IoT Based Efficient Power Consumption Monitoring and Esp32 Controlled Load Management

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Abstract— ***The project aims at developing an efficient IOT based power consumption monitoring and esp32-controlled load management system which helps in monitoring the readings from an energy meter and controlling the switching of the energy meter. This also sends data to the webpage in real time with alert status. The controlling device is a Microcontroller. IOT modem, Relay, LCD, tamper switch and energy meter are interfaced with Microcontroller. The microcontroller is programmed such that it sends the energy readings to the authorities when it exceeds the threshold level of consuming energy. It helps control the energy meter. The readings are displayed on LCD. The Microcontroller is loaded with intelligent programs written using Embedded 'C' language. The modules in the project are an IOT modem for establishing communication between the system at the house and the electricity department, an Energy meter which continuously gives usage details, an LCD to display the current reading of the meter, a Relay to disconnect the power in case of nonpayment of bill.***

Index Terms- LCD, IOT, Microcontroller, relay, modem, power consumption.

I. INTRODUCTION

Monitoring and keeping tracking of your electricity consumption for verification is a tedious task today since you need to go to meter reading room and take down readings. Well it is important to know if you are charged accordingly so the need is quite certain. Well we automate the system by allowing users to monitor energy meter readings over the internet. Our proposed system uses energy meter with microcontroller system to monitor energy usage using a meter. The meter is used to monitor units consumed and transmit the units as well as cost charged over the internet using wifi connection. This allows user to easily check the energy usage along with the cost charged online using a simple web application. Thus the energy meter monitoring system allows user to effectively monitor electricity meter readings and check the billing online with ease. An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result. The "IOT ENERGY METER MONITORING" using ESP32 microcontroller is an exclusive project which is used to designing a completely automated for physically disabled persons.

Consumers who use the IOT-based prepaid energy meter will monitor their real-time energy usage in the web database, as well as manage their whole device from the web database. To make it easier, the number of units required can also be charged in that database. As a result, the user can see how many units have been consumed and how many units remain. Once the given units have been consumed by the customer, the supply will be shut off and the consumer will receive a warning note indicating that all of the paid units have been consumed. In the event of non-payment or any other problem, the supplier retains complete leverage over the customer and can shut off the supply at any time. If the market for energy-efficient systems grows, effective control of device power and use becomes more critical, and it's a challenge that more engineers will have to solve. One approach is to use an analogue to digital converter (ADC) for both current and voltage, then multiply the result in a processor to get power. However, since both the current and the voltage will differ independently of one another, the communications delay and overhead in obtaining the current and voltage information causes time alignment errors in the power calculation.

II. LITERATURE REVIEW

BirendrakumarSahani.al [1] are made a practical model of IOT Based Smart Energy Meter. The proposed model is used to calculate the energy consumption of the household, and even make the energy unit reading to be handy. It reduces the wastage of energy and bring awareness among all.

Mayur Rawte.al [2] are developed a system to solve many problems such as over usage of electricity, large amount of manpower transparency of usage and wastage of money and resources etc. This technology allows verified customers to check status of electricity usage by using Device identification number and password in real time. This can be done from web application using Internet.

III. EXISTING SYSTEM

3.EXISTING SYSTEM

- The existing system i.e. Home automation refers to the use of smart technology and devices to control and manage various aspects of a home automatically or remotely.
- Through a centralized control system or mobile app, homeowners can monitor and control these devices, creating a more convenient and comfortable.
- A complete home automation can be achieved through the use of smart devices, sensors, and interconnected systems.

Drawback:

- It's hard to check energy usage daily without energy data.
- Without an energy meter, you won't have real-time information about how much electricity your device is consuming.
- This lack of awareness makes it difficult to track and manage energy usage effectively.

IV. PROPOSED SYSTEM

In the proposed method, the consumer can manage their energy consumption by knowing their energy usage time to time. This method not only provides two way communications between utility and consumer but also provides other functions that are if the consumer fails to pay the electricity bill the energy supply would be cut down from the utility side and once the bill is paid the energy supply is reconnected. Another huge advantage of this system is that it notifies the consumer & utility at the event of the meter tampering. By this information the consumer & utility can control the tampering are reduce energy crises

