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Distributed Electricity Bill Estimation System based on Internet of Things(IoT)

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Abstract : The aim of this project is to design and implement a Bill Estimation system based on IoT with an objective to provide the user with real-time electricity consumption and electricity bill estimation. The proposed system uses an Arduino Uno module integrated with ESP32 as opposed to the earlier model which used NodeMCU. Arduino Uno is used in order to control the appliances more efficiently and to provide accurate data to the user. To precisely measure the current it uses an array of multiple sensors based on which the appliances are controlled thus electricity is also reduced. Our system can be implemented in two ways, a decentralized version where each electrical appliance or gadget provides input data to the Arduino Uno and a centralized version that has loads coming from different rooms containing electrical appliances as an input to the Arduino Uno. Therefore our project has the potential to be used in industries as well as commercially by the public.

IndexTerms - IoT, Arduino Uno, ESP32, LDR sensor, Current sensor, Voltage sensor, Temperature sensor, LCD, Android application

I. Introduction

One of the most significant sources in a human's life is electricity. There is almost nothing that does not work on electricity, especially now that we have entered the twenty-first century. However, due to the massive demand for electricity around the world, it has become difficult to create and distribute electricity to everyone. But, if suitable actions and procedures are done to conserve electricity, future generations, as well as present generations, may be able to benefit.

Electricity, as a source of energy, must be preserved. The goal of the loT-based energy tracking and bill estimating system proposed in this research is to raise awareness among industrial and residential consumers about the use of this finite resource. This study seeks to plan simple ways to manage electricity usage. The loT-based energy meter reading system uses switching instructions and loT-based notification alerts to users. The switching instruction option is included to avoid more power consumption. The proposed system neglects the regular digital meter reading system and allows the user to remotely access the electronic meter.

The user can get the electricity consumed data access from anywhere on the planet. The brief advantages of this project are to reduce cost and save more power and also reduce workforce and time consumption. This project aims to design and implement a Bill Estimation system based on loT to provide the user with real-time electricity consumption and electricity bill estimation.

II. Literature Survey

After going through various research papers we have learned many beneficial factors for our project

- In Rishi Mathur, Kamlesh Kalbande “Internet of Things (IoT) based Energy tracking and Bill Estimation System” of 2020 IEEE Xplore Paper, proposed a system with integration of a cloud-hosted database and control unit. The proposed system also used NodeMCU, a 4-channel relay module, and the Blynk android application.
- In Bhalaji, N. "EL DAPP–An Electrıcıty Meter Trackıng DecentralızedApplıcatıon." Journal of Electronics 2, proposed a system, El DApp An electricity power consumption tracking application that harnesses both the IoT and Blockchain utilities and provides a decentralized and secure recording mechanism.
- In A. Y. Devadhanishini, R. K. Malasri, N. Nandinipriya, V. Subashini and. G. Padma Gowri, "Smart Power Monitoring System Using IoT," proposed a system that provided data for optimization and reduced power consumption. The system communicates with an embedded controller and GSM modem to transmit the data. This system also includes a motion sensor such that if there is no human in the place or house it will automatically cut the power supply.
- M. J. Islam Mozumder and S. Ghosh, "IoT Based Automatic Electricity Monitoring and Remote Load Control System Using PIC18F4550," In the paper, the existing energy meter is combined with IoT technology. By implementation of IoT in the case of meter reading for electricity can give customers relief in using electrical energy.

III. Proposed System

The goal of the proposed system is to overcome the above-listed drawbacks and construct a Bill Estimation system based on the Internet of Things to provide real-time power usage and bill estimation to the user. In contrast to the former model, which employed NodeMCU, the suggested system employs an Arduino Uno module. To operate the appliances more efficiently, Arduino Uno has been combined with ESP32. And, in order to save energy, it employs a network of various sensors to manage the appliances, resulting in a reduction in electricity usage. For a more decentralized and specialized approach, this technology allows individual access to each appliance. The sensors employed in the model are:

a)**Current/Voltage sensor**: Voltage and current sensors are utilized in this project to provide accurate results.

b)**Temperature Sensor**: A temperature sensor is a device that measures the temperature of an object. This sensor is used to detect the temperature of the surroundings so as to increase or decrease the usage of air conditioning appliances

c)**LDR Sensor**: A LDR sensor is used to detect the usage of lights in the surroundings for an extensive period of time.

d)**LCD**: An LCD is used to display the results.

