

Remote-Controllable and Energy-Saving Room Architecture with Security System Based on Zigbee Communication

M.BHARATHI, V.RENU, U.TAMILSELVI

Abstract- Our paper proposes remote controllable and energy-saving room architecture with security system to make the room easily controllable with single remote based on zigbee communication. Here we use PIC (16F877A) microcontroller to reduce circuit complexity and it requires less power. Energy saving can be achieved by using sensors like Passive Infrared sensor, light dependent resistor sensor, level sensor, temperature sensor, power monitoring circuit to trip off the home appliance which draws more power than the normal power consumption. To enhance security vibration sensor is used.

Index terms- Zigbee, Remote Control, Energy-saving, Power Outlet, PIC, Sensors.

1. INTRODUCTION

Now-a-days we are in need to avoid wastage of power in home. As more and more consumer electronics and home appliances are deployed and the size of them is becoming large, power consumption in home area tends to grow. Moreover, useless power consumption occurs during day time and also when the human being is not present in the room. So through this project we are overcoming the above mentioned threat by using various sensors to enhance security and to save power.

In this system, zigbee as wired or wireless networks are used to transfer the control information and the measured power [5]. zigbee is a low-cost, low-power, wireless mesh networking proprietary standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. The user can also check the power consumption of the home appliances through the remote control unit [1].

2. AUTOMATIC STANDBY POWER CUT-OFF OUTLET

In previously, they have designed a remote power on/off control and a current

measurement for electric outlets, based on both an embedded board and on Zigbee communication [5]. The design consists of two parts: the ZigBee control module and the server module. The ZigBee control module contains several controllable outlets, a current measurement circuit, the ZigBee receiving and transmission circuit and a micro control unit. The measurement circuit senses the current and sends back a signal to the server module through the ZigBee [2]. The measurement data of the current and voltage detection can be stored in the embedded board, and they can be designed to become aware of any overload and to send out a message to the circuit breaker for safety [2].

The automatic standby power cut off outlet is composed of an AC/DC conversion, one two port relay, a power monitoring circuit and a microcontroller. The AC input is connected to the two port relay. One output port of the relay is connected directly to the AC output outlet and the other. Remote-Controllable and Energy-Saving Room Architecture based on Zigbee Communication output port is connected to it via the power monitoring circuit. The power monitoring circuit consists of a transformer, rectifying diodes and additional components. It converts the measured power consumption into a voltage. The microcontroller digitizes the voltage and calculates the consumed power. Based on the calculated power, it controls the

relay to cut off the power supply [2]. The AC/DC conversion circuit supplies the necessary DC power to the microcontroller in which a Zigbee Radio Frequency (RF) module is integrated to communicate with the remote control unit. Zigbee is a wireless network standard which is aimed at remote control and sensor applications requiring for low power consumption and low data rates [1].

This power outlet periodically monitors the power consumption via the power monitoring circuit. Initially, it has its own threshold power in the memory of the microcontroller. When the connected home appliance is changed, the threshold power can be reconfigured by measuring the normal power consumption and the standby power consumption [2].

When the monitored power is below the threshold power for the predetermined time, the microcontroller turns off the relay to completely cut off the AC power. Then it goes to the off state. Now the microcontroller does not monitor the consumed power but waits for a turn-on command through Zigbee communication [5]. When it receives the turn-on command, it turns on the relay to supply the AC power to the output port. This method can reduce even the standby power of the home appliance because the power outlet completely cuts off the power supply. Although some power is consumed in the microcontroller and the AC/DC circuit, it is very small compared to the standby power of the home appliance. This proposed automatic standby power cut-off outlet can cut off standby power without the central units.

3. ENERGY SAVING ROOM ARCHITECTURE WITH PIC MICRO CONTROLLER

The proposed model is designed to have the capability of automatic power cut-off in order to avoid wastage of power. Fig.1 shows the sample model of architecture of the power outlet, which is composed of one two port relay, a power monitoring circuit and a PIC 16F877A microcontroller. The AC input is connected to the two port relay. One output port of the relay is connected directly to the AC output outlet and the other output port is connected to it via the power monitoring circuit. The power monitoring circuit consists of a transformer, rectifying diodes and additional components. It converts the

measured power consumption into a voltage. The microcontroller digitizes the voltage and calculates the consumed power. Based on the calculated power, it controls the relay to cut off the power supply. The AC/DC conversion circuit is present inbuilt in the PIC 16F877A microcontroller and it is the major advantage when compared to other microcontrollers [3].

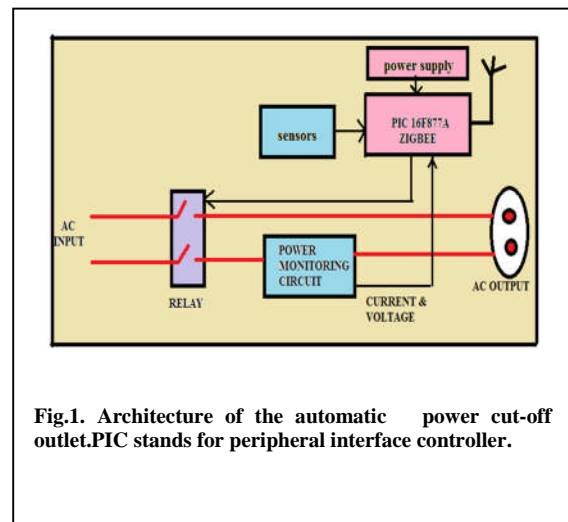


Fig.1. Architecture of the automatic power cut-off outlet. PIC stands for peripheral interface controller.

