IOT based Energy Meter with Smart Monitoring of Home Appliances

Dr.R.Jennie Bharathi [1], A. Janani[2], S. Kamalesh[3], S. Kamalraj[4]
Assistant Professor(SG) 1, UG Scholar [2,3,4]
Department of Electronics and Communication Engineering,
Saveetha Engineering College, Chennai, India

ABSTRACT- Today, technology has changed all over the world in the way that humans interact with the physical world. The Internet of Things has paved the way for us by allowing us to embed technology in everyday physical objects. In this paper, an energy meter with smart home appliance monitoring function based on Internet of Things is built. This paper proposes a system that eliminates labor by manually adjusting meter readings and generating invoices, minimizing errors that are a major cause of energy-related corruption. The requirement for transparency in the field of energy estimation has arisen due to the lack of verification basis. The ATmega328P is used as the central control unit in this system. For the energy meter, the ZMPT101B voltage sensor and the ACS712 current sensor are interfaced with a microcontroller. Indicators of voltage, current, power consumption, no. Units and corresponding prices are calculated and displayed on the 16*2 LCD display modules. Monitoring of home appliances is performed using a 2-channel relay module to which the loads are connected. And operate through web-based technology that is interfaced with an IoT-based web application. A DHT11 sensor is used to monitor the temperature and humidity in the house. All readings taken from the sensor are sent to the cloud storage via the ESP8266 Wi-Fi module.

Keywords— *ESP8266 WiFi-Module, ATmega328P Microcontroller, IOT, Web App, Energy meter.*

I. INTRODUCTION

Today, technology is implemented in everyday physical objects. With its advancement, we can teach subjects to respond to our presence, our movements, and other automatic physiological behaviors. A gadget called an energy metre can be used to measure energy use. To avoid large bill usage, the user is notified about the cost and frequent utilisation of power consumption. The energy metre displays the number of units spent and transmits the information to both the client and the electrical board, minimising manpower. The user may monitor their Power use at any time and from anywhere. Using relay and Arduino interface, the Internet of Things is utilised to turn on and off domestic appliances. This system's goal is to keep track of how much power is used. By lowering total Power usage, both the distributor and the customer will gain.

RELATED WORK

[1] Mr. Vishal Kumar conceived a part of a distributed system that measures the main power system quantities and gives the possibility to manage the whole power plant.

[2] System giving SMS for everyday consumption is developed by Patel using the first type metering method.

[3] A brief review on the IoT-based energy management system in the smart industry was given by Bagdadee.

[4] Mr. Liyanage reviews the state-of-the-art applications of DL in smart grids and demand response, including electric load forecasting, state estimation, energy theft detection, energy sharing and trading.

[5] Mr. Mishra created a webpage for interfacing with consumers where they can monitor the power usage from their home.

[6] Mr. Vishnukant proposes a system which eliminates manpower by self-regulating meter readings and bill generation.

[7] Mr. Ahmed identified a New technology raised in recent years is known as Cloud IoT or the Cloud of Things (CoT). And proposed the optimization of energy schemes for the CoT by applying a Genetic Algorithm (GA).

[8] Hashmi presented the architecture framework, design, and implementation of an IoT and cloud computing-based EMS.

[9] The paper of Bharathy mainly deals with smart energy meter, which utilizes the features of embedded systems.

[10] Naziya Sulthana proposed a system with objective to monitor the amount of energy consumed to benefit both the distributer and consumer.

II. PROPOSED WORK

We often come across the word Internet of Things. IoT has the ability to communicate with many different sensors, devices and people allowing a seamless connection between humans and machines. As a step forward in IoT devices, we offer IoT- based energy meters with smart home device monitoring. This system uses the ATmega328P microcontroller as the main control unit. The functions of this project fall into two categories, namely energy meters with digital display and monitoring of home appliances using IoT. For the energy meter, the microcontroller is interfaced with the voltage sensor (ZMPT101B) and current sensor (ACS712). The values are noted and the units are measured with the corresponding values and therefore the price is calculated. The acquired output is displayed on a 16*2 LCD modules. Collected readings are sent to cloud (web) storage via Wifi, where they are recorded and analyzed. Home appliance monitoring is achieved by connecting the 2-channel relay module to the ATmega328P. Loads are connected to the relay module and operated through a web technology platform that is interfaced with an IoT based web application. A humidity and temperature sensor is interfaced for noting and monitoring the room temperature. Fig.1 depicts the structure diagram.

