IMPLEMENTATON OF DIMMING CONTROL OF LIGHTING SYSTEMS WITH ZIGBEE COMMUNICATION AND MATLAB

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***Abstract*—The digital control for home lighting system includes on/off control and dimming of light sources including LED, incandescent and fluorescent lamps, within an area. It should be noted that the dimming of fluorescent lamps is not possible. The design uses a ZigBee wireless module which sends the control and sensing signals between the units, remote controllers and lamps. The architecture consists of an embedded light controller, sensor nodes, a microcontroller unit, a programmable logic device etc. The user can choose a function. The intensity of light can be controlled according to the user needs**

The Graphic User Interface is done with the help of MATLAB. The signals from the PC are provided to an ARM board LPC 2148, which act as the master and send it via ZigBee to the slave board. The slave board is designed using PIC as the microcontroller. To this section light sources are connected. The operations of these light sources are controlled from the PC.

The implementation of this design will lead to many advantages as energy saving of about 20%, reduction in home wiring by about 40%, etc. Also similar principle can be utilized in areas like fan speed control.

I. INTRODUCTION

There are many types of illumination equipment in a home or a building, like incandescent, fluorescent and LED lamps. They have different ways of controlling their on/off or status, and voluminous papers have been published and commented on worldwide.

Yet only few products combine the dimming circuit and the remote circuit in a lighting control system which can fit every light source. As for the dimming circuit, there are many different types, for instance phase control or pulse width modulation with AC power. LED dimming control can be done using PWM in high power LED. In this design, the dimming control of LED, Fluorescent and incandescent lamp is done using triac. Also LED dimming is implemented using PWM. Dimming LEDS, like the less efficient CFL, is difficult. Through careful explicit design, they can be made to perform identically, to what the end user is familiar with, using traditional incandescent phase cut dimmer controls. [3]

The design uses a ZigBee wireless module which sends the control and sensing signals between the units, and the ZigBee also has the advantage that it can increase the number of sensor nodes to 255. Zigbee is the only standards based wireless technology designed to address the unique needs of low cost, low power wireless and control networks in just about any market. [2] There is a disadvantage in using earlier remote controllers in the home. The types, quality and dimming of lamps are not the same, so it is difficult to control different lamps using same remote control.

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II. BLOCK DIAGRAM

The simplified block diagram is shown below. The whole system is divided to a master and a slave section. Control from the GUI from PC is given to the ARM board and sent to the slave side using Zigbee. At the other side, the transmitted signals are received and sent to the PIC controller. Using this data, the intensity of specific light source is controlled.