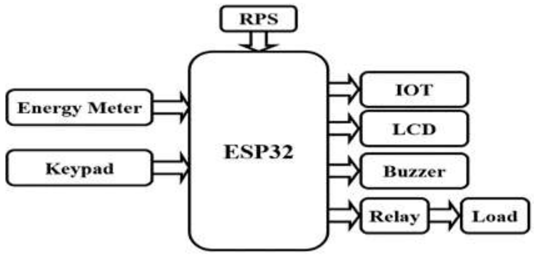


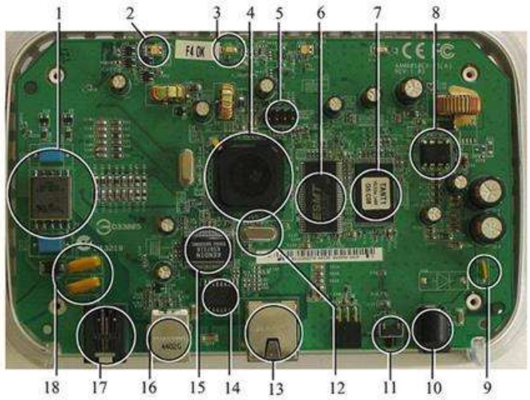
FIG-4.1 Block Diagram

The software aspect of the project is implemented using the Arduino Integrated Development Environment (IDE), providing a user-friendly platform for programming and configuring the microcontroller. The schematic diagram and detailed interfacing of the ATMEG When the various appliances of the household consume energy the energy meter reads the reading continuously and this consumed load can be seen on meter. We can see that the LED on meter continuously blinks which counts the meter reading. Based on The blinking, the units are counted. Normally, 3200 blinks is one unit. In our project we are trying to develop, a system in which ESP32 Uno act as main controller, which continuously monitor energy meter. As per the blinking of LED on energy meter the ESP32 will measure the unit consumption.

WORKING : The smart meter will monitor by using ESP32 microcontroller that is ATMEGA328. It maintains 8bit data size, operating range will be 3.3v to 5v. Wi-Fi module (ESP8266) works under six AT commands. Interfacing the Wi-Fi module, liquid crystal display, buzzer, and meter pulse by using C language on ESP32 ID1.6.9. LCD is 2line 16 characters, here providing 5v to activate and then it displays the IP address which needs to connect the Wi-Fi module to send the data to processor. The crystal oscillator is used to convert the digital current signals to alternate current signal which requires maintaining the entire module of energy monitoring system. Load takes 5v power from the power transformer. Energy meter will read the pulse to calculate the amount of consumed power. Here meter pulse will be counted for calculating how much power is consumed by the consumer. One example to calculate the amount for consumed power.

V. EMBEDDED SYSTEMS

5.1 Embedded Systems: An embedded system is a computer system designed to perform one or a few dedicated functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today. Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. For example, air traffic control systems may usefully be viewed as embedded, even though they involve mainframe computers and dedicated regional and national networks between airports and radar sites. (Each radar probably includes one or more embedded systems of its own.) Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.



5.1.1 History: In the earliest years of computers in the 1930–40s, computers were sometimes dedicated to a single task, but were far too large and expensive for most kinds of tasks performed by embedded computers of today. Over time however, the concept of programmable controllers evolved from traditional electromechanical sequencers, via solid state devices, to the use of computer technology. One of the first recognizably modern embedded systems was the Apollo Guidance Computer, developed by Charles Stark Draper at the MIT Instrumentation Laboratory. At the project's inception, the Apollo guidance computer was considered the riskiest item in the Apollo

5.4 APPLICATIONS OF EMBEDDED SYSTEMS:
5.4.1 Consumer applications: At home we use a number of embedded systems which include microwave oven, remote control, vcd players, dvd players, camera etc….

5.4.2 Office automation:
We use systems like fax machine, modem, printer etc …

5.4.3. Industrial automation:
Today a lot of industries are using embedded systems for process control. In industries we design the embedded systems to perform a specific operation like monitoring temperature, pressure, humidity ,voltage, current etc.., and basing on these monitored levels we do control other devices, we can send information to a centralized monitoring station.

VI. HARDWARE DESCRIPTION

6.1 Micro controller:

- Integrated Crystal– 40 MHz
- Module Interfaces– UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, capacitive touch sensor
- Integrated SPI flash– 4 MB
- ROM– 448 KB (for booting and core functions)
- SRAM– 520 KB
- Integrated Connectivity Protocols– WiFi, Bluetooth, BLE
- On–chip sensor– Hall sensor

The original ESP32 chip had a single core Tensilica Xtensa LX6 microprocessor. The processor had a clock rate of over 240 MHz, which made for a relatively high data processing speed. More recently, new models were added, including the ESP32-C and -S series, which include both single and dual core variations. These two series also rely on a Risc-V CPU model instead of Xtensa. Risc-V is similar to the ARM architecture, which is well-supported and well known, but Risc-V is open source and easy to use. Specifically, Risc-V and ARM have good support from GNU compilers, while the Xtensa needed extra support and development to work with the compilers.

