WSN-Based Home Energy Management System using Smart Sensors and ZigBee Technology

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Abstract- WSN-Based Home Energy Management System using Smart Sensors and ZigBee Technology is the system that allows real time management of all the house hold appliances. The system principally monitors electrical parameters of household appliances such as voltage and current and subsequently calculates the power consumed. The novelty of this system is the implementation of the controlling mechanism of appliances in different ways. The developed system is a low-cost and flexible in operation and thus can save electricity expense of the consumers. The prototype has been extensively tested in real-life situations and Experimental results are very encouraging. A Visual Basic application is used to control the entire connected load and allow their operation as per priority set. Solid state relays are used for switching of loads. The system is controlled by Arduino Microcontroller. The system provides reduction in electricity consumption providing better efficiency and power management.

Keywords-*Energy Management, Wireless Communication, Sensors.*

I. INTRODUCTION

The requirement of electricity in India is increasing day by day as our population grows. An effect of this is that we require installing more generating unit at generating side, however components for transmission and distribution of electricity causes an additional increase in cost. Also due to this access need of electricity the gap between generation and demand side increases. People have no control over electricity use due to its easy access. The system introduced in this paper allows slight reduction in electricity use fulfilling daily need of electricity of a residential load at different hours of time. It allows setting different priorityof all connected load so they can switch their operation as per different hour of the day.

The system continuously monitors the power taken by each load, using a current sensing unit. A relaying unit or switching unit is used for connection and disconnection of load. The system is controlled through master software which is a Visual Basic application. For communication between all nodes and master software a 2.4GHz radio link is provided among the sensor nodes.

II. LITERATURE SURVEY

Now a day's more than 50% of the load of commercial and residential load is of lighting loads. Most of the intelligent buildings such as big offices, hospitals, malls uses lighting load as their inherent beauty. Also these buildings are employed with air conditioning system. Management of such a load becomes critical. In such a case an automatic load management system should be there so that all equipment in the system operates economically. Also it is necessary to analyze the power consume by each load. All of the above can be achieved by using the system discussed in this paper.

WSN-Based Home Energy Management System using Smart Sensors and ZigBee Technology can be able to operate all loads as per their priority and at what time they should operate. The wireless control is employed using ZigBee. Hall Effect sensors are used to monitor Electrical quantity such as current and voltage. A 16x2 LCD display indicates the active loads and the power consume by them. The solid state relays are used for connecting and disconnecting loads when the signal is given by the controller.

The system is control through a VB (Visual Basic) Application wirelessly from a Master (Computer/Laptop). The system can also be used with Proximity sensors which includes additional saving of energy. Proximity sensors provide that when there is no one in the room the system will disconnect all the lighting and AC load in the room.

III. SYSTEM DESCRIPTION

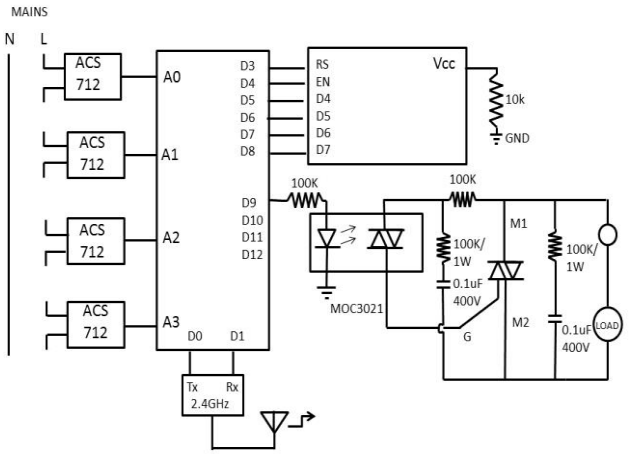

Fig.1 System Block Diagram

The input rated supply voltage first comes down to lower limit i.e.9V, 1A for the satisfactory work of microcontroller

