitoring system for home appliances that can be used to calculate household energy consumption and keep the user informed about electricity consumption via an android app where he can view the units of electricity used and a prediction of the bill at the end of the month.

3. PROPOSED METHODOLOGY

Many of the existing studies work to comfort and relieve customers suffering from excessive energy use. Also, the common purpose of research is to reduce the energy that research can benefit from. In a similar way, there is a network of IoT devices connected together to give the user the best experience with light control. In addition, there is a set of sensors, a Raspberry Pi 3, and a database, as they are available in almost every research. In detail, there are light sensors and motion sensors used for most of them, some research uses Ethernet shields and Arduino but we do not. We tried to choose the most effective way that was easy for the customer to understand. The consumer monitors the energy consumed daily, and a daily invoice is generated on the web page or application. Others can set the monthly electricity billing budget.

There are some gaps in the previous related research, for example, the advanced smart energy meter for energy conservation. They are focused on billing methodology, and they use only the LDR sensor without using any other sensors, and it's not enough to reduce electricity consumption. These related studies described many IoT systems, and as a result, our research was able to improve by gaining knowledge of the work of other researchers and taking advantage of what others overlooked. After reviewing the connected research, it is evident what sort of component we need to examine, as well as how the system might be improved by utilizing past knowledge provided to our research. Our research will use IoT technologies to reduce electricity consumption, automatically detect energy use, and calculate the bill. Also, GPS is used to identify the location of the meter. Moreover, the data and information will be stored in a cloud database.

The diagram below shows the simple planning of system use for the Smart Energy Meter Monitoring System. We will use the motion and photo sensors, which are used to sense the person's movement when near the place and if there are any lights around. The current sensor used to measure electric current. The flame sensor detects and responds to the occurrence of a fire or flame. We've also included an LCD screen; LCD actuator is a device that displays warning messages when there is an event or any movement. The alarm is used to alert the customer when there is a problem. Also, we include a GPS module to determine the location of the E-meter.

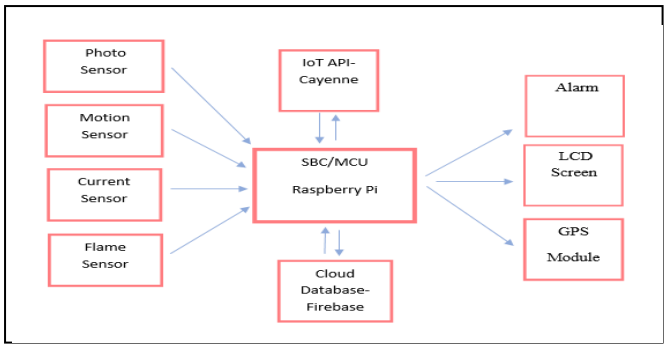


Figure 1: Block Diagram

4. SYSTEM REQUIREMENTS AND SPECIFICATIONS

The following are the hardware and software requirements of our research.

4.1 Raspberry Pi 3

The Raspberry Pi 3 Model B is the Raspberry Pi's third generation. The Raspberry Pi 3 Model B maintains the popular board style while providing a more powerful processor that is 10 times quicker than the original generation Raspberry Pi. It also has a wireless LAN and Bluetooth connection, making it an excellent choice for linked designs. [19]

Figure 2: Raspberry Pi 3

4.2 Piezo Buzzer

This motor consists of two main components, “stator” and the armature.” The stator is a permanent magnet. The armature is the rotating part. We are going to use this motor for rolling up and down the curtain. [21]

Figure 3: Piezo Buzzer

4.3 LED Lights

The term "light emitting diode" refers to a device that emits light. In comparison to incandescent light bulbs, LED lighting products produce light up to 90% more effectively. How do they function? A microchip receives an electrical signal, which ignites the tiny light sources known as LEDs, resulting in visible light. The heat generated by LEDs is absorbed into a heat sink to prevent performance difficulties.

Figure 4: LED lights

4.4 Photo sensor

A photoelectric sensor detects changes in the intensity of light.

Figure 5: Photo sensor

4.5 Motion sensor

A motion sensor (or motion detector) is a type of electrical device that detects and measures movement.

Figure 6: Motion sensor

4.6 Flame sensor

A flame-sensor is a type of detector that is primarily intended for detecting and responding to the occurrence of a fire or flame.

