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Remote Control System using AC Power Line

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***Abstract* - Power Line Communication or Power Line Carrier (PLC) is basically a technology that enables narrow or broad band speeds through power lines by varies advanced modulation technology. It is based on the principal of controlling each unit or specifically each electrical device connected to an electrical socket with the existing power line in the house. In this paper, the main purpose of developing remote control using power line communication is because this technology doesn't require extra cabling. It only uses the existing power cable in the house. Hence, the owner of the house doesn't have to restructure their cabling system which is very inconvenient and costly.**
The basic remote control through power line will be established and the ATMEGA controller will be able to control any electric appliances that plug in to the power line interface socket. Besides that, one control and monitor system is being develop and able to control and monitor the power line interface socket by the help of RS-232. The system is able to control ON/OFF of the domestic product, provide the detail data like date and time of the socket being ON/OFF to user.

1. INTRODUCTION

PLC is used for transmitting (50/60 Hz 220/110 V) power signal. It is not designed to convey high frequency signal such as 20 MHz communication signals used in the home plug 1 protocol. A power line channel is somewhat wireless channel, both suffer from noise, fading, multipath, and interference. Power line noise is produced by operation of electrical device. Fading, multipath and interference are caused by the imperfection of power line channels. Also limits the available bandwidth for communication purposes. In compliance the usable bandwidth in the home plug standard is 25MHz. There an extensive on going studies of power line channel characteristic.

To conquer the above problems, robust signal modulation and data coding are needed.

2. THE PROBLEM

Traditionally, device control is usually achieved through direct physical contact (wire) between computer and the device to be controlled. In huge control system that extends for long distance; the wires have available resource. Thus, the idea of replacing the wires with one of the available resources to reduce the total cost takes place. One of these resources is alternative current (AC) power lines that are used in all of the power systems to transfer electricity to consumption area. Those wires are available in the electric systems, so, I can use them as a transmission medium to transmit control signals that to transmitted to different part of the system, so that I get rid of an extra cost that arise from purchasing wires.
Several options, with different costs, can provide voice and data communication service. The simplest solution is connecting lines. This solution is potentially quite costly because of the number of lines involved. A wireless system has also been suggested for communication. This option reduces local loop fees, but increases hardware costs and radiation issues would be there. Another alternative involves running high bandwidth lines. These lines could be fiber, ATM, or broadband coaxial cable. This option avoids local loop fees, but is beset by equipment fees. Communication between various departments in the large industries, schools or in hospitals requires large amount of resources and it is so difficult to maintain.

3. OBJECTIVE OF THE STUDY

- The main aim of this paper is to design and develop a remote control system in the real time using the power lines such that it can communicate with maximum efficiency. This device is:

1. Economical
2. User friendly
3. Reliable

- Design remote control system replacing the conventional wires with AC power lines to reduce the total cost.
- Design special receiver to detect the high frequency control signals.

4. METHODOLOGY OF THE SYSTEM

This system contains two components which are the hardware and software components. On the hardware part, the power line transmission function needed to be developed with the ATMEGA microcontroller in order to control appliances through power line. Interfacing of power line modem with ATMEGA microcontroller is the main part of the hardware while the software part requires designing a control system panel that is able to interact with the hardware. Microsoft Visual basic 2010 software has been chosen in this paper to design the control interface and serial communication is used to connect the system with the control interface. All the operation of the system with control interface is using the serial port communication.

5. HARDWARE ORIENTATION OF REMOTE CONTROL SYSTEM

With the proposed system to be designed certain hardware components are required. These are as follows

1. Two PLM.

2. WIZ 110SR.

3. Personal Computer.

4. MAX 232

5. ATMEGA 16L microcontroller.

6. Serial communication cable.

7.ULN2003

8. Three relays

9. Two RJ-45 cable

10. Electric deviceS (fan ,motor ,LED)

11. Five capacitors (1x1000 μF + 4x1μF).

12. Resistant (100 Ω)

13. 5V DC adaptor.

6. METHODS AND MATERIALS

The hardware development of the GUI Based Remote On/Off Control and Monitoring Single Phase Automation Device is as shown in Figure 1. The system consists of a personal computer (PC) as a main controller with the ATMEGA 16L microcontroller circuit system which acts as a slave unit. The proposed technique of centralization utilizes a concept of master/slave communication. In this system, one master device controls the other slave units. All these slave units have their own unique identification address. When the slave units receive the same address data, they extract the address from the master and compare it with their identification address. The slave units with matching addresses will send back the address to the master devices for confirmation for a successful transfer. This is aided by an auto handshaking line driver for transmitting and receiving which is controlled by the ATMEGA 16L microcontroller. The slave units are controlled using the ATMEGA 16L microcontrollers, which provide serial-embedded communication to external link configurations through the software.