IV. Hardware Used

a) Power Supply: It supplies electric power to components. The components require +5V to function, which is provided by the power supply. The IC LM7805 is used to provide a consistent voltage of +5V. The alternating current voltage (220V) is linked to a transformer, which reduces the alternating current voltage to the appropriate direct current output. A diode rectifier generates a full-wave rectified voltage that is filtered by a simple capacitor filter to produce a direct current voltage. There is some ripple in the resultant dc voltage. A regulator circuit eliminates ripples while also maintaining the same dc value even when the input dc voltage fluctuates.

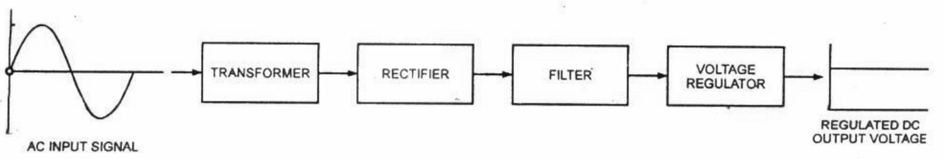


Fig. 1: Block Diagram of Power Supply

b) Arduino Uno R3: It provides electricity to components. To work, the components require +5V, which is supplied by the power source. The LM7805 integrated circuit is used to deliver a constant voltage of +5V. The alternating current voltage (220V) is connected to a transformer, converting it to a suitable direct current output. A diode rectifier produces a full-wave rectified voltage, which is then filtered with a simple capacitor filter to produce a direct current voltage. The resulting dc voltage has some ripple. A regulator circuit reduces ripples while maintaining a constant dc value even when the input dc voltage varies.

Fig. 2: Arduino Uno

c) ESP32: The ESP32 is a low-cost, low-power Microcontroller with Wi-Fi and Bluetooth built-in. It is the successor of the ESP8266, another low-cost Wi-Fi microprocessor with severely restricted capability. It includes an integrated antenna and RF balun, as well as a power amplifier, low-noise amplifiers, filters, and a power management module. The complete solution occupies the smallest amount of printed circuit board space.

Fig. 3: ESP32

d) Voltage/Current Sensor: The voltage/current sensor is an accurate, low-cost voltage sensor. It is designed using the resistive voltage divider method. It may reduce the red terminal connection input voltage by 5 times. The Arduino analog input voltage is limited to 5V, while the voltage detector module input voltage is limited to 5Vx5=25V.

Fig. 4: Voltage/Current Sensor

e) Temperature Sensor: The Arduino temperature sensor transforms the ambient temperature into electricity. It then converts the voltage to Celsius, then to Fahrenheit, and displays the Fahrenheit temperature on the LCD panel.

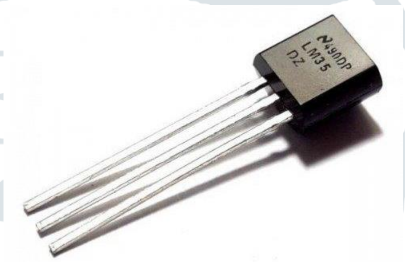


Fig. 5: Temperature Sensor

f) LDR Sensor: Photoresistors, also known as light-dependent resistors (LDR), are light-sensitive devices that are commonly used to detect the presence or absence of light or to quantify the intensity of light.

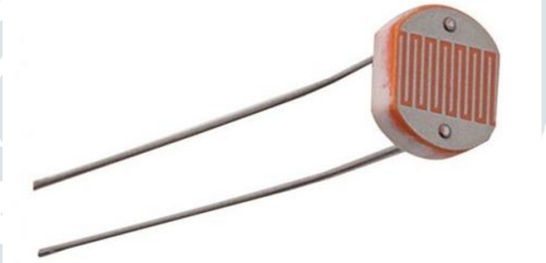


Fig. 6: LDR Sensor.

g) L293D Motor Driver: The L293D is a 16-pin Motor Driver IC that can operate two DC motors in any direction at the same time. The L293D is capable of bidirectional driving currents of up to 600 mA (per channel) at voltages ranging from 4.5 V to 36 V (at pin 8!). It is capable of controlling tiny dc motors.

Fig. 7: L293D Motor Driver

h) LCD 16x2: An LCD (Liquid Crystal Display) screen is a type of electronic display module that has several applications. A 16x2 LCD is a relatively simple module that is utilized in a variety of devices and circuits. A 16x2 LCD can display 16 characters per line and has two of them. Each character is represented by a 5x7 pixel matrix on this LCD. The 16 x 2 intelligent alphanumeric dot matrix display can show 224 distinct letters and symbols.

