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PREPAID ENERGY METER WITH HOME AUTOMATION

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Abstract - *One of the major works in the power distribution is the billing process. This has to be carried out with outmost care. Current billing process is entirely based on the idea of post-paid services. Here the consumers enjoy the product first and then pays for it. However this technique has resulted in many drawbacks and faces many challenges. To overcome them one of the proposed method is introduction of prepaid billing system, were consumers pays first and then uses it. In the design proposed here the system is interfaced with a microcontroller and GSM module to carry out the prepayment. The need for this new technology is depend upon many factors and these are discussed in subsequent chapters. Technology is a never ending process. To be able to design a product using the current technology that will be beneficial to the lives of others is a huge contribution to the community. This paper presents the design and implementation of a low cost but yet flexible and secure cell phone based home automation system.*

The design is based on a stand-alone Arduino BT board and the home appliances are connected to the input/ output ports of this board via relays. The communication between the cell phone and the Arduino BT board is wireless. This system is designed to be low cost and scalable allowing variety of devices to be controlled with minimum changes to its core. Password protection is being used to only allow authorized users from accessing the appliances at home.

Key Words: Arduino BT board, GSM module, microcontroller, Optocoupler, Relay Driver, wiz smart home.apk.

1. INTRODUCTION

Wireless technologies are becoming more popular around the world and the consumers appreciate this wireless lifestyle which gives them relive of the well-known cable chaos that tends to grow under their desk. Now with the embedded Bluetooth technology, digital devices form a network in which the appliances and devices can communicate with each other. Today, home automation is one of the major applications of Bluetooth technology. Operating over unlicensed, globally available frequency of 2.4GHz, it can link digital devices within a range of 10m to 100m at the speed of up to 3Mbps depending on the Bluetooth device class. With this capability of Bluetooth; we propose a home automation system based on Bluetooth technology. In this paper we present a low cost secure cell phone based, flexible home automation system. Appliances at home are connected to the Arduino BT board. The communication between the cell phone and the Arduino BT board is wireless. Additional devices can be connected into the system with little modifications. Since the cell phone script is written in Python, it is portable and can run on any Symbian Operating System platform.

1.1 BASIC BLOCK DIAGRAM

The control unit is an interface program that must satisfy the following two conditions. The output from the interface program is forwarded to a wireless transmitter and sent to a receiver through wireless channel. The receiver at the appliances accept the receive signal to turn ON, OFF and control various parameters of the devices. The voice command is captured by using a smartphone application and sent to the Bluetooth module HC-05. Voice commands are send to microcontroller through bluetooth, the microcontroller processes the data and response the voice commands either on, off or adjust various parameters of the devices.

Fig-1 shows the basic block diagram of the proposed system.

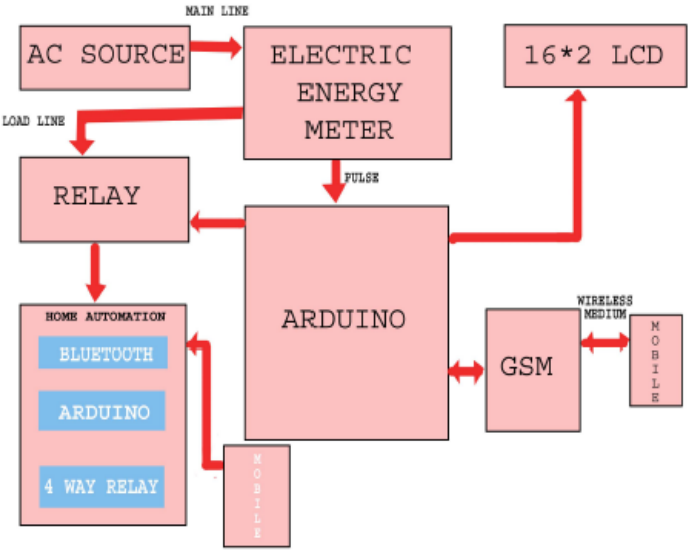

Figure 1: Block Diagram of the proposed system

2. PROPOSED SYSTEM

Proposed system consists of two main sections:

2.1 PREPAID ENERGY METER

The power supply to the design is given from a 230V ac supply. This is directly given to the energy meter. From the energy meter the CAL LED generates pulses according to the intensity of load given to it. These pulses are then given to

the input pins 12 of the optocoupler (4n35). According to the input of the 4n35 output pulses are generated which is interfaced with the microcontroller or arduino board. According to the pulses, microcontroller decrements the balance amount and increments the units consumed. When the balance amount is completely used microcontroller cut out the relay interfaced through a driver (say ULN2003A). When the load goes off, energy meter do not produce any pulses and hence counting is stopped. This continues still the setup is again recharged.

Fig-2 shows the Circuit diagram of prepaid energy meter.