Figure 7: Flame sensor

4.7 Current Sensor

A current sensor detects electric current in a wire and produces a signal proportional to it. An analog voltage or current, or a digital output, might be generated. The resulting signal can then be utilized to show the measured current in an ammeter, saved for future analysis in a data collection system, or used for control

Figure 8: Current sensor

4.8 MCP3008 IC

The MCP3008 is a low-cost 10-bit analog to digital converter with eight channels. This ADC has similar precision to an Arduino Uno, plus it has 8 channels, so you can read a lot of analog signals from the Pi. If you only need to read basic analog signals, this chip is a great choice.

Figure 9: MCP3008 IC

4.9 LCD

An LCD screen is an electronic display module that generates a visible display using liquid crystal. The 16*2 LCD display is a basic module that is used in many

circuits. The 16*2 corresponds to a two-line display with 16 characters per line. Each character is presented in a 5x7 pixel matrix on this LCD. [21]

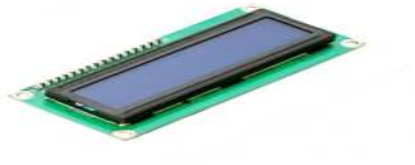


Figure 10: LCD

4.10 Cayenne-IoT

Cayenne is a smartphone and PC program that lets you operate the Raspberry Pi and, shortly, the Arduino via a beautiful graphical interface and a stable, good communication protocol. [11]

4.11 Cloud database- Firebase

Google Firebase is a Google-backed app development platform that allows developers to create apps for iOS, Android, and the web. Firebase includes analytics monitoring, reporting, and app issue fixes, as well as marketing and product experimentation capabilities. [12]

4.12 Raspbian operating system

Raspbian is a free operating system based on Debian that is designed specifically for the Raspberry Pi device. An operating system is a collection of fundamental apps and utilities that allow your Raspberry Pi to function. Raspbian, on the other hand, offers more than just an operating system: it includes over 35,000 packages, which are pre-compiled software packages packaged in a convenient style for quick installation on your Raspberry Pi. [13]

4.13 Python 3

Python 3.0 is a new version of the language that is incompatible with previous releases in the 2.x series. [14]

4.14 Packet tracer version 8

Cisco Packet Tracer 8 is a network technology teaching and learning application that offers a unique blend of real-world simulation and visualization experiences, assessment and activity authoring capabilities, and chances for user cooperation and competition. [15]

5. RESULTS AND DISCUSSIONS

5.1 Circuit diagram

The following is a circuit diagram of our proposed system developed using the Fritzing tool.

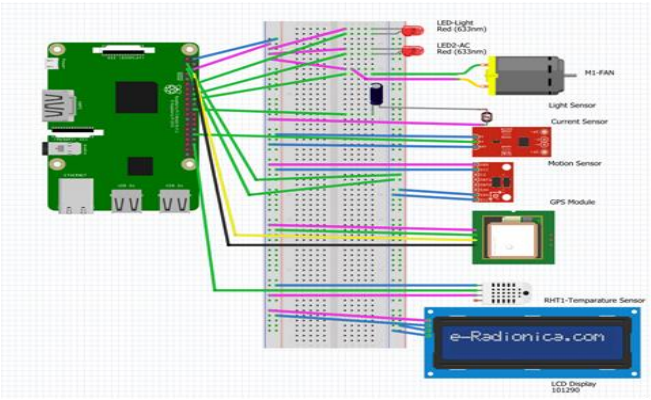


Figure 11: Proposed System Circuit Diagram

5.2 Calculating the consumption of power

Voltage = I x R

I = Voltage / Resistance

P = V X I

1 unit = 1 KWh = 1000 Watts

The wattage of the one light to be used in a room is 40 watts.

Normally, we use lights in our home for 9 to 10 hours. We are reducing electricity consumption by closing the lights if there is no motion in the room and enough sunlight is available. Normally, we use fans in our home for 18 to 20 hours. We reduce electricity consumption by ensuring that if motion is not available in the room, the fans will be closed.

