A Review on Energy Monitoring and Control Using Internet of Things (IoT) System

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ABSTRACT_ The use of technology has become an essential part of improving lifestyle, work efficiency, and a catalyst for economic growth. The benefit of the Internet of Things (IoT) and connected nodes has been on a steep incline in recent years. This paper aims to research ,build, test and implement a low-cost energy monitoring and control system using IoT devices. Electrical appliances (e.g., air conditioning units and overhead lighting) can be controlled and monitored using IoT technology from any place in the world. In order to accomplish this goal, a complete front-end to back-end system that includes a smart device application (IOS platform), a cloud-based database, an Application Programming Interface (API), and a hardware development is proposed. A small programmable specialized computing device (e.g., Raspberry Pi) for preliminary testing. This smart node was chosen due to familiarity, and its capabilities, such as general purpose pins and built-in Wi-Fi chip. The end goal is to observe energy efficiency by monitoring and controlling air conditioning appliances and standard overhead lighting units. These smart IoT devices allow for the usage energy data from each unit to be collected and stored in a Cloud-based database that can be analyzed and reported for energy conservation and analysis.

1. INTRODUCTION

In 2016 the U.S. consumed 4,079,079 million kWh of energy, this number can be significantly reduced by decreasing energy waste through the Internet of Things (IoT) [1]. According to researchers, "The IoT is a system ofinterrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human- to-computer interaction "[2]. Many researchers have beenstudying the concept of IoT, its applications, and security of these applications using IoT [3, 4]. This project aims to implement a system in which electrical devices can be securely controlled and monitored using IoT technology on an international level (e.g., from any place in the world). Also, it deals with complete front-to-back aspects includinga mobile application, a cloud-based database, the creation of an API, and hardware development. The goal is to observe energy waste that may occur during the daily use of energy consuming appliances such as air conditioning units and standard overhead lighting units. These smart units are connected to Apple devices set up with iOS applications to control the unit's electrical status and monitor energy consumption, which is recorded in a database for analysis. Additionally, it consists of usage reports on the air conditioning units along with trends in consumption in kWh per unit time.

The United States, the largest economy in the world, consumed 12.96 million watt-hours per capita in 2014 [1, 5]. Despite energy consumption having a strong positive correlation with the economic development within a country, energy is not a free resource and has many environmental, social, and political dimensions associated. Data from March 2017 indicates that the United States energy consumption came primarily from petroleum and natural gas, sources that contribute to greenhouse gas emissions, which have been proven to increase global warming [6, 7]. This project is conducted at the Punta Leona Hotel y Club, Costa Rica, a resort and country devoted to the natural ecology of their region. Costa Rica aims to run primarily on renewable energy sources, where in 2016,98.1% of electricity came from renewable sources [8, 9].

THE INTERNET OF THINGS (IOT) SYSTEM

The hardware aspect of this project requires a variety of components that had to be tested before ordering and implementing into the system. A small programmable specialized computing device, the Raspberry Pi v3, was used for preliminary testing. The Raspberry Pi v3 was chosen due to familiarity and its built-in capabilities for all aspects of the project, including general purpose pins and Wi-Fi capabilities. The Raspberry Pi v3 also had a variety of external attachments for monitoring and control

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purposes.Following the preliminary testing phase of the project, this computational device was changed to the Raspberry Pi Zero Wireless due to its affordability, similar features, and smaller size, as seen in Figure I below.

2.BLOCK DIAGRAM:

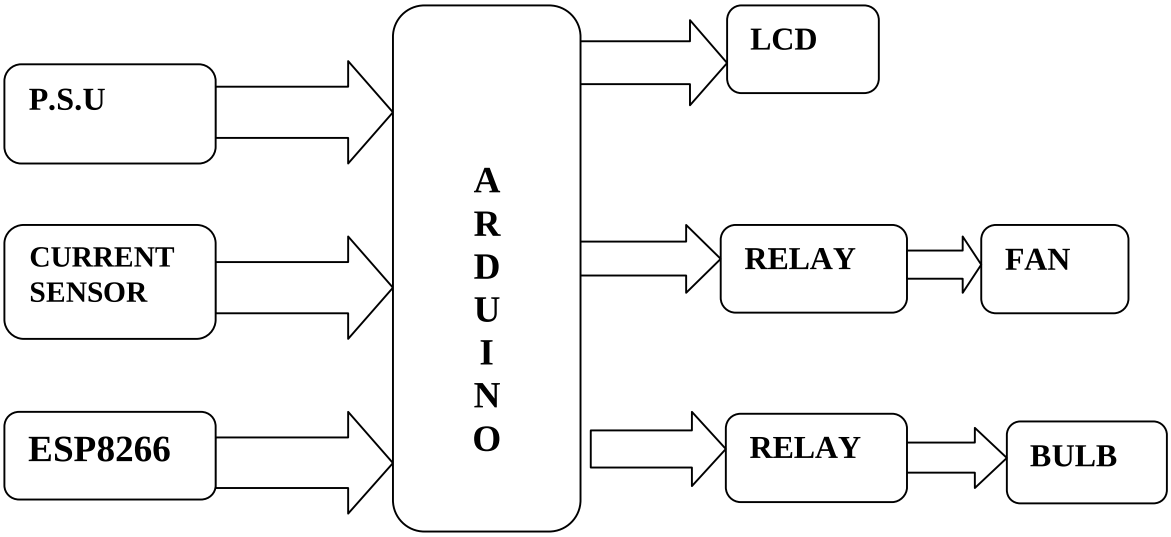
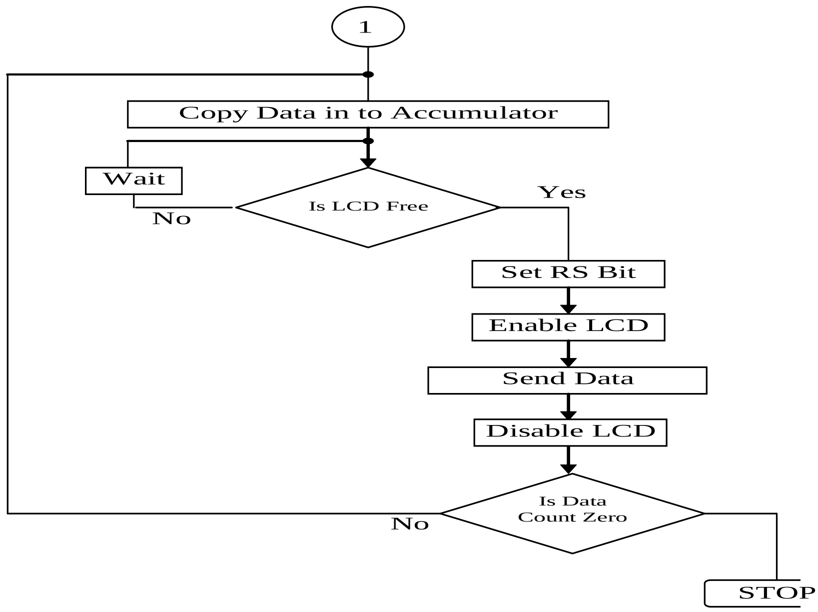
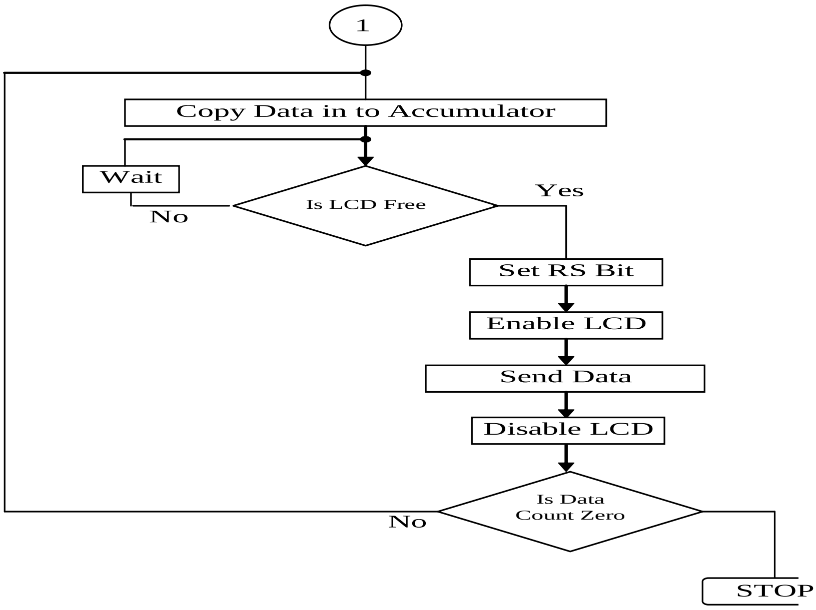