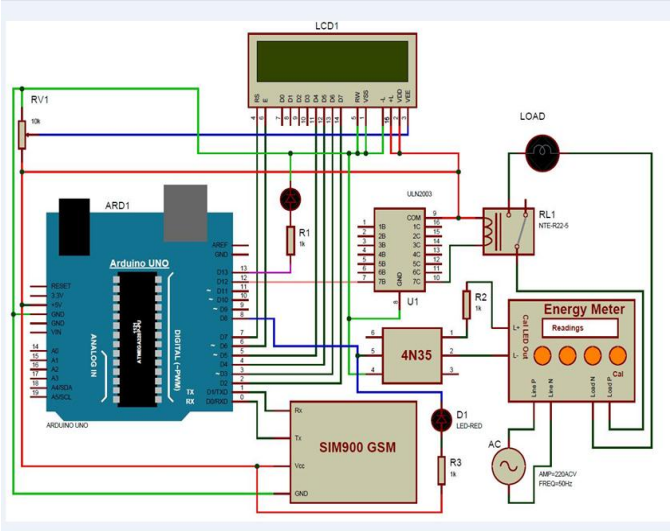

Figure 2: Circuit diagram of prepaid energy meter

For the purpose of recharging one can use Smart Card technique or SMS (as in this case). A GSM module is interfaced with the microcontroller through which SMS is sent and received. Whenever balance is over, one can recharge using a particular syntax command, say #amount*. The SIM card in the module acts as the authority to which the SMS is sent. This technique also provides us with the alert mechanism, through which consumers are alerted about LOW BALANCE. In the SMS sent, amount is stored in the EEPROM of the microcontroller as the new balance, which then decrements according to the use. 16X2 LCD display is also interfaced with the microcontroller which displays the current status of balance amount and units consumed.

On interfacing GSM, the Tx and Rx pins of GSM is given to Rx and Tx pins (0 and 1) of arduino. Similarly LCD module pins are interfaced with the digital pins (7, 6, 5, 4, 3, and 2) of arduino. Optocoupler and relay drive are connected to digital pins 8 and 12 of arduino.

2.2 HOME AUTOMATION

This home automation system consists of two main hardware components: the cell phone and the Arduino BT board. The cell phone hosts the Python script which enables the user to access the home appliances and also the control commands for the appliances. This Python script communicates with the Arduino BT board and sets up an ad-hoc communication protocol between the two devices, which allows controlling the behavior of the Arduino BT board. An off-the-shelf readymade Arduino BT is an 8-bit microcontroller board based on the ATmega168 and the Bluegiga WT11 Bluetooth module is used. It supports wireless serial communication over Bluetooth. This board has 23 digital input and output ports, 16kB of ash memory, 10-bit analog to digital converter, pulse width modulator and extra hardware resources which makes it suitable for the required task. The Arduino BT board can be programmed wirelessly over the Bluetooth connection using the microcontroller's high-level interactive C language.

Fig-3 shows the Circuit diagram of Home Automation.

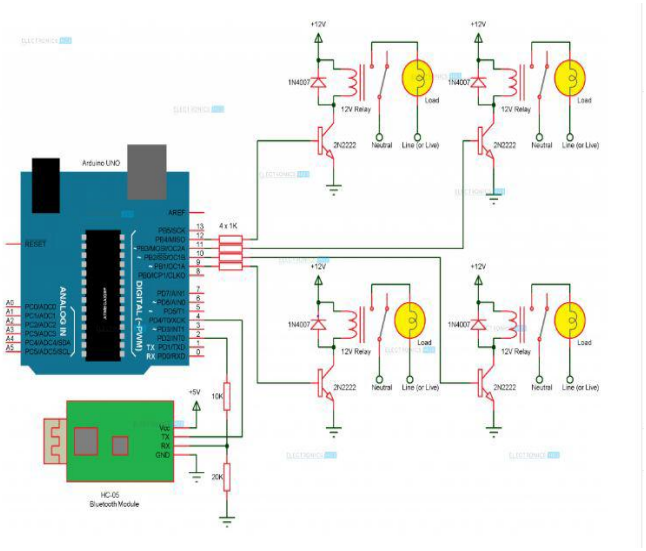

Figure 3: Circuit Diagram of Home Automation.

The Bluetooth antenna in our module picks up the packets sent from the cell phone. Subsequently, these packets containing the appliance status commands are pipelined through ATmega168 microcontroller and the designed analogue circuitry according to the definition of each output. Different home appliances are connected to the digital output ports of the Arduino BT board via relays to provide suffciently high currents and voltage compatibility.

2.3 COMPLETE SYSTEM

Sending commands from software to turn ON/OFF a device may not guarantee the successful operation of the device as the device may be defective. To solve this problem, a feedback circuit has been designed and implemented to indicate the devices actual status after it receives the command (ON/OFF) from the cell phone. Once the command has been sent to turn ON a device, the feedback circuit senses the current and gives an output signal by turning ON a respective led on the switching circuitry indicating that the device is ON. Otherwise, the device is malfunctioning indicating that the command was not executed successfully.

