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IOT BASED SMART ENERGY METER USING NODE MCU

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Abstract

In our nation, electricity use is continuously growing day by day. Technology is changing people's lives, reducing their reliance on manual labour, and boosting national economic growth thanks to the industries' increasing use of wireless communication. Before manual reading techniques were widely used, workers had to put in a lot of effort. A representative from the electricity office visited our home, took a manual reading, and then calculated or estimated the amount of the consumer's bill to send it to them. It will be challenging for them to manage and compute the bill because each house worker must go to each area to take the reading and then return if the consumer is not present. It is impossible to receive an exact bill or prevent consumers from receiving more money than their consumption unit when doing all these chores since they occasionally make mistakes when taking readings or calculating the bill, misplace the bill, or both. Only IoT can help to solve all the problems; it is used to provide accurate metre readings over the internet without the need for human intervention, used to reduce power consumption and use only the necessary amount, and used to protect the system from theft if someone attempts to misuse the electricity or if the user did not pay the given bill for whatever they consumed at a given time. Relay hosts will then automatically cut the supply from the remote area. In this work, NodeMCU and IoT are used to transform a conventional metre reading into a smart metre reading. Given that they can view their daily energy consumption, consumers can adjust their power usage as necessary.

Keywords: IoT, Energy meter, electricity, NodeMCU, energy consumption

1. INTRODUCTION

The world is shifting towards automatic wireless technologies, which favour not only minimizing human efforts but also aiding in the autonomous and efficient operation of systems. When a system can act autonomously and make decisions without being told what to do, this is referred to as intelligence. An energy or electric metre counts the

number of electrical units consumed by all of the devices that draw power from the main power source. There are two types of meters on the market to monitor unit consumption: electromechanical and electronic metres.In rural areas, where adoption of contemporary technology is lower than in cities, electromechanical metres are frequently utilized [1]. Nowadays, electromechanical metres are obsolete. Electromechanical metres are replaced by electronic metres. The LCD/LED in this metre is used to display the reading. On the metre, a calibration led is utilised to display the expended units. To read the metre and record the reading, labour is needed. The reading on the metre, which is used to calculate the electricity bill, is rising.

The same activity is performed by an IOT-based smart electricity metre and billing system without the need for human labour [2]. A microcontroller board called the Arduino Mega is used to control IOT-based SEM systems. This board was chosen for its effectiveness and memory. In terms of memory and GPIO, it is more effective. The acquired data is subsequently uploaded to the cloud over the internet. Using the internet, it is simple to send data wirelessly across great distances without any noise interference. The data is incredibly accurate and efficient because there is no human involvement because it is delivered directly to the cloud, where there are no range or distance issues [3]. Due to their restricted range, other wireless technologies like Zigbee and Bluetooth cannot be used efficiently over very long distances. In order to change the existing issues the electricity board and the user are currently facing, this paper envisions the usage of the internet and the idea of IOT to keep base stations and users informed of the current consumed units. The distribution businesses are unable to keep up with the shifting maximum demand of consumers under the current invoicing scheme. Even though bills are paid on time, the consumer still has issues with receiving past-due bills for payments that have already been made as well as with the reliability and quality of the electrical supply [4].

The solution to all of these issues is to regularly monitor consumer load in order to ensure proper billing, monitor peak demand, and identify threshold values. The current article "IoT Based Smart Energy Metre" covers the issues that distribution businesses and customers both face. The focus of the study is the smart energy metre, which combines hardware and software to provide desired functionality using embedded system capabilities. In order to introduce the "Smart" notion, the article compares Arduino and other controllers and discusses how GSM and Wi-Fi modems can be used. The consumer and service provider can both access the consumed energy reading and associated amount using a GSM modem [5]. Consumers can also receive text-based notifications via GSM when they are approaching a threshold value that they have defined. The user can also track his read material with the aid of a Wi-Fi modem and can change the threshold value via a website. With the use of this method, the electricity department can read the meter readings monthly without having to send someone to each home. This can be done by using an Arduino device which tracks and stores energy metre readings in a permanent (non-volatile) memory location. On request, the consumer can view the live metre reading on a webpage where this system continuously records the measurement [6],. When necessary, this device can also be used to cut off the house's power supply.