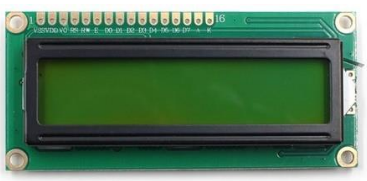


Fig. 8: A 16x2 LCD

V. Software Details

a) **Programming Language Used:** C++

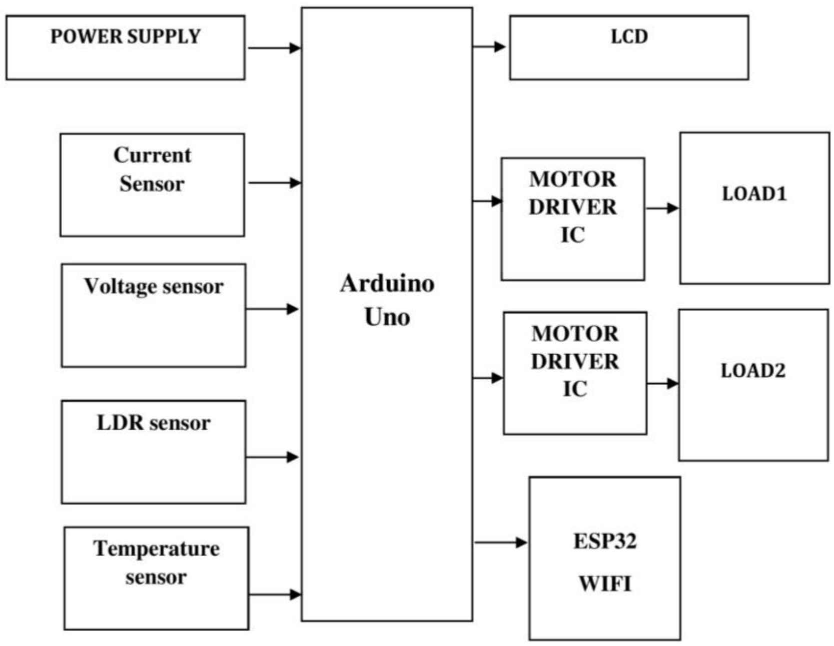
b) **IDE Used:** The Arduino IDE

c) **Software Used:** Arduino Software

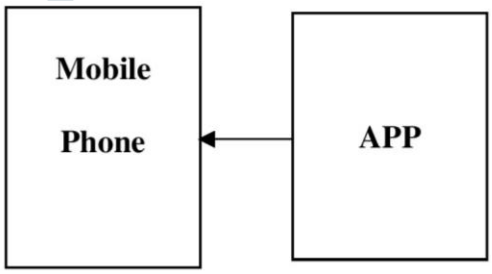
d) **Database:** It is a platform for developing mobile and online applications that includes a real-time database and storage service. This is a Backend-as-a-Service technology that allows for the creation of apps without the need for server programming. A Database project with a real-time database and storage unit is established in this system. As a result, the platform may be used to save time and voltage/current values.

VI. Block Diagram

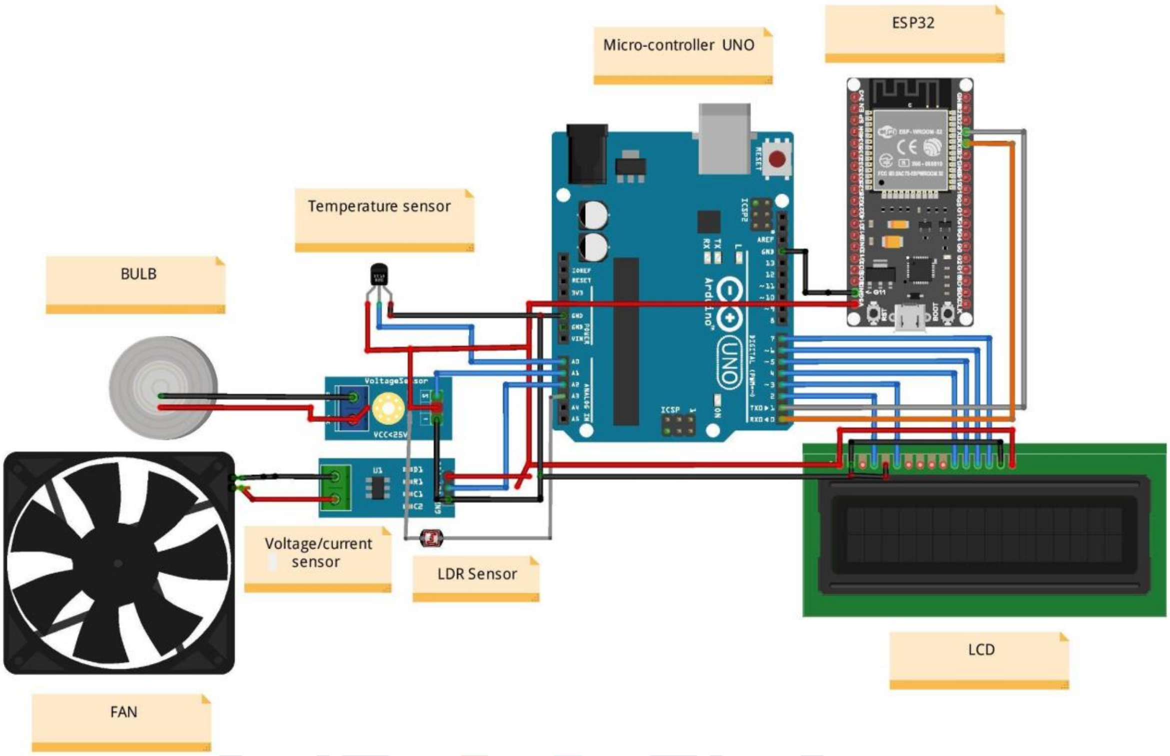
Transmitter:



