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Smart Electricity Meter Using ARM Controller

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Abstract -In the most of the developing countries, the effort of collecting electricity utility meter reading and detecting illegal usage of electricity is a very difficult and time consuming task which requires a lot of human resources. Energy meter reading and monitoring system using Internet of Things (IoT) present an efficient and cost-effective way to transfer the information of energy consumed by the consumer wirelessly as well as it provides facilities to detect the illegal usage of the electricity. Aim of this study is to measure electricity consumption in the household and generate its bill automatically using IoT. The IoT based smart energy meter is based on ARM. In this system we reduce the human participation in electrical energy maintenance. The theft of the electricity increases the costs paid by customer. Hence this system is used for the detection of theft. The ARM checks the main meter and sub meter reading. If the difference between the main meter and sub meter is occurred then that theft has occurred message will be display on the LCD display and also display on the IOT. By using the consumer number it can be access on the globe at the anytime.

Key Words:Energy Meter, IOT web Server, ARM LPC2138 Controller, Energy Theft.

1.INTRODUCTION

To measure the amount of energy consumed by domestic, commercial and industrial user, energy meter is being used. As the population of energy consumers are gradually increasing the smart energy meter helps to ease the energy management system. The paper depicts the solution for reducing human involvement in energy management for the domestic and industrial consumers. All the data monitoring is done via a web based portal provided with a dedicated internet connection. The system has to be made in such a way that the power consumption is analyzed properly. Currently the system we use required human involvement which leads to the time consumption also, it has always been a necessity that a particular individual or person from the energy department should visit the consumer house and note down the readings and therefore errors can get introduced .So in order to overcome the stress, smart energy meter is introduced. In this work, the system uses ARM microcontroller because it is energy efficient hence it consumes less power. The system will combine with the energy meter which is already installed in place of residence. The consumer can easily access the figures of energy meter through a webpage. The distribution companies are unable to keep track of the changing maximum demand of consumers due to this consumer is facing problems like receiving due bills for the bills that have already been paid. So to overcome these problems the remedy is to keep track of the consumers load on timely basis, which will help to assure accurate billing, track maximum demand and to detect threshold value. By considering the present scenario it is important to build an efficient energy meter.

A high amount of power at destinations is lost because of theft. With few changes made with present existing architecture of energy meters we can overcome the theft. As indicated by an investigation agency distributed by Northeast Group, India is hoping to shrewd lattice framework to help handle a power robbery issue and enhance unwavering quality. Robbery costs the Indian power $16.2bn per year[2]. To control robbery, inaccurate meter perusing and charging, and hesitance of customers towards paying power charges on time. India's administration has officially dedicated billions of dollars in financing for smart grid infrastructure and total spending is anticipated at $21.6bn over the period 2015-2025.Significant measure of income misfortunes can be diminished by utilizing Energy Meters.
Automatic Meter Reading (ARM) technology facilitates the assessment of energy consumption and analysis of data for billing and payment. ARM technology requires to bring the device online and connecting device with the internet which is in other term Internet of Things. The Internet of Things (IoT) permits object to be controlled and sensed remotely through existing communication network that creates chances for more direct integration between the physical world and computer based systems. These activities are resulting in improved efficiency, accuracy and economic benefit. This proposed IoTbased smart energy meter reading and monitoring system in this study, measures electricity consumption of each household and generate its bill automatically using IoT and telemetric communication techniques like microcontroller. Also this study provides an effective mechanism for detecting and controlling electricity theft in household site based on infrared sensor and IoT.

1.2. LITERATURE REVIEW

In this study, authors investigated the existing traditional meter reading system associated with energy provider of India and discovered various drawbacks and difficulties. Here authors have studied different technologies and methods available to reduce the meter reading problems. Finally authors modelled out a worthy and feasible solution after analysing the number of research papers and studies. Some of the important papers are summarized and evaluated in this section.

[1] Explained the modeling and working of different units of the system and also discussed the components and their functions such that IOT and its working microcontroller and its architecture. Reducing energy consumption and monitors the units consumed.

