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A Review on Topologies for Power Failure Alerts in Industry

Payal S Burande[1], Sachin S Bormale[2], Vishal B. Gaikawad[3], Omkar V. Jadhav[4], Rohit R.Panchal[5]

Assistant Professor, Dept. of EE, D.Y. Patil Institute of Engineering and Technology, Ambi, Pune Maharashtra, India[1]

UG Student, Dept. of EE, D.Y. Patil Institute of Engineering and Technology, Ambi, Pune Maharashtra, India [2-5]

ABSTRACT: Nowadays, people are unaware of the cost of energy consumed by various appliances. This project aims to design a circuit which helps the consumer in taking care of the electrical energy consumption and the extra charges incurred due to minor changes in slab categories, even though these changes are small they affect the consumer's bill severely. To make the consumer aware and to control the excess power consumption, this paper introduces, a "POWER CONSUMPTION ALERT SYSTEM". This system will intimate the consumer about his /her usage rate. It will display the total units of power consumed and how many units has been left with, in order to be in a minimum slab rate being for a period of time. In this way, the consumer can be made aware of the power consumed and can hence make the consumer use the power accordingly. Daily usage is updated to the consumer periodically through a mobile application and also in a webpage which generates a report as well. Once the maximum threshold value is reached, power is cut off with a prior notification to the consumer. It not only benefits the consumer, it also benefits the government as it is capable of reducing the power consumption and subsequently can reduce the unusual power usage. Help of mobile application/ website where report is given to used the periodically.

This system can be installed at any place where the energy consumption should be regularly monitored and controlled. The consumers can fix their own threshold budget values and can be easily customized based on their requirements.

POWER CONSUMPTION ALERT SYSTEM is used to continuously monitor the meter reading and give weekly/monthly/daily information about the number of units consumed along with its cost to the consumer. Major components used in this project are ARDUINO Board, GSM module, ESP 8266, energy meter circuit, and load. ARDUINO is a credit card sized minicomputer and acts as a fast processor system. It is the central unit of this project and is connected to GSM, ESP 8266, and energy meter through various ports. The overall operation of the proposed system is discussed in the following sections.

I. INTRODUCTION

An electrical power distribution system is the final stage which delivers electric energy directly to industrial and residential consumers. The electrical equipment and circuits are connected to the substation must be protected in order to limit the damages due to abnormal currents and over voltages. Protective relays,circuit breakers and fuses are used to detect overloads and to disconnect circuits at the risk of damage.under certain conditions a network component shutting down can cause current fluctuations in neighbouring segments of the network leading to a cascading failure of a larger section of the network. This may range from a building ,to a block ,to an entire area .the failure or tripping of protective devices must be alerted as fast as possible to authorities .The proposed system , GSM based automatic alert and switching control of secondary power distribution is a system which alerts the authorities about this failures as GSM messages .At the highest abstraction level the proposed system is the secondary distribution automation using GS

II. METHODOLOGY

2.1.SYSTEM ANALYSIS

The various literature studies that were done helped in developing a new technique for controlling and monitoring the power consumption.

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2.1.1 Issues in the existing system:

- **No cost reduction mechanism:**In the existing electrical system, there is no control over the cost exerted towards electricity and the daily consumption is not known. As a result of this, the slab rates are doubled and this leads to a high bill amount. A power cut off is the only solution for the cost reduction.

- **ii. Electricity usage is not monitored:**There is no awareness for the electricity usage in our day to day life. Only a total consumption can be measured in this system. Slab rate changes cannot be determined and measured in the existing energy meters. Only the Bi-monthly consumption is determined.

- **iii. Energy consumption is not notified:**User is not notified regarding the usage of current. Even if the user consumes higher units of current, there is no notification message or alert given which is a major disadvantage. If the user is notified in prior about the electricity usage the consumption can be reduced which in turn will drastically reduce the price as well.

2.2. PROPOSED SYSTEM:

This project is aimed to design a circuit which helps the consumer to monitor the electrical energy consumption and protect him/her from the extra charges incurred due to minor changes in slab categories, since even small changes can affect the bill at a high rate. In this project, electricity usage is updated periodically that is read from the energy meter and then sent to ARDUINO. The energy values once taken from the energy meter are digitized and processed with the help of a micro controller. The micro controller that we use here is ARDUINO. The cost value for the corresponding energy value is determined and the threshold cost value is fixed for which the consumption level increase is notified to the user. Daily consumption cost will be updated to the user through SMS and graph will be generated in an online application on a daily, weekly and monthly basis. The problem of overload can also be monitored. When the circuit is overloaded, the difference in consumption is also analysed. This deviation from the normal value is notified to customer to prevent tripping of the breakers or blowing of fuses.

III. SYSTEM DESCRIPTION

The proposed system is described with the help of an architecture diagram and its module description.