2. PROPOSED SYSTEM ANALYSIS

The power board is accustomed to the manual process and follows it even if there are many concerns involved. The client's difficulty is to get yet corrected from the energy supply board due to human errors after receiving staff charge. All things considered, the client must go to the location, wait in queue, and have it fixed. The problem is the outcome of human intervention. In this new era, a programmed reading metre reading framework was created to prevent human errors in the construction process.

2.1 PROPOSED SYSTEM

The consumer can manage their energy use using the suggested strategy by periodically becoming aware of their energy use. In addition to providing two paths of communication between the utility and the customer, the strategy also offers a number of additional features, such as the ability for the utility to cut off the customer's access to electricity if they fail to pay their bill until they do. With the suggested method, the client can manage their energy use by periodically being aware of it. The plan not only provides two-way communication between the utility and the customer, but it also offers additional features, such as the ability for the utility to cut off the customer's access to power until the bill is paid and then re-connect it. Everything in the world in which we live depends on electricity. We may put it simply by saying that electricity rules the planet. As a result, power consumption has become a crucial factor in every industry. When we look at the electricity bill, we occasionally wonder if it will surpass our monthly budget. The only way to get out of this scenario is with an effective monitoring and regulating system. One such technique is the suggested system. Simply put, the goal of the proposed system is to develop a user-friendly system for tracking energy consumption in real time. Some electronic gadgets collect data, which NodeMCU is used to send to the server.