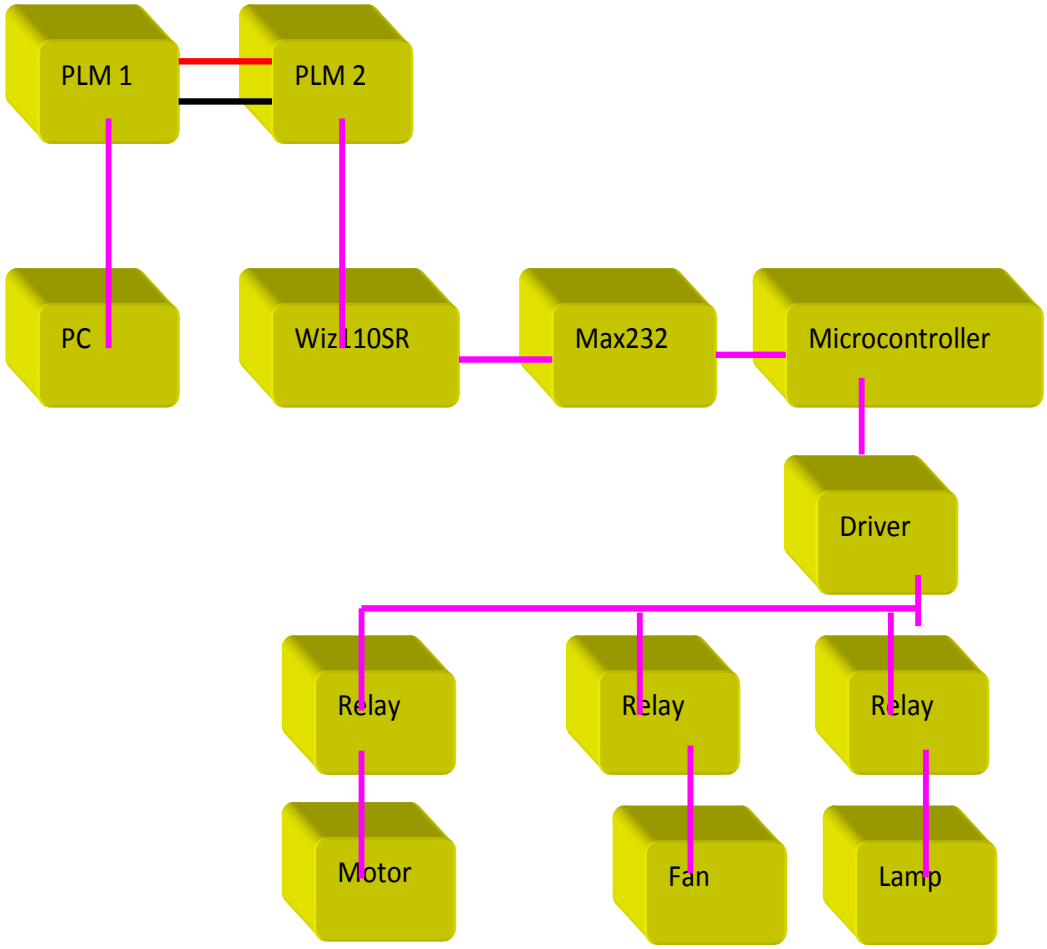

Figure 1: Remote control block diagram

7. FUNCTIONAL DESCRIPTION:

In this system the data is being transferred over AC line from PC communication port, which is encoded and decoded by PLC chips. The circuit contains PC on one side and microcontroller based relay switching drives on another side. I send the data using program prepared in Visual Basic (VB) through Ethernet port. This Ethernet port is connected to PLM. This PLM is assigned supply of 230V mains. On the receiver side, same circuit is connected to power line on the same phase. This circuit receives data from the PC attached with the circuit which is connected to ATMEGA 16L microcontroller.

Visual Basic contains the program of scheduling and manual switching operation. As this program starts, some atomization functions starts performing for the atomization industry. The PC side circuit is connected to MAX 232 for the voltage shifting. On the other side of microcontroller, relay driver is connected to relay circuit. Figure 2 indicates the circuit diagram of the receiver.

