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Advanced Centralized Electric Billing System Using IOT

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Abstract*— Internet services and mobiles have become an inextricable part of daily life, enabling communication and the management of information from anywhere and at any time. This development in the area of internet (IOT) has eased the lives of human being reducing their effort. One such system is designed which reduces the human effort to a greater extent. This system consists of modified energy meter capable of communicating with a server via a dedicated GPRS link. Thus the meter will send its readings upon request from the server and will display the bill received on their respective smart phones. Additionally the meter is capable of disconnecting the power supply automatically upon lapse of grace time period provided and on non-receipt of payment for the generated invoice. The billing will be controlled by an internet connection.

***Keywords*— ATMEGA48, GPRS, IOT, microcontroller, Electricity bill, prototype**

I. INTRODUCTION

The traditional manual Meter Reading was not suitable for longer operating purposes required human intervention thereby increasing their efforts and also material resources. It brings additional problems in calculation of readings and billing [1]. Also there have been several issues of faulty energy meter and theft of electricity. Till date, the readings are manually collected at the end of the month by a person from EB department by visiting every home. Also, the user needs to pay the electric bills either through on-line or by visiting Electricity Board (EB) offices [2]. Maintenance of such kind of meters is becoming a tedious job due to increase in the number of connections and hence there must be a way to overcome this issue. This prototype developed by us is for wireless control of the electric meter and calculating electric bill for the customer including a notification to the customer whenever necessary using wireless GPRS technology. Our project involves development of an advanced energy meter to ease the work of users as well as EB officers and thereby reducing human efforts to a greater extent.

The present day electric meters do not have any provision to monitor the consumption of electricity and notify it to the customer. Till recent, Automatic Meter Reading (AMR) systems have been implemented that used SMS as data transfer medium to the server. A major drawback of such kind of system is that it is cost ineffective and also there is need for monthly visit from the electricity board for checking the electric meter and generating the bill.

II. PROJECT DESCRIPTION AND GOALS

The module developed uses android phone with dedicated app to control the module which makes it user friendly.

Here in this project atmega48 microcontroller is used as central unit to control and monitor all devices. LCD is connected to microcontroller through parallel interface to display information as user interface. Relay is used to turn the power off when bill is not paid after the bill time is reached.

GSM/GPRS is used as secured link from server to the meter through Internet service connected to microcontroller through UART protocol, and this also used to send bill details to customer when billing time is reached.

In this module current sensor is used to sense power usage and it is interfaced through ADC to microcontroller.

The prototype is designed keeping many factors into consideration. The main aim being it to be economical the following analysis is done to achieve the goal.

III. FEASIBILITY STUDY

A. Technical:

When there is a whole range of desirable new high end features to the scene, they interact in cleverer ways. The ATMEGA48 is an 8-bit microcontroller with low-power CMOS and operates on RISC architecture. It achieves throughputs approaching 1 Million Instructions per Second per MHz, allowing the system to design and optimize power consumption versus processing speed. High performance is its main feature. It operates with a voltage of 4.5-5.5 V.

B. Economical:

The components like ATMEGA48, Max232 level converter, UART costs low, the cost of purchasing software is also low. Ultimately, the implementation of this project will reduce the expenditure of power supply board.

C. Operational:

The module provides very user friendly interface and does not need extra training for usage.

IV. TECHNICAL SPECIFICATIONS

The choice of components depends upon many factors and some of them were discussed in the earlier section. Keeping these factors in consideration, the following components are chosen for the prototype.

A. Atmega48 Microcontroller

The microcontroller is the core of every embedded module. Hence, great care must be taken in choosing the right microcontroller without compromising on functionality. Keeping many factors in view that ATMEGA48 microcontroller from Atmel Corporation's AVR microcontroller family was chosen. Some of the reasons are given below. The first being, that all AVR microcontrollers are designed to deliver more performance at lesser power consumption. It is compatible with popular protocols like I2C and SPI. It also has advanced features like an on chip analog to digital converter, six pulse width modulation channels, and data retention is supported up to a hundred years at 25º C[3].

B. Power Supply

Power supply is used to energize the components in the prototype such as microcontroller, relay, level converter and GPRS module. The power supply here is given through a 12V AC-DC adapter which is connected to the AC power supply switch.

C. Lm7805c -Voltage Regulator

An LM7805c voltage regulator has been used to convert the 12V obtained from the AC-DC adapter to 5V to power up the microcontroller and the level converter. Capacitors are connected accordingly for noise reduction.

D. MAX232 And DB9 Connector (Level Converter)

Since the RS232 is not compatible with today's microprocessor and microcontroller, we need a line driver to convert the signals from RS232 to TTL voltage levels that will be acceptable to the microcontroller's TX and RX pins. MAX232 from Maxim Corp is an example of such a converter. It converts the RS232 voltage levels to TTL voltage levels, and TTL voltage levels to RS232 voltage levels.