[2] Suggested it in light of ARDUINO UNO controller and IOT innovation. On the off chance that any altering happens the controller will send to information to the server and in addition it is chopped down the vitality supply naturally. At the point when most extreme request of vitality expends will be shown in the meter utilized by the customer.

[3] Clarified in the wake of surpassing the greatest request, the meter and subsequently the association will be consequently disengaged by an installed framework embedded in the meter sensor. The LDR (Light Dependent Resistor) sensor placed on energy meter which sense LED blinking pulse. At that time microcontroller sending this reading via GSM module and it will send this message to electricity board. In this framework a keen vitality meter is introduced in each customer unit a server is kept up at the specialist co-op side.

[4] Implemented both the meter a server furnished with GSM module which encourages bidirectional correspondence between the two closures utilizing the current GSM foundation. Shopper can without much of a stretch energize their vitality meter by sending a stick number covered up in a scratch card to the server utilizing SMS. In order to avoid all these drawbacks we have intended to construct an IOT based energy meter so that proposed energy meter measures the amount of power consumed and uploads it to cloud from which the concerned person can view the reading .The power reading send to cloud using ESP8266, a Wi-Fi module.

[5] Explained the power reading from digital wattmeter is read using the coupler and transmitted digitally to the Arduino. So it automates the process of measuring the power consumption at homes using IOT.

[6]An IoT based system that consists of Power Line Communication (PLC) modem, a theft detection unit and a WI-FI unit was proposed by (Darshan&Radhakrishna, 2015). Two separate sub systems were employed to build up the system. One of the systems is to be installed at the consumer's energy meter point while the other unit is to be installed at the utility supplier company. Generally, three microcontrollers were proposed to be used in the project; two of such will be used in the system installed at the consumers end for IoT and theft detection capabilities. The remaining microcontroller will be used in the system located at the utility office (Darshan&Radhakrishna, 2015). However, the proposed system is not cost effective as it involves the operation of two separate systems to form a functional system.

[7]Jain &Bagree, (2011) suggest Electromechanical Energy meters are being replaced by more accurate prepaid digital energy meters. They also claim that a huge percentage of electricity income was lost due to inappropriate meter reading and monitoring. Considerable amount of revenue losses can be minimized by using Prepaid Energy Meters and prepaid cards. The prepaid card system communicates with the power service provider using mobile communication medium. In this research, the proposed prepaid meter was a good solution for revenue collection from consumer, but it increases the effort of the billing process which is very problematic to consumers. In the meantime the authors put forward about communication between prepaid energy meter and power utility using mobile communication infrastructure but the communicationmodule and infrastructure are not clearly exposed in the proposed work.
Authors found most of the systems analysed in the literature require high cost for implementation. Therefore, there is need to develop a cost effective system as a single solution that will read the meter remotely and prevent meter tampering.