Average time used per day 6 hours

One-month power consumption per light = 6X40X30 = 7200 Watts

Average time used per day 15 hours

One-month power consumption per fan = 15X90X30 = 40500 Watts

Amount of charge per unit of electricity = 0.020 rial

Monthly unit consumed = 48 Unit / per light and fan

Amount of charge per month = 0.960 / per light and fan

5.3 Prototype of the research

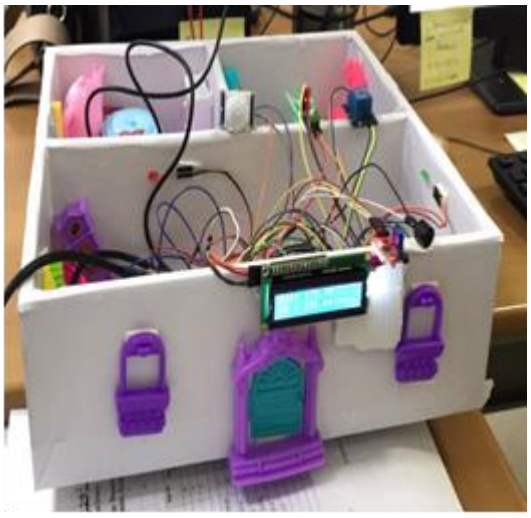


Figure 12: Prototype of the Search

Figure 14: Meter Reading on LCD

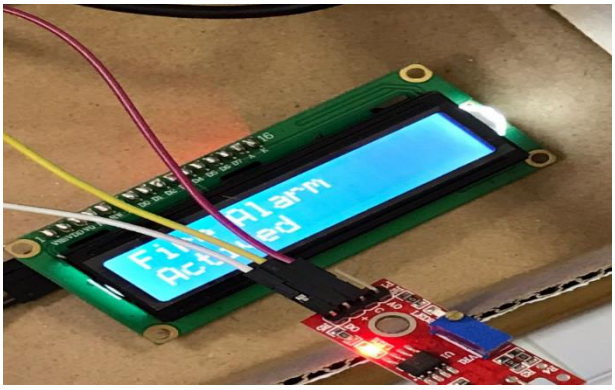
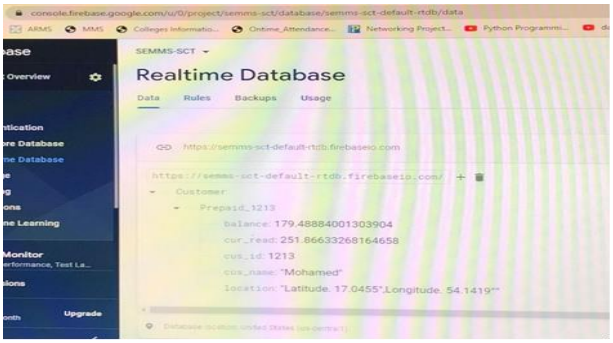


Figure 15: Fire Alarm Activated



5.4 Screenshots from the smart energy meter monitoring system

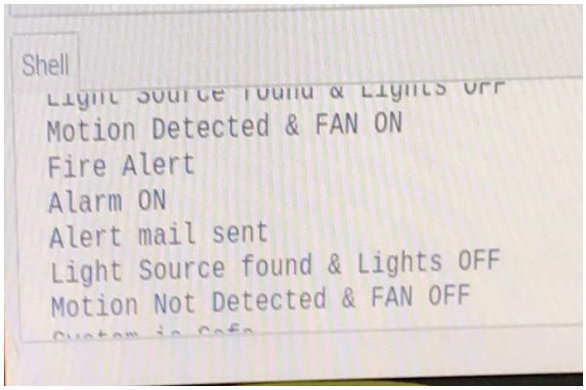


Fig. 13. Python output

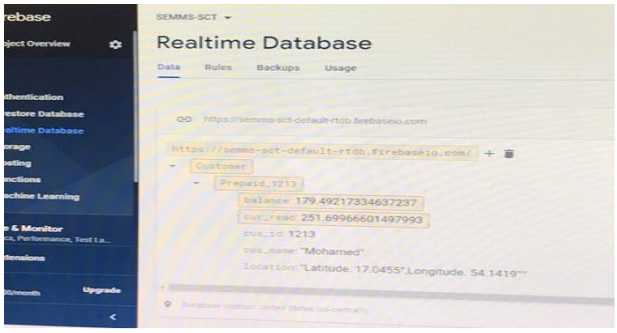


Figure 15: Real time meter reading from Firebase

6. CONCLUSIONS

The system revealed an IoT smart energy meter monitoring system for energy savings, that monitors the meter online and alerts if an emergency situation is happening. We developed this system to help reduce consumption by monitoring the user's electricity consumption and adding the prepayment feature, the consumer will be able to determine the price of the electricity bill at an early stage. In addition, electricity management and control are our most important goals in our research to reduce electricity consumption, which will be controlled by two sensors: a photo sensor and a motion sensor. As previously stated, the motion sensor will turn on and off the fan depending on movement detection. If the room is dark, the photo sensor will turn on the lights, and if there is enough light in the room, it will turn them off. The research team did their best to use IoT technology to implement this smart energy meter system.

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