The MAX232 chip uses a +5V power source, which is same as the source voltage for the microcontroller obtained from LM7805c voltage regulator. As shown in Fig. 1 the MAX232 has line drivers of two sets for transferring and receiving data. The line drivers used for TX (transmitter) are called T1 and T2, while the line drivers for RX (receiver) are designated as R1 and R2. In several applications only one of each is used. For example, T1 and R1 of microcontroller pins are used together to Transmit and Receive, and the second set is left unused [4].

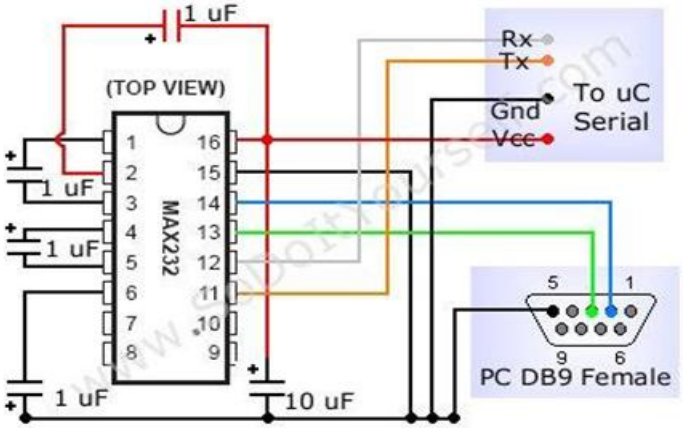

Fig. 1 MAX232 and DB9 connector

E. GPRS Modem

Modem stands for Modulation and demodulation. For long distance transfer of data using communication lines, serial data communication requires a modem to modulate and demodulate the data [5].

GPRS modem is used for wireless data transfer. The AT command set is the standard set of commands used for communicating with a modem.

The GPRS Terminal is important for embedded applications. Modem can communicate serially by RS232 [6]. There is an internal antenna embedded in the modem. It can also be interfaced to an external antenna for better signal reception and transmission.

The modem communicates with microcontroller through MAX232. The GPRS modem is connected to MAX232 through RS232 cable. This is the standard set by Electronics Industries Association (EIA) for compatibility between data terminal equipment and data transmitting equipment.

F. Current Sensor

The current sensor is required to detect the amount of current drawn by the house hold .The output of such a sensor is an analogue signal which is connected to the microcontroller's analog pin and the data received is then converted to digital data using the inbuilt ADC and is processed for generation of bill at the end of the month.

G. Relay

Relay is an electrically operated switch which can be used to control high voltage devices by giving a low voltage control signal; they allow switching to a second circuit which can be completely isolated from the first circuit. Relays can switch AC and DC which are advantageous over transistors which can only switch DC and also higher voltages than standard transistors. Hence relays are often a better choice for switching currents greater than 5A.

V. SYSTEM OVERVIEW

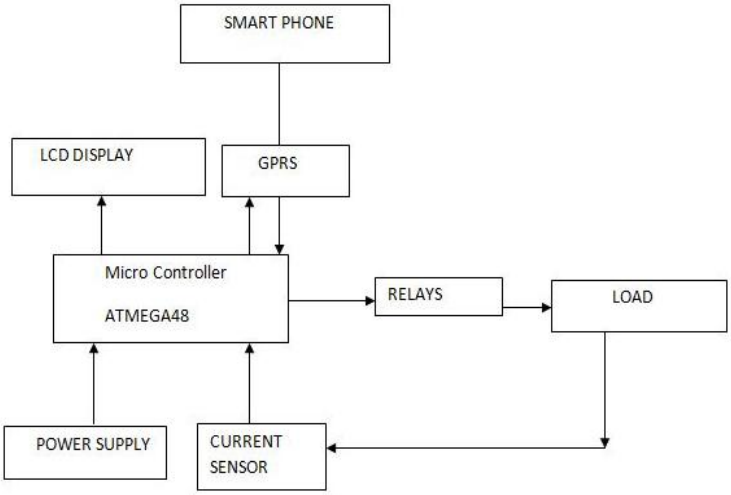

Fig. 2 Block Diagram

A brief explanation of the prototype is given using a block diagram in fig. 2 for easy understanding.
A 7805 voltage regulator is used to regulate 5v power supply is required to drive microcontroller and current sensor. The design is realized by ATMEGA48 integrated with AVR processor, which is a member of the AVR family of general-purpose 8-bit microprocessors. In this module microcontroller is used as central unit to control and monitor all devices. LCD is connected to microcontroller through parallel interface to display information. Relay is used cutoff the power when bill is not paid. GPRS is used as secured link from electricity board to the meter through GSM service connected to microcontroller through UART protocol, and the same is used to send bill details to customer when billing time is reached. In this module current sensor is used to sense power usage and it is interfaced to microcontroller through ADC.
The user can obtain the status of the energy consumption and the corresponding billed amount on the dedicated app present in their smart phones by the end of the month and the person in the electricity board can control the power supply remotely to the consumer house hold depending on the status of the bill payment.

