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Framework of Internet of Things (IoT) based Electricity Monitoring System with Web Application

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Abstract: As the industrial automation brings forward the advantages of the Internet of Things (IoT), it is becoming necessary that different organizations adopt these technologies to automate the processes and ease human lives. Automation in the industrial workspace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety and adding flexibility to the manufacturing process. Industrial automation yields increased in safety, reliability, and profitability. Therefore to enhance this prospect this paper is oriented towards saving the non-renewable resources of energy and provide the data that is reliable and fast to the electricity providers so that the waste of electricity can be reduced to a great extent and the required data can be analysed.

Introduction

Renewable energy sources have gathered a lot of attention in recent years, but saving electricity has become the need of the hour. As green technologies replace non-renewable and polluting energy sources, it is advantageous for human health and environment. However, the best results are achieved when clean power is combined with energy conservation, reducing the pressure to invest in new grid infrastructure. Since energy efficiency frees up existing generation capacity, it delays expensive upgrades to power networks.

All power generation systems have an environmental impact that must be considered before an investment decision. This is evident when dealing with fossil fuels, since their combustion releases a constant stream of greenhouse gases into the atmosphere.

Energy conservation allows more number of infrastructure to operate with the existing capacity. For instance, if a country reduces its power demand by x MW, that installed capacity becomes available to serve new infrastructure. Without energy conservation, on the other hand, the same x MW gap must be filled with new power stations.

Saving energy has both environmental and financial advantages. When buildings become more energy efficient there is comparatively less load on the power grids This reduces the total ownership cost of power systems, as well as their environmental impact.

Energy conservation also brings enormous benefits to property owners, and energy efficiency measures are among the best building upgrades available. Electricity bills represent a significant share of building operation costs, and gas bills can also be high in places with harsh winters.

Therefore this paper is oriented towards saving the non renewable resources of energy through a hardware and a web application and provide the data that is reliable and fast to the provider of electricity so that the waste of

electricity can be reduced to a great extent and the required data can be analyzed at the earliest to whosoever who needs that data to track and take precautionary measures to improve and better management of energy.

System design

This paper presents an application that is a combination of hardware and software. The hardware requirements are:

1. ESP-32 board
2. Voltage sensor
3. Current sensor (ACS)

The software requirements are:

1. For Arduino side (ESP): Object C
2. For web application:

Frontend Part: HTML, CSS, Java script, Semantic UI

Backend Part: Google Firebase real time database and firebase authentication

Hardware Requirements

2.1.1 ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, robustness, versatility, and reliability in a wide variety of applications and different power profiles. ESP32 is a highly-integrated solution for Wi-Fi and Bluetooth applications in the IoT industry with around 20 external components. ESP32 integrates the antenna switch, RF balun, power amplifier, low noise receive amplifier, filters, and power management modules. The solution occupies minimal Printed Circuit Board (PCB) area. ESP32 uses CMOS for single-chip fully-integrated radio and baseband, and also integrates advanced calibration circuitries that allow the solution to dynamically adjust itself to remove external circuit imperfections or adjust to changes in external conditions. As such, the mass production of ESP32 solutions does not require expensive and specialized Wi-Fi test equipment. There are many ESP32 Boards based on ESP-WROOM-32 Module available in the market. The layout, pinout and features vary from board to board. There are some board with 36 Pins and some with slightly less Pins. ESP32's integrated circuitry requires only 20 resistors, capacitors and inductors, one crystal and one SPI flash chip. ESP32 integrates the complete transmit/receive RF functionality including antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management module, and advanced calibration circuitries.

2.1.2 A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage, whereas the output is the switches, analog voltage signal, a current signal, or an audible signal.

The implementation of a **voltage sensor** and current sensor techniques have become an excellent choice for the conventional current and voltage measurement methods.

Current sensor (ACS 712)

With different devices having different current requirements, if a wrong amount of current is fed to them, it may result in severe circumstances (overloading, etc.). Hence, it's necessary for one to monitor the required

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current for applications, and that's when people turn to a current sensor to do the job, notably the ACS712 AC/DC Current sensor.

Figure 1: ACS 712

2.2 Software Requirements

CSS stands for Cascading Style Sheets. It is the language for describing the presentation of Web pages.

Firebase is a Backend-as-a-Service (Baas). It provides developers with a variety of tools and services to help them develop quality apps, grow their user base, and earn profit. It is built on Google's infrastructure.

Google Firebase is a Google-backed application development software that enables developers to develop iOS.

Results and discussion

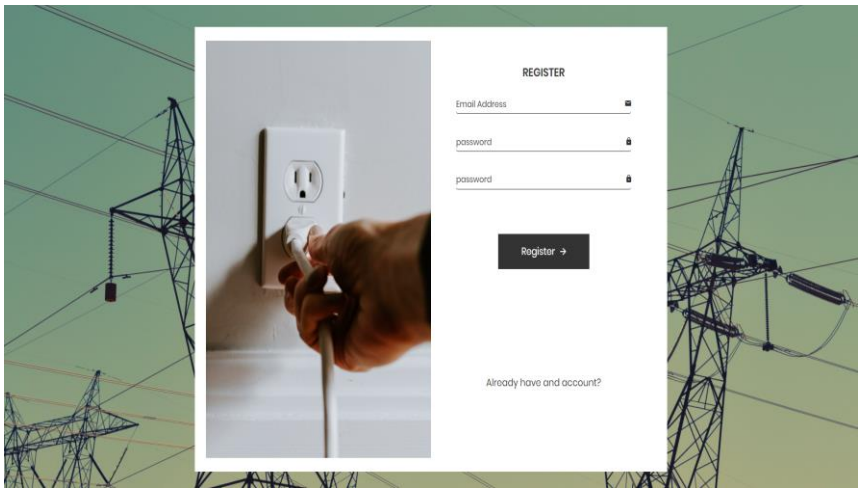

Figure 2 Registration page

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The user interface of this web application contains a signup page for the user where the user of the web application will be able to signup using his/her email address field , password field and confirm password field . The password of this web app should be at least 6 characters or digits. once the user does that and click on the register button the user proceeds to the home page. The page also contains a already have an account button where if the user already has an account then the user can click on this and proceeds to the login page