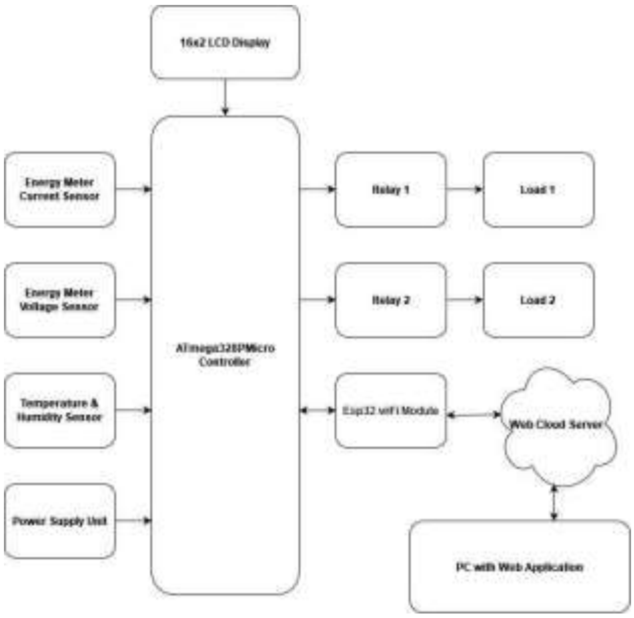


Fig.1: Block Diagram

Fig.2: Hardware Implementation

III. WORKING FLOW

The system can perform two functions simultaneously i.e. energy meter and home appliance monitoring with a single source code uploaded to the microcontroller.

A. The System when used as an energy meter device

The ATmega328P receives a working power supply (5V) and it is interfaced with a ZMPT101B voltage sensor calibrated to measure voltages up to 250V with an ACS712 current sensor detecting currents up to 30A. The wires of the main line are connected to the sensors, and the readings of the voltage and current sensors are recorded on the serial monitor. Unit quantity and price are calculated by:-

Power (kilowatts) = (Vrms*Irms)/1000

Units= Power*(3/3600)

Rupees= Units*6.77

The output is displayed on the LCD module and the collected output is sent to the cloud storage via the WiFi module where it is monitored and analyzed. The main line is operated via a 2-channel relay. Fig.3 shows the flowchart.

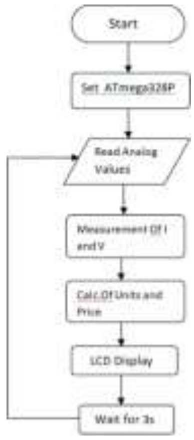


Fig. 3: Flowchart for smart energy metering

B. The system used for home appliances

ATmega328P interfaced with a 2-channel relay module is an electromechanical switch used for high power load monitoring. A DHT11 sensor is connected to monitor the current ambient temperature and humidity Various loads such as light bulbs, fans, TVs, and air coolers are powered by IoT-based web applications. It connects to the microcontroller via the ESP8266 WiFi module. Users can use web technology to interact with the device. Flowchart describes the process in Fig.4.

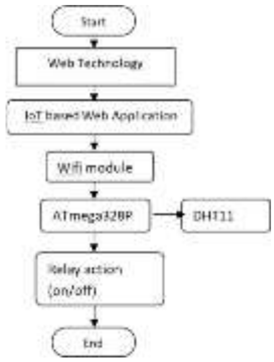


Fig. 4: Flowchart for Home Monitoring

IV. SYSTEM HARDWARE & SOFTWARE

A. Arduino ATMEGA-328

It consists of various types of memory such as flash memory, EEPROM, and SRAM. The length of the Arduino board is about 68.64mm and the width of the microcontroller is about 53.4mm. The Arduino microcontroller weighs about 20g. You can use different types of microcontrollers. B. 8-bit AVL

Atmel microcontroller and 32-bit Atmel Arm microprocessor. Of these different types of processors, you can use them for different engineering projects and industrial applications.