2.2 SYSTEM ARCHITECTURE

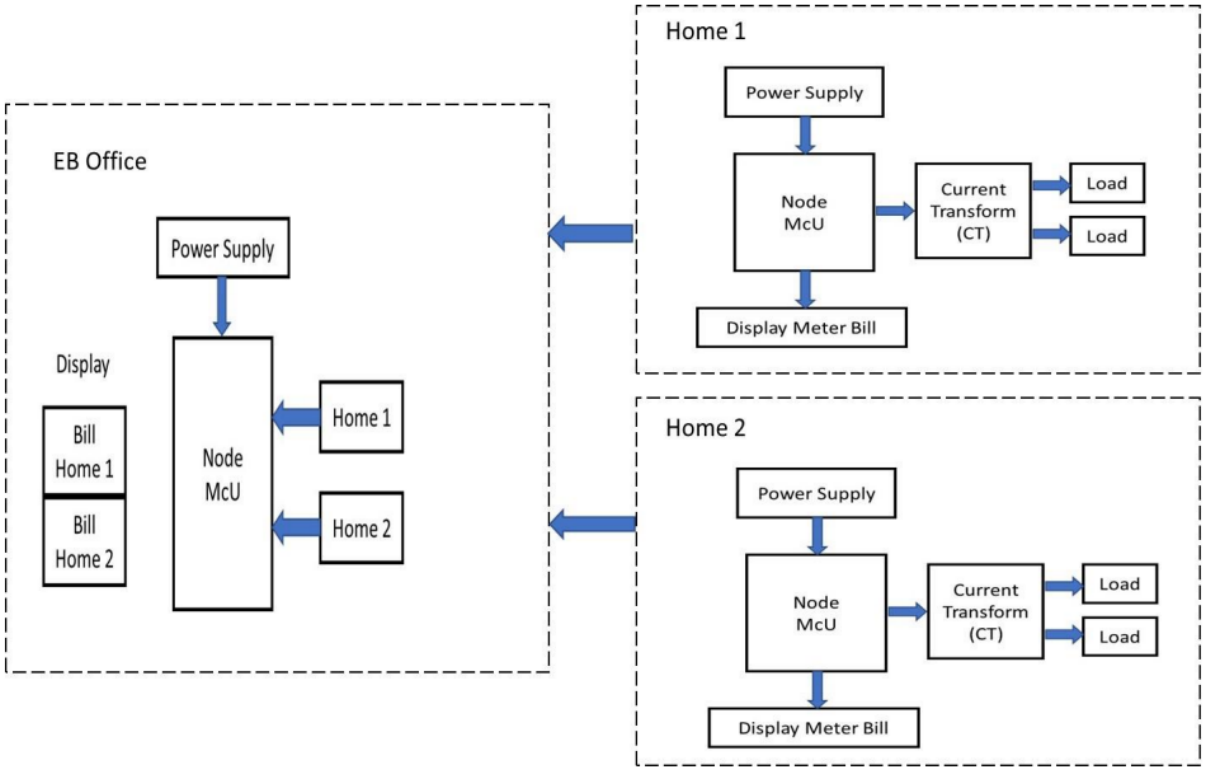

Fig 1 .Proposed methodology architecture

When power is supplied to the energy meter's input terminals from the main (substation or power station). Two input terminals and two output terminals are often seen on an energy metre.By connecting the input terminals of the energy metre and the input terminals of the ac converter in series, input from the energy metre is provided to the ac converter (220v to 12v). With this converter, 230V AC is changed into 12V DC. The converter's output is this 12V DC supply. The voltage regulator receives this output as input. The regulator's output is provided to the Node MCU as Vin's input. The load receives the energy meter's output. By shorting the lamp terminal, one of the output terminals is linked to the lamp load. The current sensor connects the second terminal to the switches. There are two terminals on the current sensor. The analogue output terminal of the Node MCU is linked to one terminal, while the other is grounded. We supply the energy metre at that time. Through the output terminal, which first passes through the current sensor, it transfers to the load. The Node MCU receives the current sensed by this current sensor by way of the wire. We linked to the Blynk app interfaces using Node MCU. It is an IOT platform used to manage Node MCU and Arduino. Create a new project with the name "IOT based smart energy metre" in the Blynk app. Finally, we insert a notification bar in a Blynk app so that when the load is reached and the threshold value, it sends a notification alert to the Mobile through the WiFi module of Node MCU. The page will now display how much load we consume and the cost of power consumed by the load over the course of a month.

3. HARDWARE DESCRIPTION

3.1 POWER SUPPLY

There are numerous varieties of power sources. The majority are made to transform AC mains power into a suitable low voltage source for electronic circuits and other devices. A power supply can be divided into a number of blocks, each of which serves a specific purpose [7]. The step-down transformer is provided the AC supply main in this instance. The transformer that has various voltages

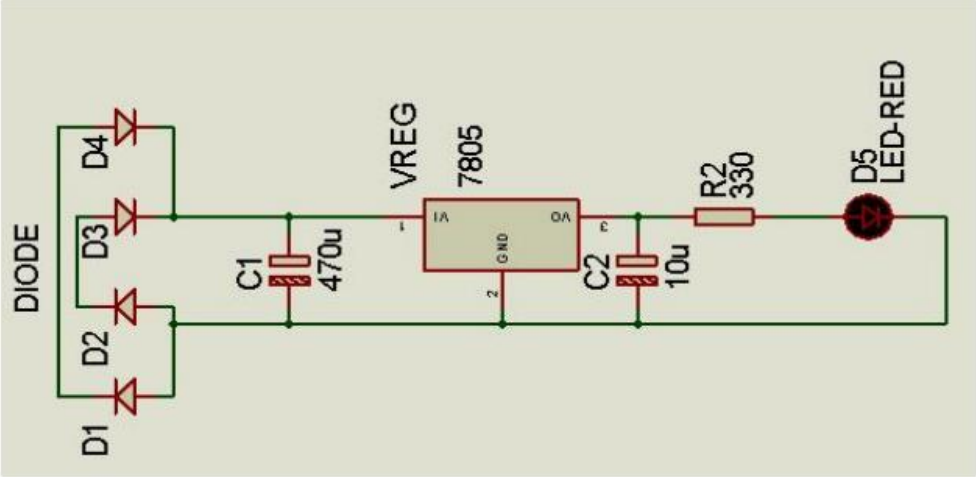

Figure 2 Circuit Diagram of Regulated Power Supply

3.2 BRIDGE RECTIFIER

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a fullwave rectifier. Smoothing is performed by a large value electrolytic capacitor connected across the DC Supply to act as a reservoir, supplying current to the output when the varying DC Voltage from the rectifier is falling [8]. The fig 3 shows the unsmoothed DC, smoothed DC by the filter capacitors. The capacitor charges quickly near the Peak of the varying DC, and then discharges as it supplies current to the output [9].