3.1. Hardware Requirements:

3.1.1. **Energy meter**

An electricity meter is a device that measures the amount of electric energy consumed by a residence, business, or any electrically powered device. There are two types of meters - electromechanical and electronic. The most commonly used electricity meter is the electromechanical induction watt-hour meter. The electromechanical induction meter operates by counting the revolutions of a nonmagnetic but electrically conductive metal disc. The speed of rotation of the disc is proportional to the power passing through the meter. The number of revolutions is thus proportional to the energy consumed. Electronic meters display the energy used on an LCD or an LED display. Electronic meters can also record parameters of the load and supply instantaneous and maximum rate of usage demands, voltages, power factor and reactive power used etc. The energy meter that is used is a single phase (AC), KWH, static energy meter .It has four LED indications which indicate phase, reversed current, earthed load and watt-hour. Its operating voltage range is between 140V-300V.

3.1.2 Arduino

The ARDUINO is an open source platform that provides microcontroller kits that can be used to build digital, interactive devices. The ARDUINO is easy-to-use and inexpensive. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, a 2KB RAM and a reset button.

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Fig-1 Arduino UNO Board

3.1.3. Optocoupler

The Optocoupler IC is an electronic component that uses a light sensitive interface to interconnect two separate electrical circuits. In this application, the IC is used to detect electrical impulses from the energy meter. This ensures complete safety when one circuit switches the either one by isolating both the circuits

Fig-2 Optocoupler

3.1.4. Arduino GSM module

The GSM is a worldwide, cellular technology that is the most widely used today. This shield allows an ARDUINO board to receive and send SMS, connect to the internet and make voice calls. The GSM works in the 900MHz band (Asia).

Fig-3 GSM Module

3.1.5. ESP8266

The ESP 8266 is a low-cost, Wi-Fi chip that uses a TCP/IP stack. It has a memory that is divided into 64KB for instructions and 96KB for data. It requires 3.3V power supply.

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Fig-4 ESP 8266 WIFI

3.1.6. Relay

A relay is an electrically operated switch that consists of an electromagnet and is operated by a small electric current andthat can turn off a larger electric current. The relay used here is a 5V, single channel relay and is easily compatible with the ARDUINO. It has three connections – Common (COM), Normally Open (NO), Normally Closed (NC) brought out to 3 pin screw terminals.

Fig-5 Relay

3.2. Software Requirements:

3.2.1. Arduino GSM module

The ARDUINO IDE is a cross-platform, easily extensible environment written in java. This helps in uploading the code to the ARDUINO UNO board.

3.3. SYSTEM ARCHITECTURE:

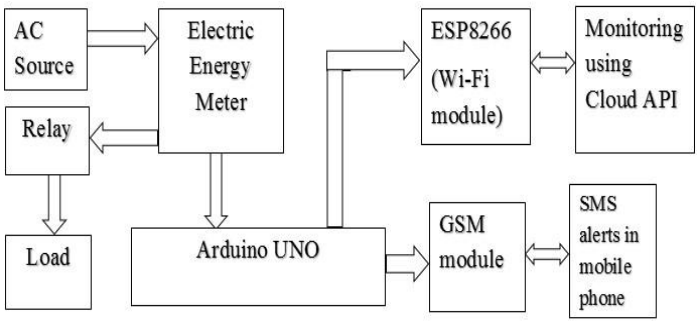

Fig-6 Architecture diagram

An AC source is given to the electric energy meter and from this the load is connected to the ARDUINO board via a relay switch. The fourth LED of the energy meter is given to one of the digital pins of ARDUINO. This is done with the help of an Optocoupler IC in order to ensure safety to both the circuits. The ARDUINO in turn is connected to the Wi-Fi module and the GSM module. The ESP8266 is interfaced with the cloud storage using a cloud API (Thingspeak). This can be updated and viewed in graphical formats. The GSM module is used to send

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and receive messages via a mobile network to give daily alerts. A relay switch is connected with the ARDUINO and the load which is used to shut off the circuit incases with overload.

3.4. MODULE DESCRIPTION :

3.4.1. Reading the pulse:

The watt-hour LED in the energy meter blinks 3200 times for every KWH. This LED indication is used to measure the electricity that is being consumed. This LED blinks using the electrical impulse that arises when electricity is consumed. This impulse is given as input to the Optocoupler IC .The output of the IC is given as the input to the digital pin 13 of ARDUINO. With the help of a counter, the number of impulses can be calculated and hence the amount of energy consumed can be measured as follows:

The pulse from the meter is used to interface it with the microcontroller. Further, the delay between the pulses is used to calculate the charge per unit. After every 0.3125 watt, the energy meter glows the LED (calibrate) once. So, if a 100 watt bulb is used for a minute then the pulse will blink 5 times in a minute. And this is calculated using the given formula.