Fig-4 shows the Circuit Diagram of complete system.

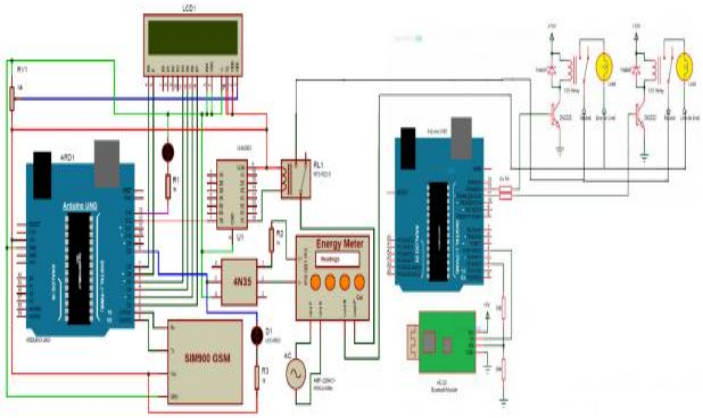

Figure 4: Circuit Diagram of complete system

3. COMPONENTS USED

Main components used are ATmega328P (ARDUINO UNO), Bluetooth Module HC-05, Digital Energy Meter, SIM900 (GSM) Module, Optocoupler (4n35), 16X2 LCD Module, Relay Driver (ULN2003A), Potential Transformer, Voltage Regulators, Relay.

3.1 Relay

The advantage of relays is that it takes a relatively small amount of power to operate the relay coil, but the relay itself can be used to control motors, heaters, lamps or AC circuits which themselves can draw a lot more electrical power.

3.2 ATmega328P (ARDUINO UNO)

ARDUINO UNO is a development board for ATmega328P microcontroller. Basically it consist of 14digial pins and 7analogue pins. Among the 14 digital pins, 2 pins say Pin

0, Pin 1 is also characterized for serial communication purposes that is for Transmission and Reception.

3.3 Bluetooth Module HC-05

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another bluetooth device, but can accept connections. Master module can initiate a connection to other devices.

3.4 Smart Phone Application Used: wiz smart home. Apk

Wiz smart home .apk is used to control the switches to turn on or off the home appliances.

Figure 5: wiz smart home.apk

3.5 Digital Energy Meter

In prepaid technology the units consumed is obtained from the number of pulses generated by the CAL LED of the energy meter. This generates pulses according to the load connected. Energy meters are available in different pulse rate say 1600imp/kWh or 3200imp/kWh, here we use the latter. These pulses generated are then processed in microcontroller to obtain the count.

3.6 SIM900 (GSM) Module

SIM900 is a member of the GSM module family which (in this case) helps the consumer to contact with the authority and vice versa. The module enhances one to easily operate them and is processed using AT commands.

3.7 Optocoupler (4n35)

An Optocoupler, also known as an Opto-isolator or Photo-coupler, is an electronic components that interconnects two separate electrical circuits by means of a light sensitive optical interface. 4n35 is photo transistor type optocoupler and is interfaced with the energy meter to count the units used based on the led flashings on energy meter. It is a 6 pin IC. Whenever the LED in energy meter ashes, 4n35 records the count in the chip microcontroller.

3.8 16X2 LCD Module

The 16X2 LCD module is a display board to display the current status of balance and units used. The display board is matrix type and has 2 rows and 16 columns. Requires a supply of 5V.

3.9 Relay Driver (ULN2003A)

The ULN2003A is high voltage, high current Darlington array containing seven open collector Darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. ULN2003A is used to interface the relay with the microcontroller.

3.10 Potential Transformer

The transformer used in the power supply here gives an output total of 12V for an input voltage of 230V. The voltage transformer used in the power supply is designed for single phase 230 V, 50Hz. The output is taken from the two end wires and is equal to 12V. Here we uses a 12V,2A transformer.

3.11 Voltage Regulators

The LM78XX series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. The XX in LM78XX determines the value of voltage to be regulated. Here we use 2 types of voltage regulators of LM78XX series such as 7805and 7812 for 5V and 12V.

4. CONCLUSION

Paper is intended to present an overview of prepaid energy meter, which can control the usage of electricity on consumer side to avoid wastage of power. Since there is need to utilize energy in better and efficient way, prepaid energy meter proves to be a boon in the power sector. The major drawback of a post-paid system is that there is no control of usage from the consumers' side. There is a lot of wastage of power due to consumers' lack of planning of electrical consumption in an efficient way. Since the supply of power is limited, as a responsible citizen, there is a need to utilize electricity in a better and efficient way. The distribution company has to receive a huge amount in the form of pending bills, which results in substantial revenue losses and also hurdles to modernisation because of lack of funds.

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