First, I prepare the program for microcontroller serial baud rate i.e. 9600 bits/sec. This program is also applicable for PC side. Then serial values come to microcontroller. This microcontroller reads the value and compare it whether these are A, B, C or D. When it finds equal, particular task i.e. relay ON/OFF is carried out. Relay doesn't drive microcontroller circuit so I use driver circuit i.e. transistor base Darlington array in a single chip (ULN 2003). This chip contains 8 Darlington arrays. The device controller end of the system will consist of ATMEGA 16L microcontroller connected to the PLCM through its TX/RX pins , which will allow for RS232 communication from the master computer to the device controller. The ATMEGA 16L will use it I/O ports to control the corresponding

device via external circuitry designed to provide electrical isolation between the ATMEGA 16L and the device, as well as sufficient power to the device.

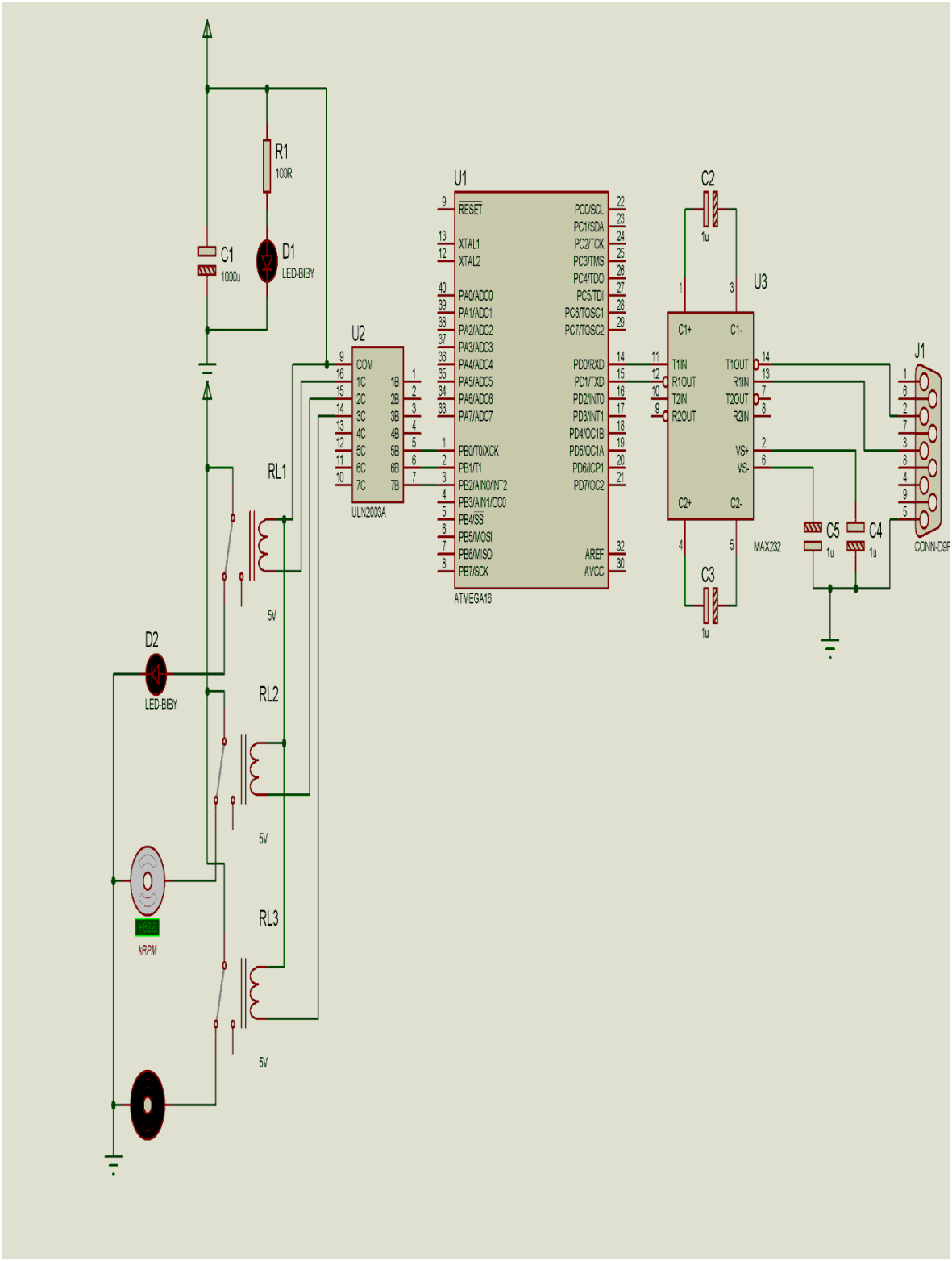

Figure 2: Circuit diagram of receiver side

7.1 Power line Modems

Two power line modems are used . PC have one connected to it to make a network through the power line and other connected to remote control side.