and other circuits, a step down transformer is introduced for this application. But all the circuitry works on DC supply so it is mandatory to do this conversion. This conversion is done by bridge rectifier. But This DC supply is having some impurities, so these impurities are removed using filer. Further to get the constant DC supply voltage regulator 7805 are used.As shown in above block diagram there are four different loads connected to Microcontroller (ATMEGA328) which performs all the logical operations in real time monitoring of load. There are four Hall Effect current sensors (ACS712) used for each load for current monitoring purpose which are connected to analog pin of microcontroller (A0-A3). The transmitter and receiver are connected to digital pin of the microcontroller (D0-D1) to collect data or information i.e. voltage and current from the external operator by means of wireless software (NRL2404 R-F link 2.4GHz with Wi-Fi). Liquid Crystal Display (LCD) is connected to digital pin of microcontroller (D3-D8) for displaying the monitored data. Variable resistance of 10k-ohm is shown for controlling the brightness of the display. A relay switching circuitry is shown in right bottom side of the figure. The relay used is solid state relay ULN2803. The whole circuitry is isolated through Opt coupler –MOC2031 in series with 100ohm resistance and connected to the digital pin (D9) of the microcontroller. Similarly there are four relay driver circuits for four different loads which perform all the switching action.

Visual Basics (V.B.) 3.2- Visual Basics is software which allows developing windows graphics user interface (GUI) application. Visual Basics is run by an event once the event is detected, the corresponding code for that is executed. V.B. has some identical features such as faster compiler, new active X data control, new data report designer and additional capabilities. It has title bar, menu bar, tool bar. This are used to make main window frame. The communication between the V.B. application and system is done by ZigBee Technology.

Following components are utilized for hardware implementation;

A) ACS 712 Current Sensor- It provides adequate solution for AC and DC current measurement in all power sectors. It easy implementation makes it favorable to the customer for different applications such as load detection, overcurrent fault protection and as a switching mode power supply. It consist of precise, low offset, linear hall effect circuit with copper conduction path which produces a magnetic field on the basis of current proportional to the voltage.

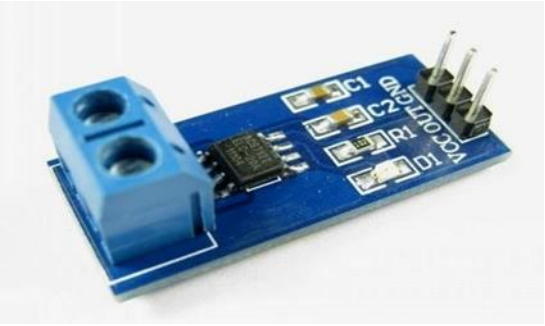

Fig.2 ACS 712 current sensor

B) ATMEGA48PA Microcontroller- ATMEGA is a low power CMOS 8 bit microcontroller. It is based on RISC architecture. It is latest, high performance and compact in size. It consists of two 8 bit Timer / Counter with Prescaler and compare mode. It also has one 16 bit Timer /counterwith separate prescaler, compare and capture mode. The operating voltage is for this microcontroller is 1.8 – 5.5 V and temperature range is 40 – 85 ^{0} C. The operating frequency is 0 – 20 MHz It is easily programmable.

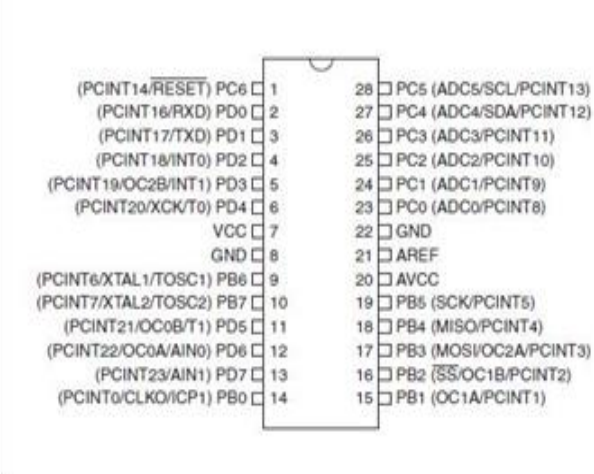

Fig.3 ATMEGA48PA Microcontroller

C) Liquid Crystal Display- The LCD used is 16x2 display is the basic module and commonly used in various electronic circuit. The reason for preferring this segment is easily interfacing or programmable, low cost and No limitation of displaying. It have one command register which stores the command instruction given to the LCD and one data register stores the data displayed on the LCD.