Externally, power supplies the necessary DC power to the microcontroller in which a Zigbee Radio Frequency (RF) module is integrated to communicate with the remote control unit. A usual home appliance consumes a large amount of power during day time as well as in the absence of human being in the room. To more efficiently reduce total power consumption, it is required to completely cut off the power supply at the power outlet in response to the sensor output signal.

4. PROPOSED ENERGY MANAGEMENT SYSTEM WITH SECURITY

The proposed room architecture consists of keypad, PIC microcontroller (16F877A), sensors and four home appliances. They are controlled by Zigbee transceiver. Here we are going to control various home appliances by using a single remote control based on Zigbee communication [1],[3],[5]. Additionally, to save power and to enhance security different types of sensors are used.

PIC microcontroller is the first RISC based microcontroller fabricated in CMOS that uses separate bus for instruction and data. PIC

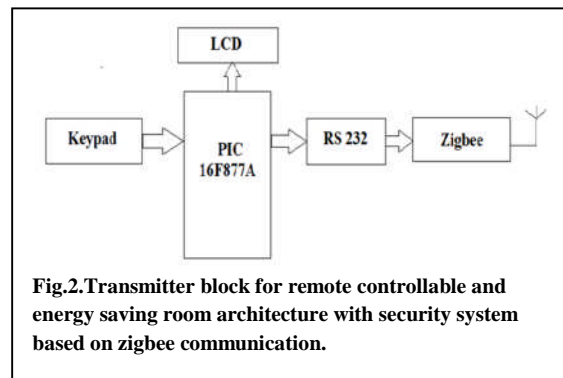
16F877A microcontroller is a stand-alone unit, which can perform functions on its own without any requirement for additional hardware like i/o ports and external memory and it is mainly used because it requires only 35 simple instructions. Whereas in other microcontrollers it is necessary to know more than 200 instructions. Execution time is the same for all of them and lasts for 4 clock cycles. Its operating speed is 20MHZ and execution time of each instruction is 200ns i.e. the program will be executed at the speed of 5 million instruction/second.

Fig.2. Transmitter block for remote controllable and energy saving room architecture with security system based on zigbee communication [5]. In the transmitter side, it consists of keypad, PIC 16F877A, RS 232, LCD, zigbee transmitter. In the keypad there are number of switches in the matrix form corresponding to the number of home appliances connected in the receiver side.

We are assigning four buttons for four different home appliances by program coding. The first button is assigned to light, the second button is assigned to fan, the third button is assigned to load and the fourth button is assigned to motor. When the first button is pressed, the corresponding signal is passed to the PIC 16F877A and the output signal from PIC 16F877A is carried to Zigbee transmitter through a serial interface RS 232.

RS-232 is simple, universal, well understood and supported but it has some serious shortcomings as a data interface. The standards to 256kbps or less and line lengths of 15M (50 ft) or less but today we see high speed ports on our home PC running very high speeds and with high quality cable maximum distance has increased greatly [4].

The rule of thumb for the length a data cable depends on speed of the data, quality of the cable. Zigbee transmitter transmits the signal through a wireless communication and it covers a distance of about 10-100 meters. A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images, and moving pictures. LCD is used to represent the home appliance which is working on the receiver side.



In receiver side, it consists of Zigbee receiver, RS 232, PIC 16F877A, sensors, relay and home appliances. When the transmitted signal is received by the Zigbee receiver, it sends the signal to PIC 16F877A through a serial interface RS 232 and then from the output signal of PIC, the relay get operated and the corresponding home appliances get activated. Here, we are using five types of sensors namely PIR sensor, LDR sensor, level sensor, temperature sensor are used to save energy and Security can be achieved by using vibration sensor. LCD is used to represent for what reason the home appliance is tripped OFF.

Fig.3. Receiver block for remote controllable and energy saving room architecture with security system based on zigbee communication. The PIR sensor switch can detect the Infrared Rays released by human body. The light or any other electrical appliance can be activated automatically by the active presence of a human body within the detection range / coverage area & when there is no presence the light will be deactivated automatically. The PIR Sensor senses the motion of a human body by the change in surrounding ambient temperature when a human body passes across the sensor. Then it turns on the lighting load to which it is connected. The lighting load will remain ON until it senses motion. Once the motion is seized it switches OFF the lighting load [3]. Level sensors detect the level of substances that flow, including liquids, slurries, granular materials, and powders.

Electronic float type level Sensors operate on a direct, simple principle. In most models, a float encircling a stationary stem is equipped with powerful, permanent magnets.