In this project Edimax HP-2001AV Power Line 200Mbps Ethernet Adapter device was chosen. See figure 3.

Figure 3: Power line modem-Edimax

HP-2001AV turns the existing electric wires in your home or office into a high-speed network. You do not have to install the network cables and be annoyed with the cables planning just use the wires that already run through the building. HP-2001AV enables you to create a network easily and cost-effectively.

7.2 WIZ119SR

WIZ110SR is a gateway module that converts RS-232 protocol into TCP/IP protocol. It enables remote gauging, managing and control of a device through the network based on Ethernet and TCP/IP by connecting to the existing equipment with RS-232 serial interface.

WIZ110SR (figure.4) is a protocol converter that transmits the data sent by serial equipment as TCP/IP data type and converts back the TCP/IP data received through the network into serial data to transmit back to the equipment. When the data is received from serial port, it is sent to W5100 by MCU. If any data is transmitted from Ethernet, it is received in the internal buffer if W5100, and sent to the serial port by MCU. MCU in the module controls the data according to the configuration value that user defined (figure.5); we configure wiznet to take THCP IP and to work as client and server.

Figure 4: WIZ110SR

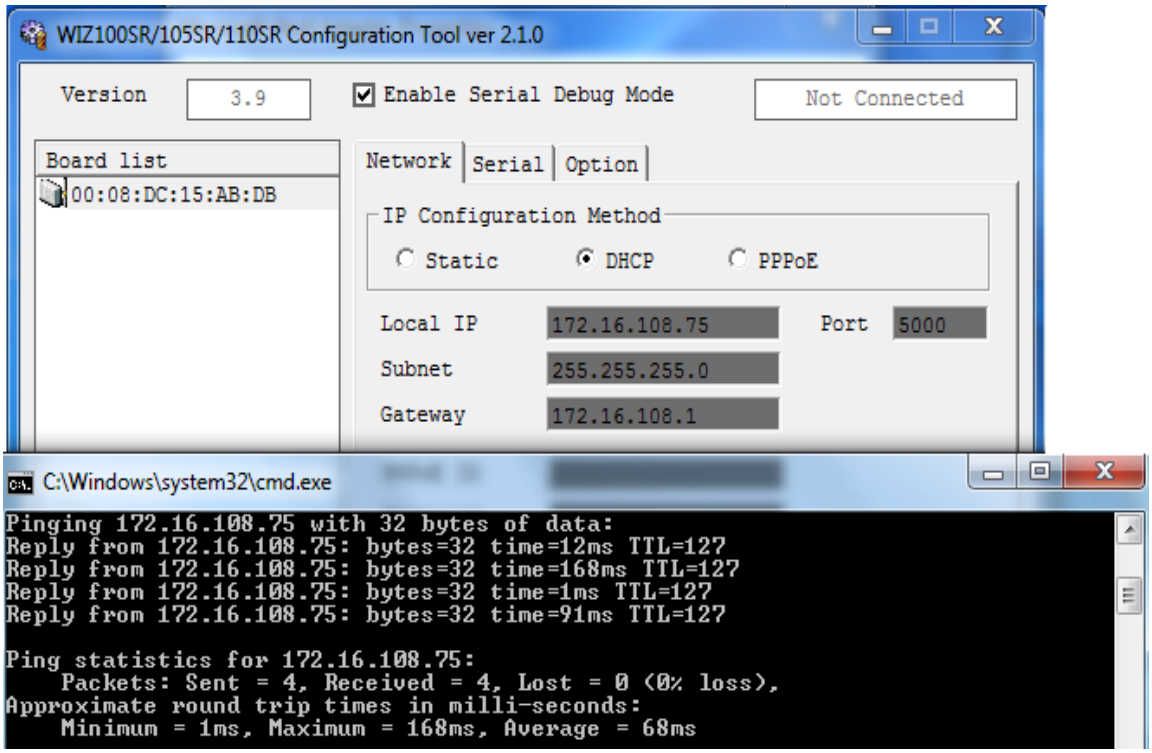

Figure 5: WIZ110SR configuration Tool

8. TEST SET UP FOR REMOTE CONTROL

The Test setup for remote control over power line is as shown in figures 6 ,7 and 8. The figure 6 indicates the receiver and figure 7 indicates the receiver connected to WIZ110SR. Figure 8 indicates the transceiver connected to the electrical sink at two different ends inside a building for data transmission and device control.