PROPOSED SYSTEM

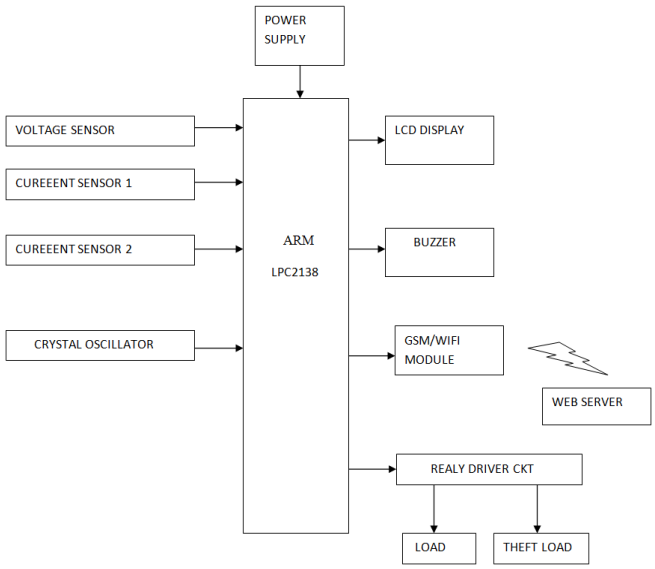

Fig -1: Block Diagram

To run the system first we need to connect microcontroller with the power supply as microcontroller is the main control unit. In input side, we have current sensor and voltage sensor. On the other hand, output is shown in the LCD display. Moreover, GSM Module helps to send data in the cloud and when the data gets uploaded, we can check the output by using Laptop or Computer by log in to the server. The load represents the devices that require the electricity to operate. The ac supply is connected to the system through the transformers to power the system. The Meter is also connected to the system to automate the power usage of the household. The readings from the energy meter are then processed and are updated over the GSM Module. If any tampering is detected the system updates the situation on the webpage used to display the energy readings. After updating the energy readings on the webpage, the system then displays the energy readings on the LCD display. In case of any tampering the buzzer will go off making a loud noise. All the information from the system is readily available on a webpage called Thingspeak.com. This is all about the block diagram which shows the entire process of hardware.

2.1ARM7 LPC2138 microcontroller:

The NXP (founded by Philips) LPC2138 is an ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions 512KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP), Two 8-ch 10bit ADC 32KB RAM, Vectored Interrupt Controller, Two UARTs, one with full modem interface. Two I2C serial interfaces, Two SPI serial interfaces Three 32-bit timers, Watchdog Timer, Real Time Clock with optional battery backup, Brown out detect circuit General purpose I/O pins. CPU clock up to 60 MHz, On-chip crystal oscillator and On-chipPLL.

Fig -2: ARM7 LPC2138

2.2Current Sensor:

The **Current Transformer** (C.T.), is a type of "instrument transformer" that is designed to produce an alternating current in its secondary winding which is proportional to the current being measured in its primary. *Current transformers* reduce high voltage currents to a much lower value and provide a convenient way of safely monitoring the actual electrical current flowing in an AC transmission line using a standard ammeter. The principal of operation of a basic current transformer is slightly different from that of an ordinary voltage transformer.

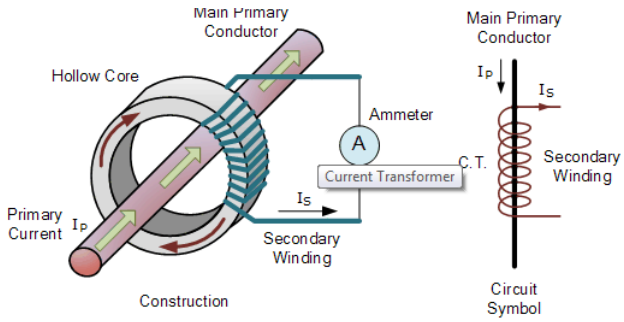

Fig -3: Current Transformer

2.3Relay Driver Circuit:

A relay driver circuit is a circuit which can drive, or operate, a relay so that it can function appropriately in a circuit. The driven relay can then operate as a switch in the circuit which can open or close, according to the needs of the circuit and its operation. Since DC and AC voltages operate differently, to build relay drivers for them requires slightly different setup. We will also go over a generic relay driver which can operate from either AC or DC voltage and operate both AC and DC relays. Now that we're using a transistor to drive the relay, we can use considerably less power to get the relay driven. Because a transistor is an amplifier, we just have to make sure that the base lead gets enough current to cause a larger current to flow from the emitter of the transistor to the collector. Once the base receives sufficient power, the transistor will conduct from emitter to collector and power the relay.

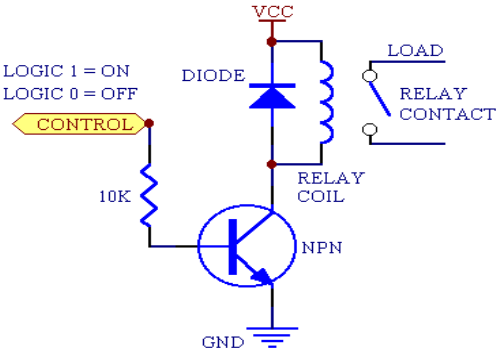

Fig -4: Relay Driver Circuit

2.4Buzzer:

Piezo buzzers are simple devices that can generate basic beeps and tones. They work by using a piezo crystal, a special material that changes shape when voltage is applied to it. If the crystal pushes against a diaphragm, like a tiny speaker cone, it can generate a pressure wave which the human ear picks up as sound.