Pulse= (Pulse rate of Meter* watt * 60) / (1000 * 3600)

If the pulse rate of a meter is 3200 imp and power consumed is 200W, then Pulse = (3200 * 200 * 60) / (1000 * 3600)

= 10.666666 per minute=~6400 Pulses will occur in an hour.

Now, from this the electricity consumed per LED blink is calculated as follows

One pulse (watt) = 200\640=0.3125

(i.e.) 0.3125W of power is consumed in a single pulse.

The calculation of units is given below:

Unit = (energy for one pulse (electricity))*number of pulses / 1000

If, One pulse = 0.3125 watt

Pulses in 1 hour = 3200

Then Unit will be

Unit = (0.3125 * 3200)/1000=1KWH

Now, if the cost for one unit is Rs.7 then for a single pulse the cost will be

Single pulse cost = (7 * one pulse energy consumed) / 1000

Single pulse cost = (7 * 0.3125) / 1000

Single pulse cost = Rs.0.0021875

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3.4.2. Connecting the Arduino with WIFI :

The ESP 8266 Wi-Fi module is used to connect the ARDUINO with a Wi-Fi network. It is placed over a baseboard. The R_x and T_x pins of the ESP8266 are connected to the digital input of ARDUINO. Now, using the AT command the connections are verified. Some other commands are used to list the available networks and connect it to a network respectively. This is done after the memory is flashed. A TCP/IP connection is setup by the module. The protocol being used for communication is the Message Queue Telemetry Transport (MQTT). It runs over the TCP and also supports publish/subscribe architecture. MQTT was released by IBM and targets lightweight M2M communication. It is used for a constrained Internet of Things devices and low-bandwidth with high-latency or unreliable networks. Because MQTT specializes in lowbandwidth, high-latency environments, it is an ideal protocol for machine-to-machine (M2M) communication.

3.4.3. Daily alerts via SMS :

The GSM module (SIM300) is connected to the ARDUINO board and serves as a medium to send SMS regarding the daily consumption values. This is sent at the end of each day (24 hour delay) to the mobile number to which the message has to be hardcoded.

Interfacing SIM300 with ATmega32:

The GSM module SIM300 is interfaced with ATmega32 through UART port. Serial communication takes place between these two components. ATmega32 can be programmed either by using Assembly language or using C programming. SIM300 is accessed using AT commands. AT commands are the instructions given to a modem to control it and AT marks the beginning of a command line. Some of the commonly used AT commands are AT+CWLAP, AT+CWJAP="*network_name*","*password*", etc.

3.4.4. Clouds storage:

The values that are collected by the Wi-Fi module are then sent to an open source Internet of Things application and API which can be used to store and retrieve data from things using HTTP via the internet. The API being used here is "Thingspeak". This API allows to create separate channels through which the data could be collected and stored. The only step for registration is logging in using an email ID. After this, the user can create his own channel. The user is then provided with the channel ID, API keys and other facilities like Data Export/Import, etc.

3.4.5.Monitiring the consumption via web or phone :

Once the values are passed through the channel, a graph is generated with user definedproperties. This graph is dynamic with some amount of delay. The updated changes can be viewed using web application and/or using the widget that is readily available. Threshold values for both upper and lower limits can be set and notifications can be made if these are exceeded. The hourly, weekly, monthly, yearly consumptions can be viewed. The channel can be cleared as and when needed.

3.4.6.Preventing overload across the circuit :

The overload across the circuit can be identified using the delay difference across the pulse in the energy meter. The delay difference of the circuit without any overload is the constant value which can be hardcoded. If any deviation from the usual delay difference occurs then the overload is identified and a total power cut off is done with the help of a delay.

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IV. EXPERIMENTAL RESULT AND DISCUSSION

An implementation of the above proposed system resulted in the following results. The text message received from the alert system looks as given below and is received every minute (for experimental purpose).

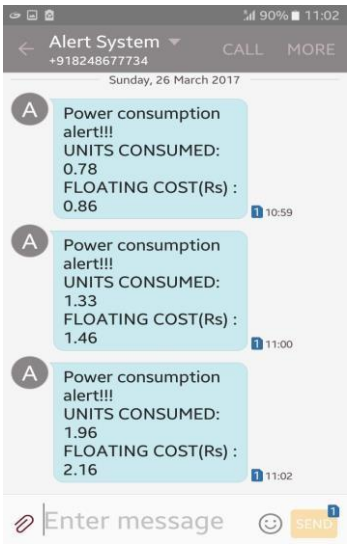

Fig-7 Screenshot showing the SMS sent through GSM

This is the graph obtained in the Thingspeak Cloud API. It gives the data regarding the delay difference between pulses, units consumed and the cost.

V. CONCLUSION

Thus, the Power Consumption Alert System is used to alert the user regarding his everyday consumption of electricity. This helps in saving electricity and also keeping the electricity bills under limits. A small module consisting of the ARDUINO board, ESP8266 and GSM can be installed with energy meter to make the electricity consumption smarter.

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