Fig.5: Arduino ATMEGA-328 Pin configuration

Fig.6: Arduino ATMEGA-328

B. ESP8266 IOT

NodeMCU is an open source IoT layer. This includes devices that depend on the firmware and ESP12 modules running on Expressive Systems' ESP8266 WiFi SoC. The term NodeMCU usually refers to firmware and the board is called the devkit. NodeMCU Devkit 1.0 consists of the associated ESP12E on the board, which makes it easy to use. In addition, it includes a transformer and a USB interface. The phrase NodeMCU (Node Micro Controller Unit) is an open source hardware and software development environment built on top of a very inexpensive SystemonaChip (SoC) called ESP8266. The ESP8266, designed and manufactured by Express, contains all the important elements of a modern computer: CPU, RAM, network (Wi-Fi), even a modern operating system and SDK.

Fig 7: NodeMCU (ESP8266) Development Board

C. Two Relay

Relays are simple switches that are electrically and mechanically operated. The relay consists of an electromagnet and a series of contacts. The switching mechanism is carried out with the help of electromagnets. The main operation of relays is where only low power signals can be used to control the circuit. It is also used when many circuits can be controlled using only one signal. A relay is built into this circuit. The driver circuit contains transistors for switching operation. Transistors are used to switch relays. An isolated circuit prevents reverse voltage from the relay and protects the controller and transistors from damage. The input pulse for switching transistors is given by the microcontroller unit. It is used to switch between the two devices. These were used to switch signals sent from one source to another.

Fig.8: Two Relay

D. AC Current Sensor

The current sensor (CT1270) is a device that detects the current (AC or DC) in the wire and produces a proportional signal. The generated signal is an analog voltage or current, and even a digital output. A voltage drop occurs when a current flows through a wire or circuit. Therefore, there are two types of current detection, direct and indirect. Direct detection is based on Ohm's law, while indirect detection is based on Faraday and Ampere's law. Direct sensing measures the voltage drop associated with the current through passive electrical components. Indirect detection measures the magnetic field surrounding. The current sensor used here is CT1270. Based on the Hall Effect principle, the CT1270IC is used to measure the current. Here, we use the CT1270IC, which measures currents up to 30A. Both sensors are connected to the analog pins of the Arduino Mega. The sensor used is shown in Figure 9.

Fig.9: AC Current Sensor

E. AC Voltage Sensor

The stress sensor block represents the ideal stress sensor. A device that converts a voltage measured between two points in a circuit into a physical signal proportional to the voltage. The AC voltage sensor operates according to magnetic modulation and is designed for AC voltage measurement. The output of this sensor is proportional to the AC input voltage. It can be used for continuous AC voltage monitoring of the system. The proposed system uses voltage and current sensors to calibrate the number of units consumed. Here, we use the ZMPT101B voltage sensor. It is based on a precision voltage converter with accurate AC voltage measurements. This is a lightweight sensor module that can measure up to 250 volts. Its supply voltage varies from 5V to 30V and the operating temperature is from 40 degree to 70 degree.

Fig.10: AC Voltage Sensor

F. 16*2 LCD

An LCD display designed for Eblock. This is a 2-line, 16-character alphanumeric LCD display connected to a single 9-pin D connector. This allows you to connect your device to most EBlock I / O ports. The LCD display requires the serial format data described in the following manuals. The display also requires a 5V power supply. Be careful not to exceed 5V as it can damage your device. 5V is optimally generated by the Eblocks Multi programmer or a fixed stabilized 5V power supply. The 16 x 2 intelligent alphanumeric dot matrix displays can display 224 different characters and symbols.