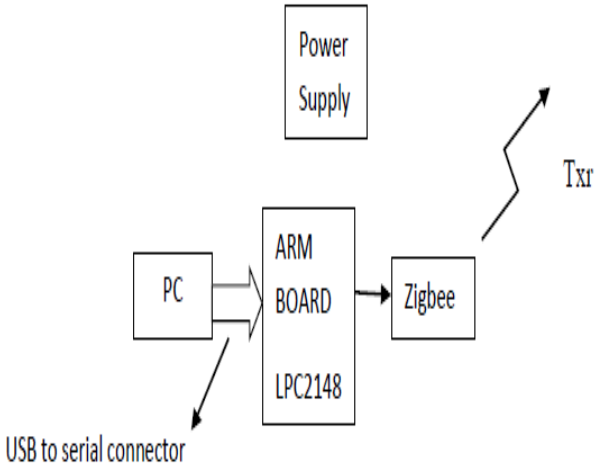


Fig 1: Master section

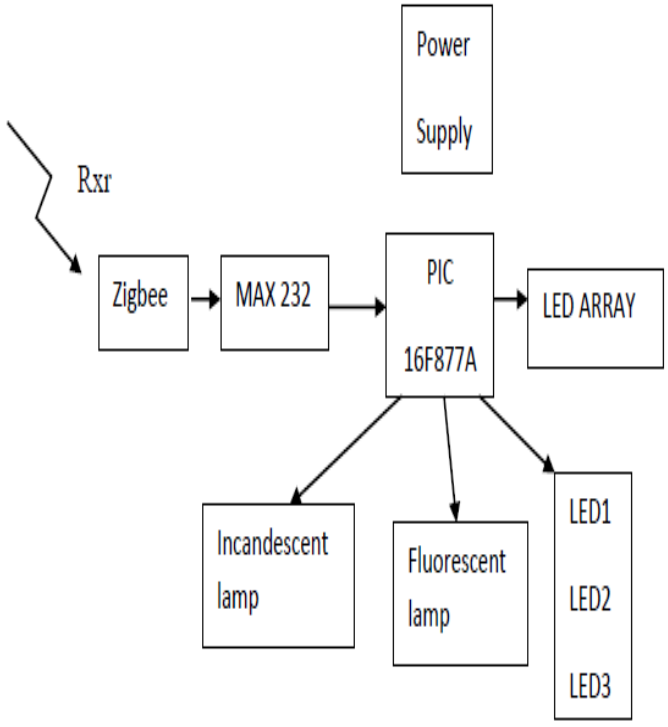
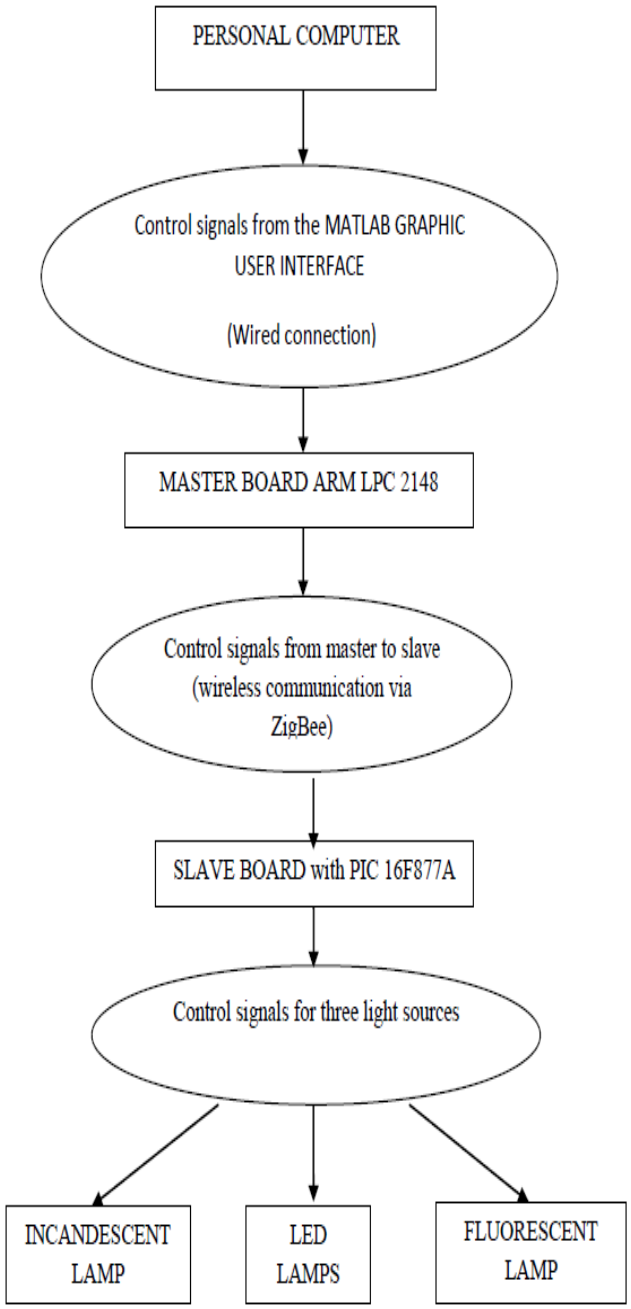


Fig 2: Slave section

III. FLOWCHART

The flowchart shows the working of dimming control implemented. Control signals are provided to different light sources.



IV. SOFTWARE DESIGN

The software or program for PIC controlled is done using MPLAB. The program corresponding to the required applications is coded and tested. When the control signals from the master board reaches the slave board, the code executes and corresponding operations carried out.