VII. SOFTWARE DESCRIPTION

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.here are currently two versions of the Arduino IDE, one is the IDE 2.0.0.

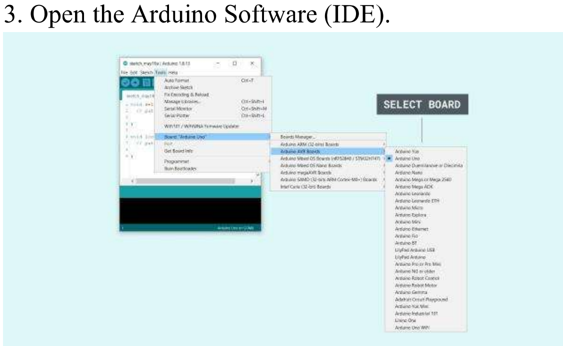
7.1 Arduino IDE – Compiler

here are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x.

The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.

The following steps can guide you with using the offline IDE (you can choose either IDE 1.x.x or IDE 2.x):

1. Download and install the Arduino Software IDE:
   - Arduino IDE 1.x.x (Windows, Mac OS, Linux, Portable IDE for Windows and Linux, ChromeOS).
   - Arduino IDE 2.x
2. Connect your Arduino board to your device.
3. Open the Arduino Software (IDE).



VIII. SOURCE CODE

```
#include <LiquidCrystal.h>
#include <stdio.h>
```

```
LiquidCrystal lcd(6, 7, 5, 4, 3, 2);
unsigned char rcv,count,gchr,gchr1,robos='s';
//char pastnumber[11]="";
float voltage=0;
int sti=0;
String inputString = ""; // a string to hold incoming data
boolean stringComplete = false; // whether the string is complete
int m1a = 8;
int m1b = 9;
int pwm_pin = 10;
int cntlmk=0;
void okcheck()
{
unsigned char rcr;
do{
rcr = Serial.read();
}while(rcr != 'K');
}
```

IX. ADVANTAGES AND APPLICATIONS

1. Real-time Monitoring: Prepaid smart meters enable consumers to monitor their energy consumption in real-time. This helps users become more aware of their usage patterns and encourages energy conservation

2. Remote Management: Utility providers can remotely manage and monitor prepaid smart meters, eliminating the need for physical meter readings. This remote accessibility streamlines the billing process and reduces operational costs.

3. Prepayment System: Consumers can load credit onto their prepaid meters using various payment methods such as mobile apps, online platforms, or designated payment points. Once the credit is loaded, the meter deducts the corresponding amount based on actual usage.

4. Budget Control: Users have greater control over their energy budget since they can monitor their remaining credit and adjust their usage accordingly. This can be particularly helpful for budget conscious consumers or those with fluctuating income.

5. No Bill Surprises: With prepaid meters, consumers do not receive monthly bills, avoiding any surprises at the end of the billing cycle. This can help users manage their finances more effectively.

6. Improved Accuracy: Prepaid smart meters provide accurate and real-time data, reducing the likelihood of billing errors. This transparency enhances trust between consumers and utility providers.

X RESULT

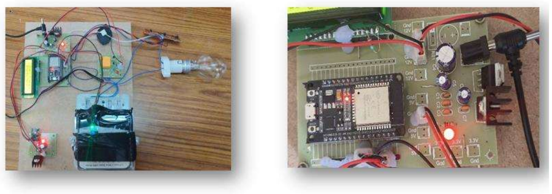


FIG-10.1 HARDWARE KIT

CONCLUSION

We designed and implemented IOT smart prepaid energy meter using Arduino, esp8266 IOT module, LCD, Buzzer, Relay and Load. The proposed IOT based energy meter is easy to install and beneficial for both energy Provider and Customer. This reduces revenue cost and reduces the human errors and problems like over running of the meter etc. This leads to reduction of outstanding dues. This device improves usage level and energy monitoring

- By using this project, we can reduce the manual effort to take the reading from the energy meter which is cost effective.
- It is user friendly and we can enhance this project, in which an electricity department can send message to the consumer about the billing information.

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