Reciever:



VII. CIRCUIT DIAGRAM



First, the appropriate connections are made in the correct order. The Arduino Uno is linked to the ESP32 to ensure that the results can be transmitted over WiFi. When triggered, the temperature sensor, voltage/current sensor, and LDR sensor are integrated with the Arduino Uno to provide input value. The input results are obtained from the electrical appliances (here a fan and bulb are used). The Arduino Uno module takes all inputs and outputs results using the provided programming. The LCD is linked to the Arduino Uno to provide real-time output results.

VIII. ALGORITHM AND FLOWCHART

A. Algorithm

Step 1 - Initialization sensor, LCD, IoT

Step 2 – Display initial message

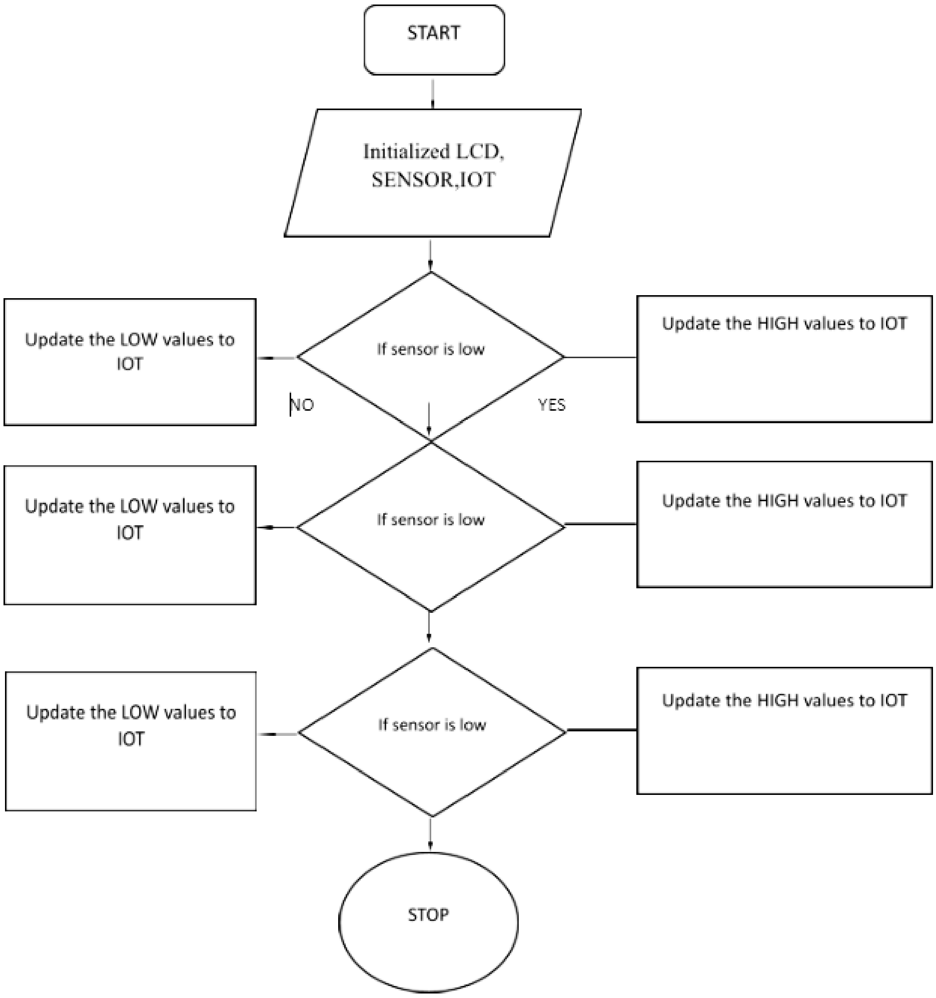
Step 3 – Checking if the sensor gets triggered