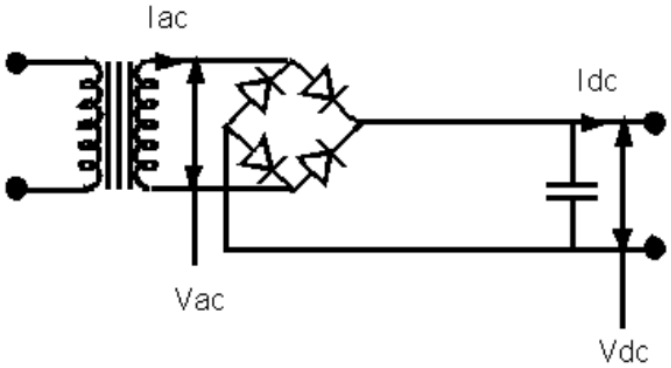

Figure 3 Bridge Rectifier

3.3 REGULATOR

Voltage regulators ICs are available with fixed (typically 5, 12 and 15V) or variable Output voltages. They are also rated by the maximum current they can pass. Negative Voltage regulators are available, mainly for use in dual supplies [10]. Most regulators include some automatic protection from excessive current and Overheating. Many of the fixed voltage regulator ICs has 4 leads and look like power transistors, Such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

3.4 NODEMCU

The NodeMcu is an open-source firmware and development kit that helps you to Prototype your IOT product within a few Lua script lines. The ESP8266 is a very low-cost Systemon-a-Chip (SoC), and the NodeMCU (Node MicroController Unit) is an open source software and hardware development environment that is based on it. The ESP8266, created and produced by Express, includes all essential components of a contemporary computer, including a CPU, RAM, networking (wi-fi), and even a contemporary operating system and SDK. The ESP8266 chip costs only $2 USD per unit when purchased in bulk. It is therefore a fantastic option for this system design [11].

The NodeMCU aims to simplify ESP8266 development. It has two key components.

- An open source ESP8266 firmware that is built on top of the chip¬ manufacturer's proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn. And to add on NodeMCU can be programmed with the Android IDE too.
- A development kit board that incorporates the ESP8266 chip on a standard¬ circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standardsized GPIO (General Purpose Input Output) pins that can plug into a bread board.

