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IoT Based Energy Meter

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***Abstract*: In the modern world, electricity is one of the major entity for the survival of humanity. This paper shows how to efficiently manage energy distribution and power outage using AI in automatic meter infrastructure. The project is to create AI based Energy Meter using Raspberry Pi. Developed nations are already using computerized meter frameworks (AMR). These are more precise estimating gadget than the ordinary electromechanical meter perusing framework. This paper shows a how to efficiently manage energy distribution and power outage using AI in automatic meter infrastructure. Microcontroller is used to identify the power consumption and identified power consumption will be transferred to Raspberry Pi to call the Wi-Fi Module to transfer the data to Azure. Power Consumption will be stored in Azure SQL Database. We also collecting the data of weather conditions based on locations. Data collected from Raspberry Pi and weather data were consumed into AI and it predicts the pattern in Power Usage. With the help of collected data power outage notification will be sent to technician and electricity customers. The proposed system continuously sends data to the cloud to monitor data from anywhere using Microsoft Power BI.**

***Keywords*: Azure, Power BI, SQL Database, Twilio, Xively.**

1. Introduction

Energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device.

Every month a person needed to check the reading of meter and making the bill to consumer. It makes an error while reading manually and it consumes a lot of time. So energy meters installed at customers premises for billing purposes. They are usually read once each billing period. When energy savings during certain periods are desired, some meters may measure demand, the maximum use of power in some interval. "Time of day" metering allows electric rates to be changed during a day, to record usage during peak high-cost periods and off-peak, lower-cost, periods. Also, in some areas meters have relays for demand response load shedding during peak load periods. The most common unit on measurement of electricity meter is Kilowatt hour(KWH).

Distortion of the electric current by loads is measured in several ways. Power factor is the ratio of resistive (or real) power to volt-amperes. A capacitive load has a leading power factor, and an inductive load has a lagging power factor. A purely resistive load (such as a filament lamp, heater or kettle) exhibits a power factor of 1. Current harmonics are a measure of distortion of the wave form.

In addition to metering based on the amount of energy used, other types of metering are available. Meters which measured the amount of charge (coulombs) used, known as ampere-hour meters, were used in the early days of electrification. These were dependent upon the supply voltage remaining constant for accurate measurement of energy usage, which was not a likely circumstance with most supplies. The most common application was in relation to special-purpose meters to monitor charge / discharge status of large batteries. Some meters measured only the length of time for which charge flowed, with no measurement of the magnitude of voltage or current being made. These are only suited for constant-load applications and are rarely used today.

2. Literature Review

In [1] Electric meter reading through IoT by using Raspberry pi model by Satish Kumar Pal, Amit Ranjan, Abhishek Mishra, Chandra Prakash Singh, Amitabh Srivastava in 2018.

In [2] Joint Energy Management System of Electric Supply and Demand in Houses and Buildings by Sungjin Lee, Beom Kwon, and Sanghoon Lee in 2014.

In [3] Analysis and Clustering of Residential Customers Energy Behavioral Demand Using Smart Meter Data by Stephen Haben, Colin Singleton, and Peter Grindrod in 2016.

3. Existing Systems

The conventional mechanical energy meter is based on the phenomenon of “Magnetic Induction”. It has a rotating aluminium Wheel called Ferriwheel and many toothed wheels. Based on the flow of current, the Ferriwheel rotates which makes rotation of other wheels. This will be converted into corresponding measurements in the display section. Since many mechanical parts are involved, mechanical defects and breakdown are common. More over chances of manipulation and current theft will be higher.

Electronic meters display the energy used on an LCD or LED display, and some can also transmit readings to remote places. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as instantaneous and maximum rate of usage demands, voltages, power factor and reactive power used etc. They can also support time-of-day billing, for example, recording the amount of energy used during on-peak and off-peak hours.

The standard business model of electricity retailing involves the electricity company billing the customer for the amount of energy used in the previous month or quarter. In some countries, if the retailer believes that the customer may not pay the bill, a prepayment meter may be installed. This requires the customer to make advance payment before electricity can be used. If the available credit is exhausted then the supply of electricity is cut off by a relay.