As the float rises or lowers with liquid level, the magnetic field generated from within the float actuates a hermetically sealed, magnetic reed switch mounted within the stem and it indicates the level of water which is above or below the sensing point in the water tank.

Vibration sensor is used to protect door or window. It generates a loud beep when somebody tries to break the door or window. The circuit uses a piezo element as the vibration sensor. A piezoelectric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical signal [3]. There are certain materials that generate electric potential or voltage when mechanical strain is applied to them or conversely when the voltage is applied to them, they tend to change the dimensions along certain plane. This effect is called as the piezoelectric effect. Piezoelectric sensors have proven to be versatile tools for the measurement of various processes. They are used for quality assurance, process control and for research and development in many different industries.

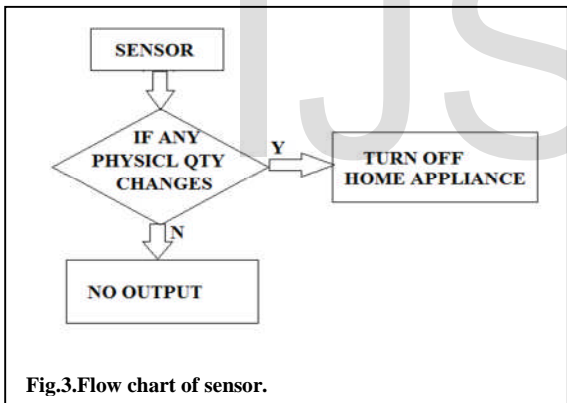


Fig.3.Flow chart of sensor.

As a result when any theft happens in home, due to the vibration or stress that was made over the door by thief electrical signal will be passed to the PIC 16F877A and further the output is given to our mobile through GSM.

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are

most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages .A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

A photo resistor or light dependent resistor or cadmium sulphide (CdS) cell is a resistor whose resistance decreases with increasing incident light intensity [4]. It can also be referenced as a photoconductor. A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

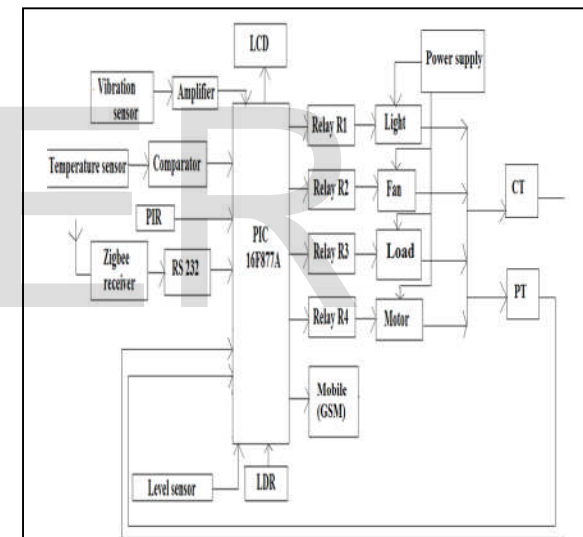


Fig.3.Receiver block for remote controllable and energy saving room architecture with security system based on zigbee communication.

A thermistor is a type of resistor used to measure temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor. Thermistors are commonly used to measure temperature, because they are inexpensive, rugged and reliable and they respond quickly. A current transformer (CT) is used for measurement of electric currents [2].When current in a circuit is too high to directly apply to measuring

instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments.

A current transformer also isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the industry. Current transformers, together with potential transformers (PT), are known as instrument transformers. Potential transformer is used for measurement of electric voltages. When the operating voltage and current of home appliance exceed the normal voltage and current, the current transformer sends signal to PIC 16F877A. And according to the output from the sensors and CT, PIC 16F877A sends signal to the respective relay and the corresponding home appliance is operated.

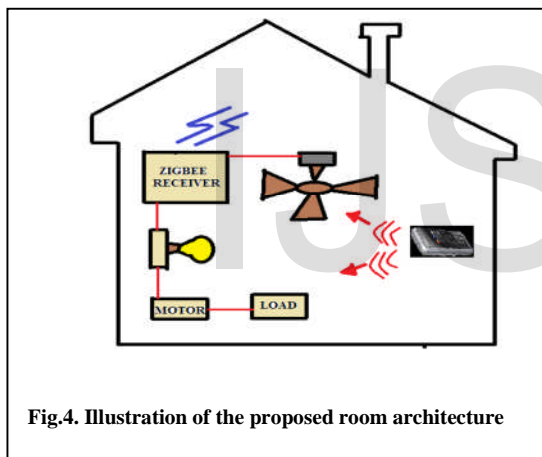


Fig.4. Illustration of the proposed room architecture

5. CONCLUSION

We proposed remote-controllable and energy-saving room architecture with security system. With the help of this architecture a user can control various home appliances and save the total power consumption of a room. To configure this room architecture we proposed the automatic power cut-off outlet and zigbee controller.

The power outlet monitors the consumed power periodically. When the monitored power is above or below the normal power consumption the relay will automatically trip off the home appliance. In addition to this, the relay also gets operated when there is any response from the sensors. This can reduce the wastage of power. To enhance security, GSM is used to give an alert message to the mobile when the house owners are not in home.

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