Fig 2.1 Block Diagram

FLOWCHART:





Relay

A relay is used to isolate one electrical circuit from another. It allows a low current control circuit to make or break an electrically isolated high current circuit path. The basic relay consists of a coil and a set of contacts. The most common relay coil is a length of magnet wire wrapped around a metal core. When voltage is applied to the coil, current passes through the wire and creates a magnetic field. This magnetic field pulls the contacts together and holds them there until the current flow in the coil has stopped. The diagram below shows the parts of a simple relay.

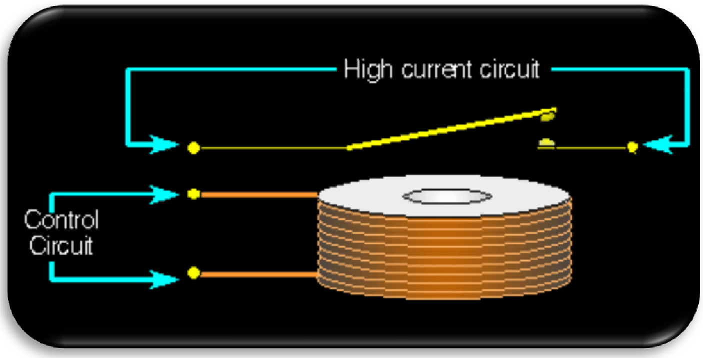


Figure2.2 : Relay

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Current Sensors

Measuring a voltage in any system is a "passive" activity as it can be done easily at any point in the system without affecting the system performance. However, current measurement is "intrusive" as it demands insertion of some type of sensor which introduces a risk of affecting system performance.

Current measurement is of vital importance in many power and instrumentation systems. Traditionally, current sensing was primarily for circuit protection and control. However, with the advancement in technology, current sensing has emerged as a method to monitor and enhance performance.

Fig. 2.3: A Representational Image of a Current Sensor

Knowing the amount of current being delivered to the load can be useful for wide variety of applications. Current sensing is used in wide range of electronic systems, viz., Battery life indicators and chargers, 4-20 mA systems, over-current protection and supervising circuits, current and voltage regulators, DC/DC converters, ground fault detectors, programmable current sources, linear and switch-mode power supplies, communications devices , automotive power electronics, motor speed controls and overload protection, etc.

ESP8266

Your ESP8266 is an impressive, low cost WiFi module suitable for adding WiFi functionality to an existing microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone WiFi connected device–just add power!

The feature list is impressive and includes:

802.11 b/g/n protocol

Wi-Fi Direct (P2P), soft-AP

Integrated TCP/IP protocol stack

This guide is designed to help you get started with your new WiFi module so let's start!

The hardware connections required to connect to the ESP8266 module are fairly straight-forward but there are a couple of important items to note related to power:

The ESP8266 requires 3.3V power–do not power it with 5 volts!

The ESP8266 needs to communicate via serial at 3.3V and does not have 5V tolerant inputs, so you need level conversion to communicate with a 5V microcontroller like most Arduinos use.

However, if you're adventurous and have no fear you can possibly get away with ignoring the second requirement.