Smart meters go a step further than simple AMR (automatic meter reading). They offer additional functionality including a real-time or near real-time reads, power outage notification, and power quality monitoring. They allow price setting agencies to introduce different prices for consumption based on the time of day and the season.

4. Proposed System

To develop an energy meter which can provide the data of current consumed in daily life through which the consumption and the outages of power can be predicted with which the distribution of the power can be controlled and to inform the consumer and the technician in case of any outage.

5. Description

Hardware:

- Current Sensor-ACS712
- Voltage Divider
- Load
- Power Supply
- Arduino
- Raspberry Pi

Software

- Microsoft Azure
- Microsoft Power BI
- Twilio

6. Methodology

In the Modern world the Electricity is one of the necessities to survive in this world. The Energy meter provide a way to know the amount of power consumed by us. The proposed system provides a way to predict the amount of power needed and outages in our system. The Proposed system can help us to decrease the amount of power distributed and it can let us know in case of any power theft or power shortages etc.

The Proposed system has two modules,

- Energy Meter
- Power BI

In the energy meter the current, voltage and the power is noted.

Power:

Power is product of voltage (volt) and current (Amp)

P=VxI

Unit of power is Watt or KW

Energy:

Energy is product of power (watt) and time (Hour)

E= Pxt

Unit of Energy is Watt Hour or Kilowatt Hour (kWh)

The current is measured with the help of a current sensor ACS712. The Allegro™ ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switch mode power supplies, and overcurrent fault protection

The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flow through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sampling. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8). This allows the ACS712 to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

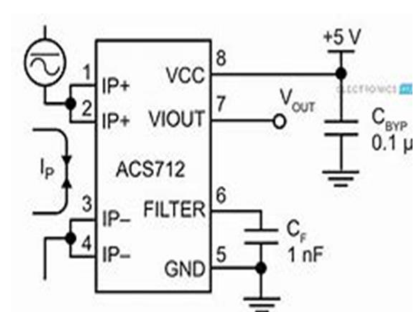

Fig. 1. Circuit diagram

The voltage is measured with the help of a voltage Divider circuit. A Voltage or Potential Divider Circuit is commonly used circuit in electronics where an input voltage has to be converted to another voltage lower than then the original. This is very useful for all analog circuits where variable voltages are required. A voltage divider circuit is very simple circuit built by only two resistors. The required output voltage (VOUT) can be obtained across the resistor R2. Using these two resistors we can convert an input voltage to any required output voltage.

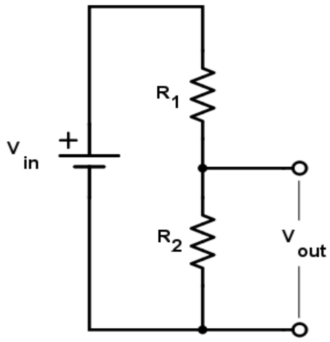

Fig. 2.

The output from the current sensor and the voltage divider is analog it is converted into digital using the Arduino board.

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

Analog to Digital Conversion(ADC) is a very useful feature in microcontrollers to interface sensors. The main purpose of this features is to interface analog sensor with the Arduino UNO or any microcontroller. There are different physical quantities in nature like pressure, temperature, humidity and light intensity etc. Sometimes we develop the system that using these properties. While working on this property we first convert it in the digital so microcontroller can understand. For doing this we need Analog to Digital Conversion. Arduino UNO has 6 ADC channel from A0 to A5. For enabling this ADC feature we use the function analog Read().

Arduino UNO has 10-bit (210) ADC. Whatever analog value from 0-5V it reads it converts in the range from 0 to 1023 in digital. Based on this digital value we do some programming code and controlling the devices accordingly.

The data from the Arduino is transferred to the Microsoft Azure database through the raspberry pi.

7. Conclusion

This paper presented an overview on IoT based energy meter.

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