Step 4 – Update the unit’s value on the LCD

Step 5 –If sensor value is low or high update the values to IOT

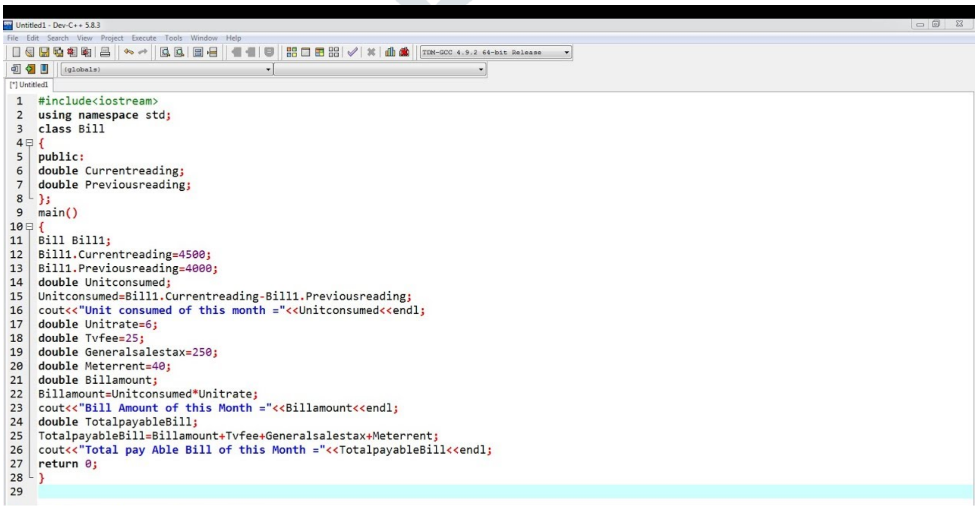
Step 6 – Stop

B. Flowchart



IX. Results

In the results it has been observed that when an electrical appliance is being used, the data regarding the appliance including the time as well as the current and voltage values being used is sent to the Arduino Uno with the help of the array of sensors used. The Arduino Uno then computes the result according to the algorithm and provides the output data in real-time. Depending upon the usage the module also provides informative data to the user through a mobile application or the LCD panel.



```
#include<iostream>
using namespace std;
class Bill
{
public:
double Currentreading;
double Previousreading;
};
main()
{
Bill Bill1;
Bill1.Currentreading=4500;
Bill1.Previousreading=4000;
double Unitconsumed;
Unitconsumed=Bill1.Currentreading-Bill1.Previousreading;
cout<<"Unit consumed of this month ="<<Unitconsumed<<endl;
double Unitrate=6;
double Tvfee=25;
double Generalsalestax=250;
double Meterrent=40;
double Billamount;
Billamount=Unitconsumed*Unitrate;
cout<<"Bill Amount of this Month ="<<Billamount<<endl;
double TotalpayableBill;
TotalpayableBill=Billamount+Tvfee+Generalsalestax+Meterrent;
cout<<"Total pay Able Bill of this Month ="<<TotalpayableBill<<endl;
return 0;
}
```

Fig: Program to calculate Electricity Bill

Fig: The proposed model.

X. FUTURE SCOPE

- As we know nowadays it keeps getting harder and harder to correctly calculate the electricity bill without the help of a government official hence this project can be implemented as a plug-and-play device to make bill monitoring easy.
- Can be implemented on a larger scale consumer end product.
- Can be built from the ground up as a more cohesive product.

XI. APPLICATIONS

Our device can be used in a wide variety of forms:

- The device can be used in commercial households as a plug-and-play device
- The device can also be used in industries, commercial buildings, etc.
- It can also be implemented in govt. sectors where heavy electrical machinery is required.
- Since the project has two methods of implementation it proves to be useful in areas that require a centralized as well as a decentralized approach.

XII. ACKNOWLEDGEMENT

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