Hardware Connections

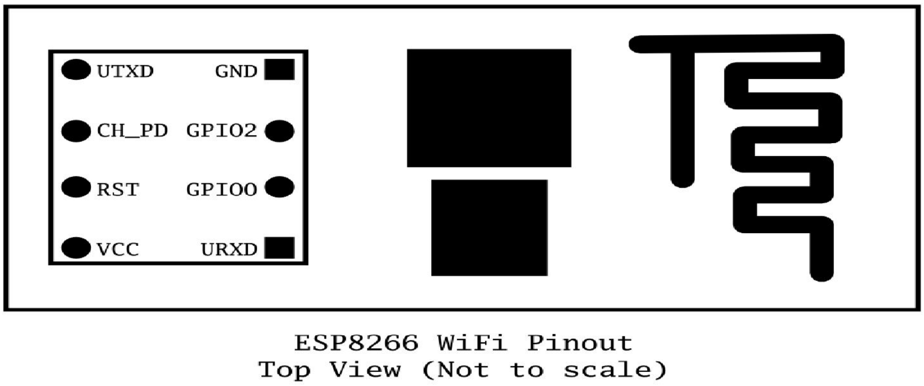

Fig 2.4: ESP8266

3. RESULTS AND DISCUSSIONS

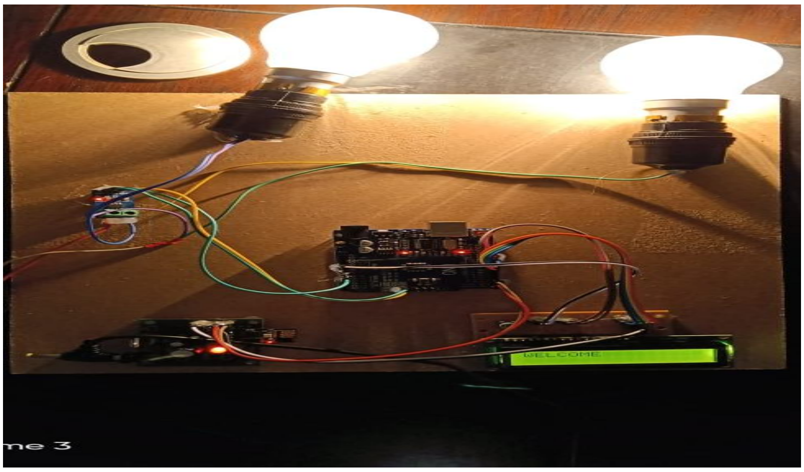

Fig 3.1

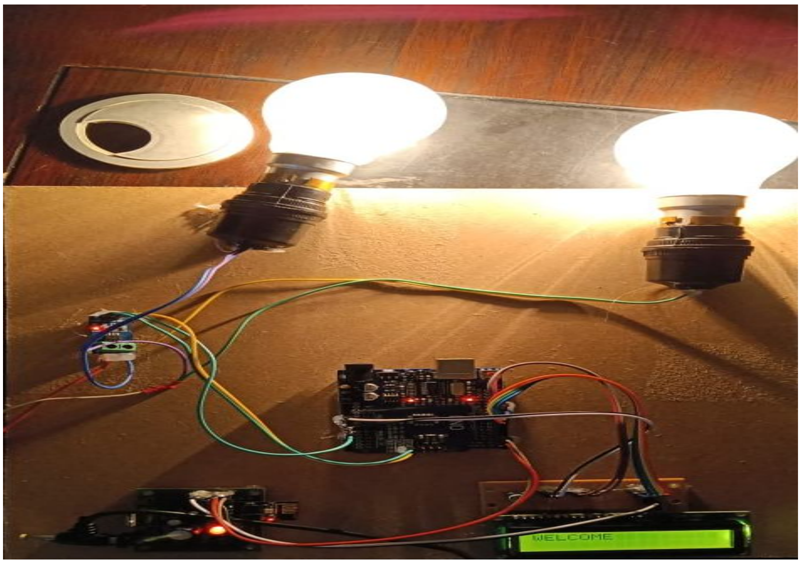

Fig 3.2

4.CONCLUSION

Thus the article explains the basic structure and system design for IOT based energy meter billing and monitoring system emergency system. The article also explains the basic blocks and components used in this system. It's a complete case study for the proposed system design. The system is very much helpful for reduction in energy wastage and prevention in electric shortage. In this system consumer can do power management by knowing energy usage time to time. Using this system we can provide real time bill monitoring system and time reduced billing system.

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