VI. PROTOTYPE TEST APPROACH

The demonstration and working of the prototype shown in fig. 3 is discussed in the following sub sections.

A. Peripheral and Load Connections

- The power supply to the board is given from a 12V AC-DC adapter which is converted to 5V using voltage regulator and can be used as a power supply to the microcontroller.
- LCD is connected to PORT B and PORT C .the power supply is given from the 5V and GND pins present on the PCB board.
- GSM modem's TX is connected to RX of ATMEGA48 and RX of GSM modem is connected to TX. The power is supplied from the PCB board which has dedicated two pins for this purpose.
- The output of the current sensor is connected to analog pin in PORT A and the other two terminals are connected to the load (in this case two bulbs connected in parallel acts as load)
- The terminals of relay are connected one to the microcontroller for triggering and the other terminals to the load accordingly.

B. GSM Modem and Microcontroller Initializations

GSM Modem: The GSM modem has to be initialized by inserting a sim card with internet access to it. As soon as the power supply is given to the PCB containing the microcontroller, the power of the GSM modem should be switched on and should be left for 25 seconds for initialization. The time taken depends upon the signal strength of the SIM card and as soon as it is initialized IP address will be displayed on the LCD screen which is connected to the microcontroller.
This prototype now acts as a server with an IP address and listens to all the client connections which is a smart phone consisting of an application called TCP client in which the IP address displayed is entered and port number 1234 is also entered as this is the port number used in the code for connection to the prototype.
Microcontroller: The microcontroller is configured using SPI interface through in system programmer (ISP). The code written in the Code Vision AVR cross compiler and is converted into hex file. This hex file is dumped into the microcontroller using AVR programmer software.

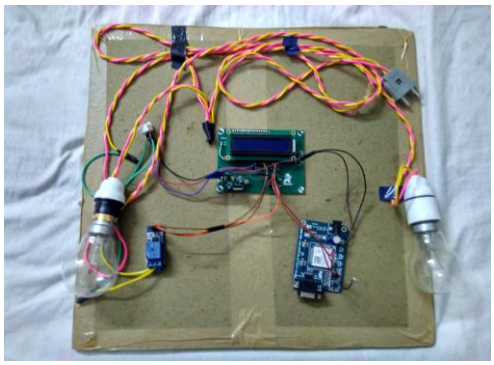

Fig. 3 Prototype model of the desired system

C. Working of the Prototype

The working of the prototype is discussed in the steps below

- The load as well as the prototype are connected to the power supply and is switched on.
- The GSM modem which already has a SIM card inserted in it is switched on and left idle for some time for initialization.
- The server is created by the modem and IP address is displayed on the LCD screen.
- The displayed IP address and port number 1234 is entered in TCP client software installed on an android smart phone.
- The smart phone is now connected to the module and this acts as a controller to cut off the power when the bill is not paid.
- The smart phone is a depiction and is used by the people in the EB (Electricity Board) to switch off the power when the customer fails to pay the bill.
- The prototype notifies the bill every 30 sec which are taken as a depiction instead of 30 days of a month for project demonstration.
- As soon as the bill is displayed; the controller connected to the load waits for 30 more seconds as a grace period to pay the bill.
- If the bill is not paid the power is cut off automatically and if the bill is paid then the person in the EB office passes a command "$a" notifying the controller connected to the load that the bill is paid.
- The process repeats for every 30 seconds and the bill is displayed.

The output on the smart phone is displayed as shown in the Fig. 4. It also has IP address displayed which is unique and known to the Electricity Board officers.

Fig. 4 Output

VII. FUTURE ENHANCEMENTS

i. The module can be equipped with a faster and more capable microcontroller to integrate control of many more devices at the same time.

ii. Voice alerts can be used to indicate the various controlling of devices their status of operation.
iii. Advanced AVR microcontrollers with bigger flash memories can be used to create an increased number of functions and programs for better functionality and for a user friendly interface.
iv. We can include the touch sensors or pressure sensors in the system so that the security is provided whenever intruders try to tamper the electric meter.

The module is, therefore functioning as a very good tool. Incorporating the future enhancement as specified earlier would make the hardware a perfect tool, which would help the user.

VIII. SUMMARY

Satisfactory results have been obtained by using the design approach and the microcontroller is sufficient for measuring the required parameters. The power consumption has been limited as low as possible and the measurements made by the device are quite reliable. Accordingly a highly interactive user friendly module based embedded technology with microcontrollers was developed to solve the problem. The module which is developed will make the job of process easier. The user module has resulted in reducing work of human.

ACKNOWLEDGMENT

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