Fig.11: LCD

G. Wi-Fi Module- ESP8266

Manufactured by Espressif Systems, it is a Wi-Fi module that supports embedded IoT applications. It features 2.4 GHz Wi- Fi with a 32-bit RISC CPU based on the Tensilica xtensa L106. It comes with 64 KB of RAM (instructions), 96 KB of data RAM, and 64 KB of boot RAM, and is widely used because it is a low-cost stand-alone wireless transceiver.

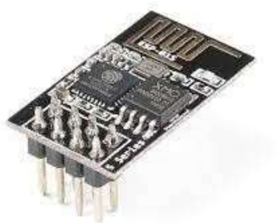


Fig.12: Wi-Fi Module

H. Temperature and Humidity Sensor

Humidity is a measure of the water vapor present in the air. Humidity affects a variety of physical, chemical and biological processes. In industrial applications, moisture can affect product operating costs and employee health and safety. Therefore, humidity measurement is very important in the semiconductor and control system industries. Humidity measurements that can be a mixture such as water vapor, nitrogen, argon, or pure gas. There are two types of humidity sensors based on the unit of measurement. Relative humidity sensor and absolute humidity sensor. DHT11 is a digital temperature and humidity sensor. The maximum current used during the measurement is 2.5mA. The DHT11 sensor has four pins VCC, GND, data pins, and one unconnected pin. 5k-10k ohm pull-up resistors are available for communication between the sensor and the microcontroller.

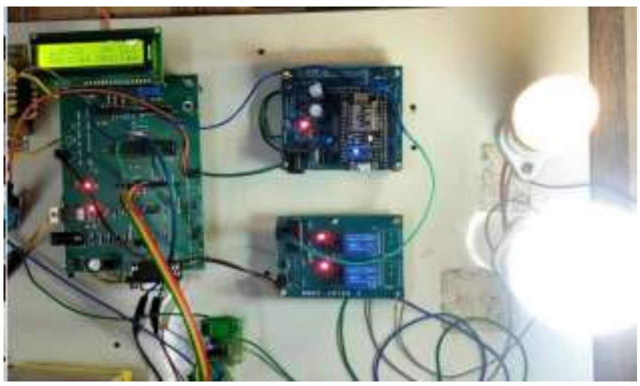
determine the amount of water present in a gas

Fig. 13: Temperature & Humidity sensor

I. IOT and Software Platform

Programs written using Arduino Software (IDE) are referred to as sketches. These sketches are written within side the textual content editor and are stored with the record extension .ino. The editor has functions for cutting/pasting and for searching/changing textual content. The message region offers comments whilst saving and exporting and additionally shows errors. The console shows textual content output with the aid of using the Arduino Software (IDE), inclusive of entire blunders messages and different information. The backside right hand nook of the window shows the configured board and serial port. The toolbar buttons can help you confirm and add programs, create, open, and shop sketches, and open the serial monitor.