The programming microcontroller atmega16L is programmed for data communication and control applications. At transmitting end, the PC senses the key pressed and the corresponding ASCII value is transmitted to the PLC modem circuit. At receiving end, it takes the ASCII value from the PLC modem circuit and sends information to microcontroller. It also controls different devices connected to it through relays.

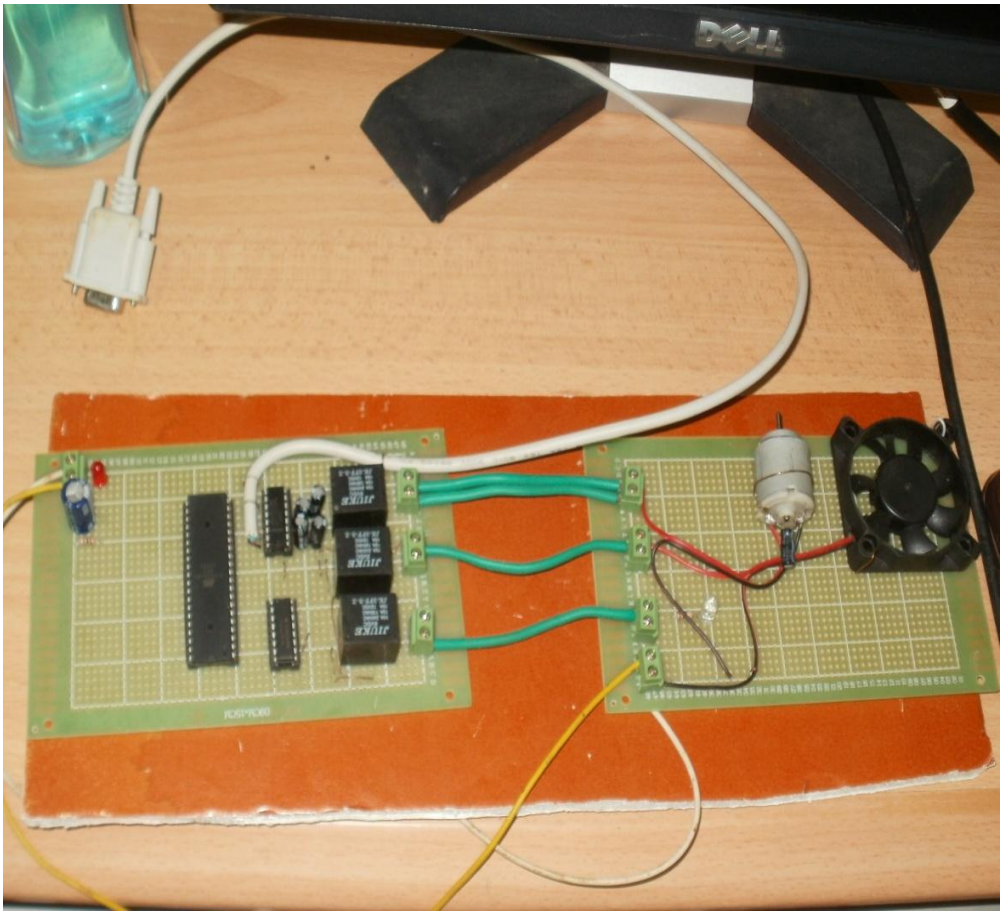

Figure 6: Receiver

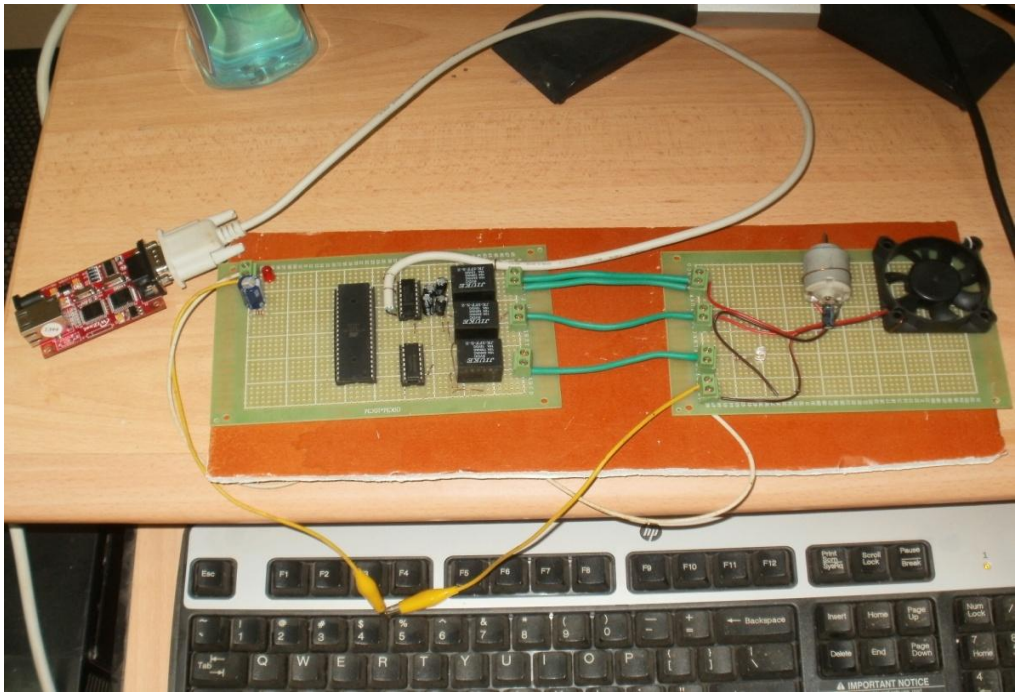

Figure 7: Receiver connected to WIZ110SR

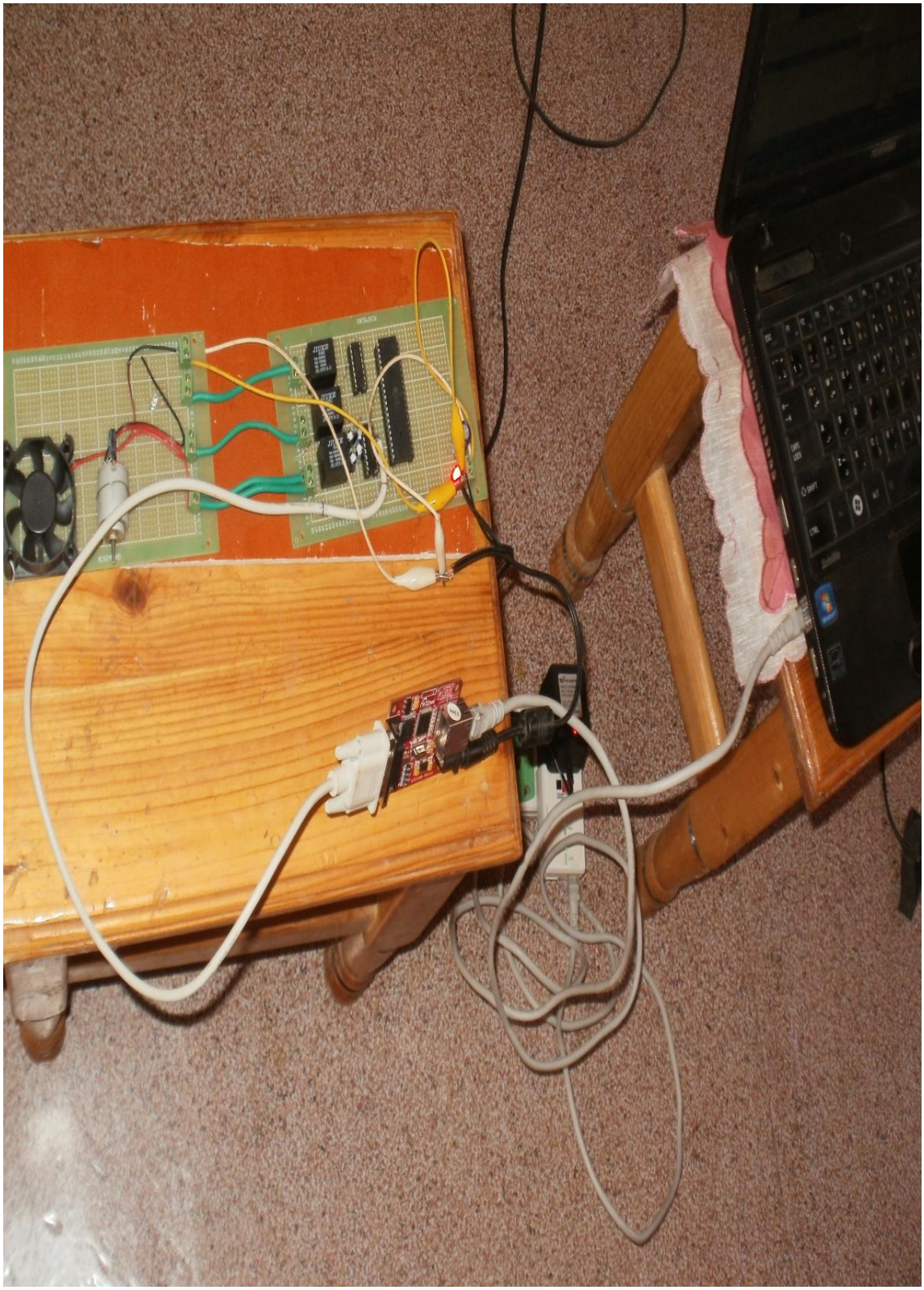

Figure 8: The remote control system

9. CONCLUSION

Power line communication provides an alternative way of communication. This paper provides an efficient way of control through the existing power lines as a communication medium. my system is more applicable in large industries, schools or in hospitals where we want to communicate between various departments.

This system of remote control over power line communication was successfully designed and implemented; also the system objectives introduced in section 3 meet the achieved design goals. This system is cost less because of the availability of equipments and there is no need to establish a new network since it's already exists for electrical power distribution purposes. This make the electrical network has the ability of data transmission and receiving in addition to the main distribution function. This paper is a proof of possibility of using the existing power line as a communication line giving high satisfied result. In the design of the system both software and hardware