The user interface of this web application contains a login page for the user where the user of the web application will be able to login using his/her email address field and password field. once the user fills all the required fields and click on the login button the user proceeds to the home page. The page also contains forgot your password button where if the user already does not remember his/her password then the user will be able to reset the password

The user interface of this web application contains a Home page for the user where the user of the web application will be able to see three sections. These sections are as follows

1. Energy monitoring system

This is the part where there are three sections first is the monthly energy consumption where the user will be able to monitor his/her monthly energy consumption and to take further precautionary steps. It also has weekly energy monitoring system where the user will be able to monitor his/her weekly energy consumption. More over this section also has daily power cut counter which tells the user the number of times the voltage and current went out to be null around the circuit.

2. The second part of the home page contains the sections where it tells the exact values of the load and the current, which device is on and which device is off. The section also includes the location tracker where it asks the user to track its location and dynamically gives the information to the user where its current location is. Moreover it also tracks the real time date and time to store the data

3. The third part of this home page is divided into two parts one is the map of the location of the user where the user current address is and points to its current location.

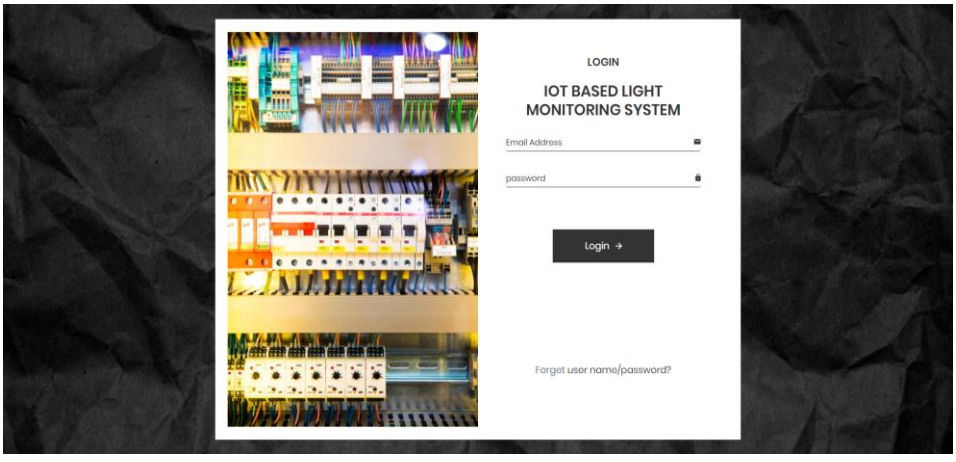

Figure 3:Login page of User Interface

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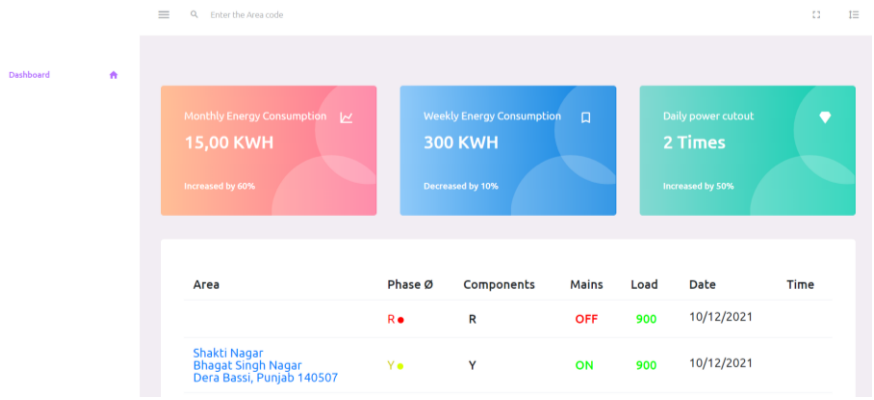

Figure 4: Home page of User interface

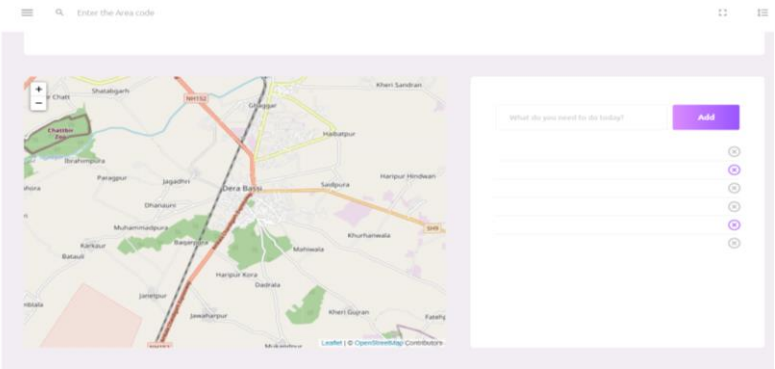

Figure 5: Home page of User Interface

The proposed system gives the overall daily, weekly and monthly energy consumption of power to the consumers. Future work includes using humidity sensor, temperature sensor and smoke sensor to monitor the humidity , temperature and smoke in a particular area and take the precautionary measures after monitoring these values. Currently this project is only able to monitor current and voltage values. The energy monitoring system in this system is static in nature . along with the future additions of sensors will make this energy monitoring system dynamic to show the real time data of the readings.

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