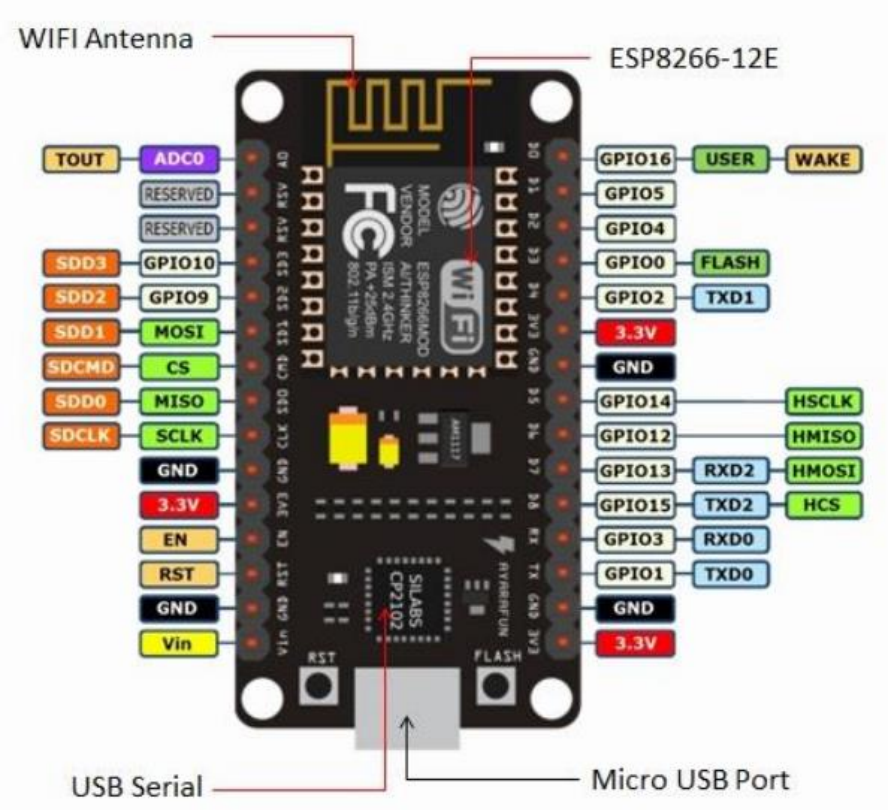

Fig 4 xxcv 67 Node MCU Pin diagram

The ESP8266 WiFi Module is an integrated TCP/IP protocol stack-equipped self-contained SOC that allows any microcontroller access to your WiFi network. The ESP8266 is capable of offloading all Wi-Fi networking tasks from another application processor or hosting an application. Each ESP8266 module has an AT command set firmware that has been pre-programmed, so all you need to do is connect it to your Arduino device to obtain nearly the same amount of WiFi functionality as a WiFi Shield (and that's just right out of the box) [12].The ESP8266 module is a very affordable board with a sizable and expanding community.

Through its GPIOs, this module may be coupled with sensors and other application-specific devices with a minimum of upfront development and runtime loading thanks to its robust on-board processing and storage capabilities. Because of its high level of on-chip integration, it only requires a small amount of external circuitry, and even the front-end module is made to take up little space on the PCB. The ESP8266 includes a self-calibrated RF that enables it to operate in all operational environments and does not require any external RF components. It also supports APSD for VoIP applications and Bluetooth coexistance interfaces. The ESP8266 has access to a nearly endless supply of knowledge, all of which has been made possible by the great community support. You may discover several tools to help you use the ESP8266, including instructions on how to turn this module into an IoT, in the Documents section below.

- NodeMCU is an open source IoT platform. Which includes firmware which runs on the ESP8266 Wi-Fi Module from Espressif Systems,and hardware which is based on the ESP-12 module [13].

- The term "NodeMCU" by default refers to the firmware rather than the dev kits. NodeMCU firmware was developed so that AT commands can be replaced with Lua scripting making the life of developers easier. So it would be redundant to use AT commands again in NodeMCU.
- The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and microcontroller capability

3.5 SOFTWARE DESCRIPTION

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. The IDE is launched when the Arduino programme is launched. To make things as clear-cut and uncomplicated as possible, it has been purposefully streamlined. When a file is saved in Arduino, it is referred to as a sketch; this is where written computer code is saved.The programming language used by Arduino is extremely similar to C++, which is well used in the field of computing [14]. The code you learn to write for Arduino will be extremely similar to the code you learn to write for any other computer language because all the fundamental concepts are the same. If you decide to study other programming languages, you simply need to learn a new dialect. The process of compiling is seamless to the user. All you have to do is press a button. If you have errors in your computer code, the compiler will display an error message at the bottom of the IDE and highlight the line of code that seems to be the issue.

4. CONCLUSION

The primary motivation for the construction of an IOT-based E-meter is to lower household power usage. It saves money and human power by avoiding human interference. Both automatically and manually, it functions. Without requiring human participation, this metre sends billing immediately to a mobile device before the due date. First, we need to turn on the mains, which detects how much electricity the load is using. Analogue output is provided by this. The monitoring hardware system is connected to the internet using the Node MCU. The cloud, or Thing Speak cloud, graphically displays the amount of electricity used by the load. It periodically displays how much electricity is being used by the linked load or loads. An novel IOT application called energy monitoring was created to enable remote cloud-based home appliance control from any location in the world. In the project under consideration, a current sensor is employed to gauge the current and show it online via IoT. The system uses the public cloud THINGSPEAK to update the information on the internet every 1 to 2 seconds. Wi-Fi is used in the current system to access energy load consumption, which will aid users in reducing unnecessary electricity use. IoT technology that enables online bill payment and energy use monitoring. Additionally, a system that sends an SMS to a user when their electricity usage exceeds a certain threshold can be installed. When theft is discovered at the consumer end, we can create systems that can SMS the concerned metre reading man of that region. Additionally, we can forecast future energy consumptions utilising cloud analytics.

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