Features

- sealed: yes
- operating power: 3-6V DC / 25mA
- extremely compact, ultrathin construction
- no electrical noise
- low current consumption yet high sound pressure level

Fig -5: Buzzer

2.5 GSM module:

This GSM modem has a SIM800A chip and RS232 interface while enables easy connection with the computer or laptop using the USB to Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800 modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manger of the USB to Serial Adapter. Then you can open Putty or any other terminal software and open a connection to that COM port at 9600 baud rate, which is the default baud rate of this modem. Once a serial connection is open through the computer or your microcontroller you can start sending the AT commands.

Fig -6: GSM Module

2.6LCD Display:

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD.

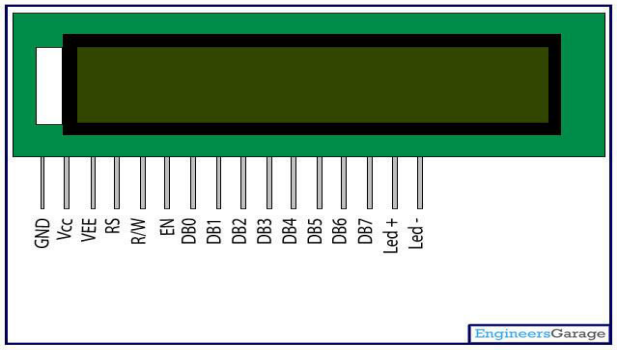

Fig -7: LCD Display

2.7 IOT Platform:

a) Use the Thinkspeak platform to send data to the cloud from any Internet-enabled device.

b) You can then configure actions and alerts based on your real-time data and unlock the value of your data through visual tools.

c) Use the Thinkspeak offers a platform for developers that enable them to easily capture sensors data and turn it into useful information.

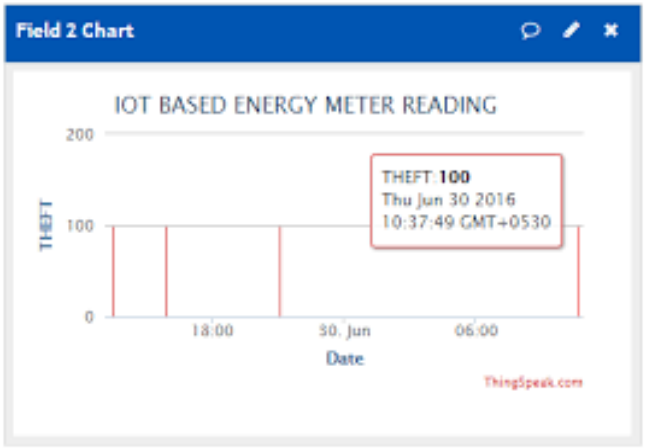

Fig -8: Meter ReadingsonThingsspeak

3. CONCLUSIONS

IoTbased smart energy meter reading and monitoring system was proposed in this paper. The system provides many significant advantages, such as wireless data transmission, low-workload, remote monitoring and controlling,anti-theft mechanism and less-expenses. The system would provide a simple way to collect the meter reading and detect an electrical power theft without any human involvement. The use of embedded microcontroller and IOT Technology increases the stability of wireless data transmission. By using this system the customer can anytime check their consumed unit and bill in the Internet in which paper is not required for

billing which saves paper and printing cost. The bill can be paid using online customer support system. In future, the project can be integrated to form smart cities using Internet of Things based sensors as done globally. When compare with the existing SMS based and other traditional energy metering and monitoring system, the propose system is more efficient and cost effective. It allows the consumer to check the energy consumption and bill any time they login to the system whereas other existing system send the bill monthly or on request to the customer.

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