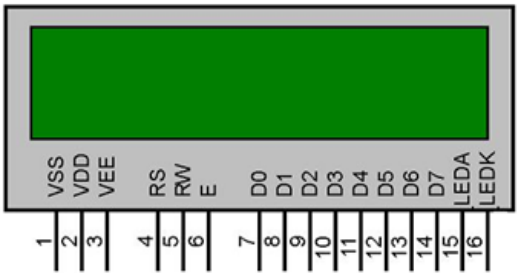

Fig.4 Pin out and Pin Description of 16x2 LCD Module

D) Arduino- Arduino is board on chip microcontroller. The hardware made of an open-source hardware designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel. Its features like USB interface, 6 analog input pins, as well as 14 digital I/O pins that accommodate various extension boards makes it popular in this electronic Era. It allows users to write programs for Arduino using C or C++. An Arduino board consists of an Atmel 8-bit AVR microcontroller with complementary components. It includes a 5 volt linear regulator and a 16 MHz crystal oscillator.

E) Relay driver circuit ULN2803- The ULN2803 is designed to be assured with standard TTL families. The ULN2803 has a 2.7k input resistor for 5V TTL and CMOS. All types are supplied in an 18-lead plastic DIP with a copper lead which feature the adequate input opposite-output pin out to simplify circuit.

Fig.5 Arduino UNO R3

F) GHz RF link module-It is ideal for medium range full-duplex, high-speed and reliable communication. RF 2.4 GHz serial link module is an embedded solutions providing wireless end-point connectivity to devices. They are designed for high-throughput applications requiring predictable communication timing.It can be connected to any TTL/CMOS logic serial RXD and TXD lines and can support baud-rate of 9600bps, 19200bps, 38400bps and 57600bps. It also supports 4 unique RF channel. It does not require any configuration RF communication. It does not require any configuration RF communication. Automatic switching from receive or transmit mode is possible.

Fig.6 GHz RF link

IV. ELECTRICAL CIRCUIT AND RESULT ANALYSIS

A. Voltage Measurement- The input transformer used is of 230/9V, 1A step down transformer. The step down transformer is used to step down line voltage to 9V. The secondary voltage of step down transformer is further regulated to 5V DC by means of rectifier, filters and voltage regulators. The 5V is given to Vcc pin of Microcontroller for its operation.

B. Current Measurement- ACS712 sensors are used for current measurement which works on the Hall Effect principle. When current flows this current sensor produces a magnetic field which is measured in terms of voltage. The ACS712 produces an analog signal, Vout Output which varies linearly with uni-or Bi-directional AC or DC primary sampled current. Following equation is used for output of the system:

Output = 2.5V + /- 185mV per 1Amp

C. Graphical Representation:

Fig.7 shows graphical representation of voltage and sensed current.

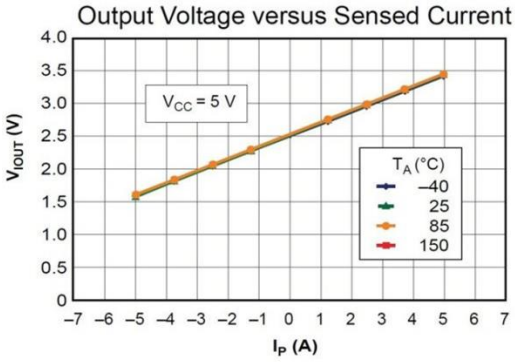

Fig.7 Output Voltage versus Sensed Current

V. CONCLUSION

In this paper, we conclude that a system providing automatic and efficient control of all Residential and Commercial load can be implemented. The system can reduce electrical unit consumption to a great extent. The automatic connection and disconnection of loads allows smooth control of electricity used. . By using proximity sensors the system can make a normal house an intelligent smart home. So the system reduces electricity tariff by eliminating unnecessary use of electrical appliances.

VI. REFERENCES

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