V. RESULTS



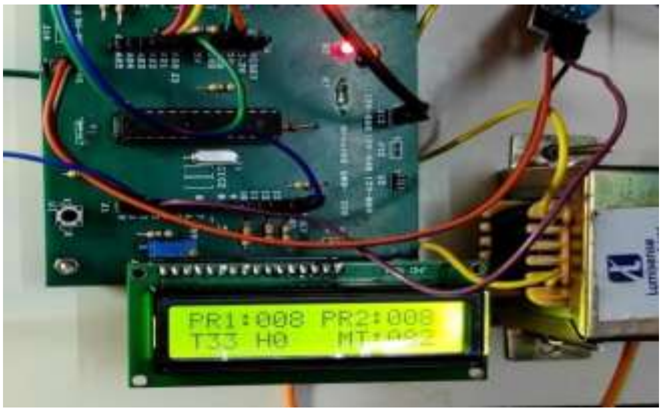


Fig.13

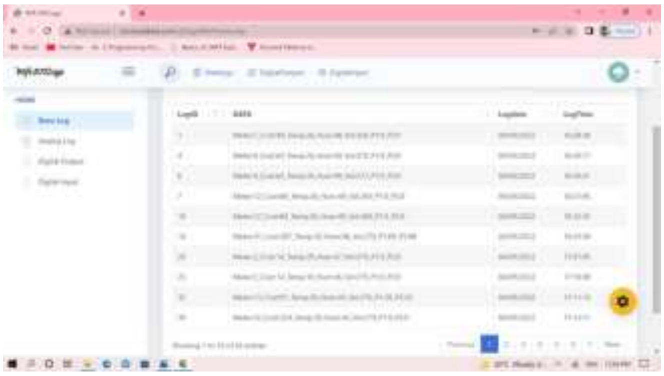


Fig.14 Output(without exceed warning)

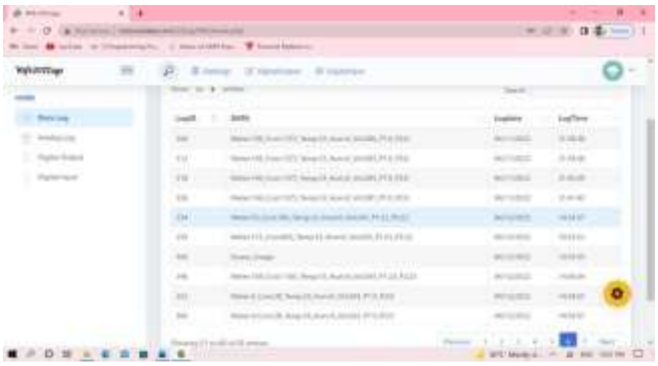


Fig 15: Output(with exceed warning)

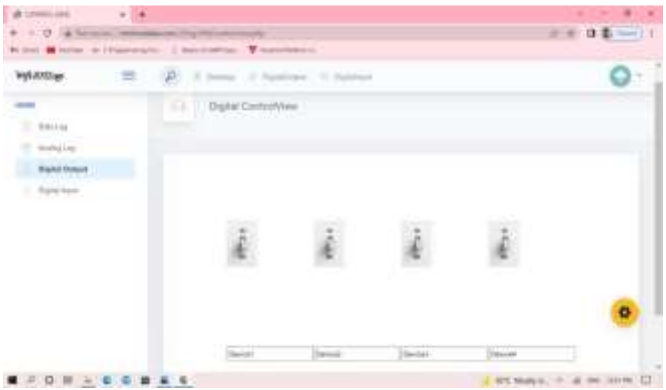


Fig16: Digital Control

CONCLUSION AND FUTURE WORK

Figures 13,14 and 15 shows the results of number of units and power consumption. Checking the operation of the system gives very important results. Current and voltage sensor readings, along with consumed units and prices, are obtained on the output screen of the Arduino IDE platform. The value was displayed on the 16 * 2 LCD modules. This cycle was repeated with a delay of 3 seconds. An analog analysis of the resulting data is displayed in cloud storage transmitted over a Wi-Fi network. Similar results are shown in Figures 12, 13 and 14. Both appliances are monitored by IoT-based web applications. This feature is handled by the WiFi network (ESP8266 module) and helps improve the usability of the device. Figure 13 shows the output of a serial monitor.

Overall, the performance and functionality of the system is well monitored with moderately important power, and safety measures also help reduce power consumption.

The ATMEGA328-based energy meter and smart appliance monitoring system are energy efficient systems that perform two functions on a common microcontroller board. In addition, the microcontroller used in this system allows for more computer interfaces for other devices and is properly connected via the ESP8266 WiFi network. From the results obtained, get an overview of the proposed work system.

In the future, many more advanced features will be able to be integrated into the device as of consisting of the web server by the electricity authorities for storing the data,take the necessary steps against electricity theft, and provide many other services in a convenient and fast way. Features like paying bills directly from the cloud where we see our log without using separate platforms to pay bills which makes life more fast and convenient.

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