tools are used together each with its specific function to accomplished the entire job in a flexible manner. One of the benefits of the network through power line communication is the ability to connect to the network just by plug in the PLM to one of the available sockets, so it easy to make a small network in a house or any building using this effective feature. IN this paper a TCP/IP protocol and MODBUS protocols were used for managing the network traffic perfectly since they Simple and robust.

10. ADVANTAGES

The advantages of the system are as listed below:

- **No need for additional networking:**

The power grid is ubiquitous; it constitutes an existing network infrastructure to billions of private consumers and businesses. The power grid offers last-mile conductivity. The power grid supports information based services with strong growth potential.

- **High transmission rate**:

Right now 40 Mbps in uploading and downloading. The data transmission rate is expected up to 200 Mbps in the future by improving the PLC chip. this technology may be used to provide broad band internet over ordinary power lines.

- **Lower investment cost**:

Lower costs are achieved because the service is implemented on standard electrical lines. The service is also convenient because it's already in your home.

- **Security service**:

Greater security (all products are sold with encryption turned on)

- **Simplicity**

Setup takes just a few minutes - just plug in!

- **Safety**

This system can be used in Nuclear Power Stations or Power Grid Stations, which are very hazardous for human beings to work in and needs heavy data transmission between the points.

11. LIMITATION

- The limitation of this system is that it will successfully transmit data only over a single same phase power line thus restricting the range of transmission. With some additional hardware can achieve data transmission over all three phases of power lines thus enabling the transmission over a greater range. Once that is achieved, this concept can be used in various applications like home automation, home networking, street lighting, security system control, control of various remote devices in industry and even internet access.
- The main problem to be faced would be the same faced by all new technologies the absence of any standard protocols. For the technology to a success and for large scale implementation, a body such as IEEE would have to come forward with a set of rules or standards for digital data transmission over power lines.

This would allow various equipment manufacturing companies to produce equipment conforming to the standard valid over all countries and the service providers to transmit and receive data as per a fixed protocol.

- My final product will need to be capable of controlling more complex devices. Currently, my system can only control the on/off state of the corresponding electrical devices. As for future improvements, I am aiming to interact further with the internal circuitry of more complex devices. For example, I could use my system to control the overall operation of an electrical oven such as controlling its temperature, the corresponding heating pads, its internal clock, and timer.

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