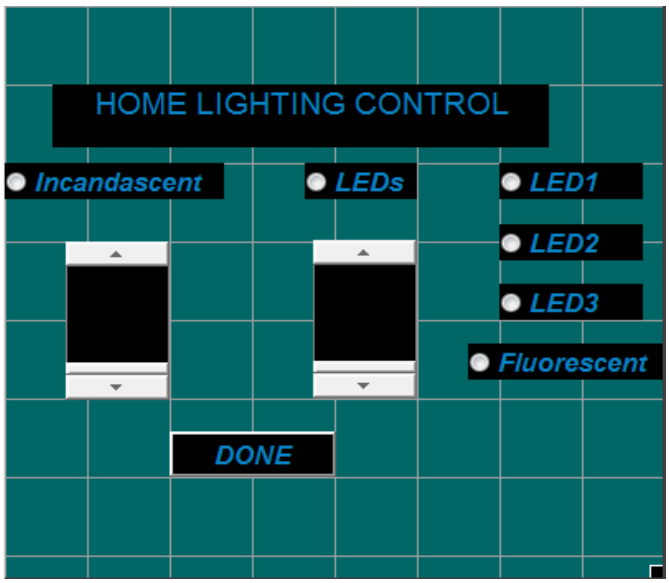


Fig 3: GUI using MATLAB

The Graphic User interface is designed using MATLAB. The selection for three types of light sources can be controlled with the user interface. The particular selections are sent by Zigbee.

V. HARDWARE DESIGN

In the hardware design, sensor and control module control three kinds of light sources, fluorescent, incandescent and LED lamps. Triacs make up the heart of AC light dimming controls. [4] Fluorescent lamps mostly have no adjustment of their brightness, therefore in this sensor module remote control can be used to turn on/off and receive the status of the light.

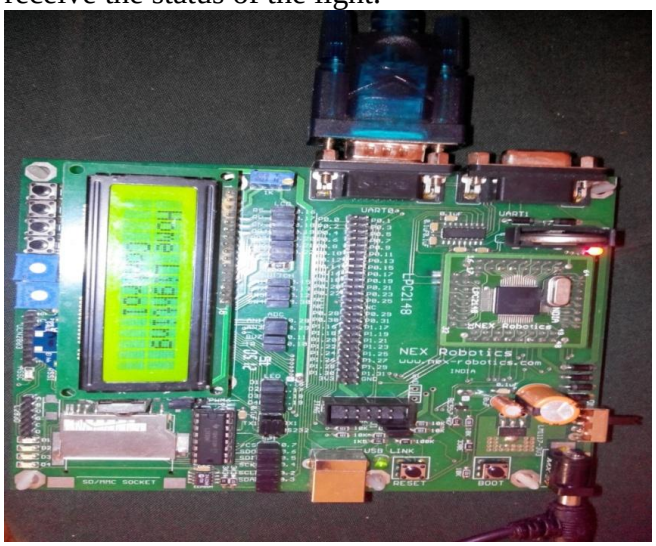


Fig 4: Master section using ARM LPC2148

Same mode is used to control incandescent lamps, including on/off and the status of the light. For the PWM LED control our design provides the second mode which sends the PWM control signal to the LED lamp to adjust the brightness. Also the dimming control of incandescent lamp is done.

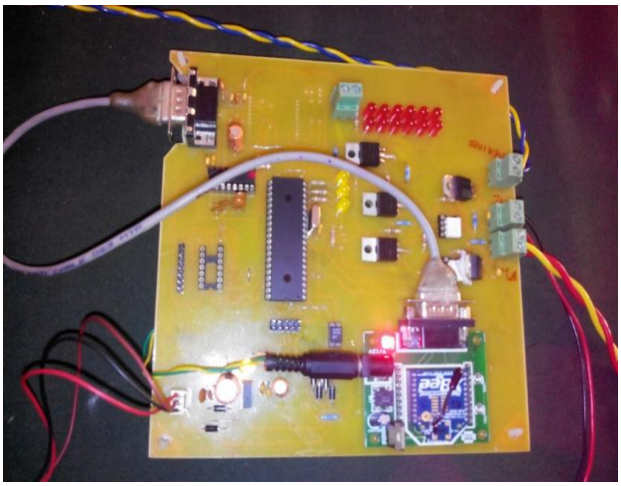


Fig 5: Slave section using PIC 16F877A.

VI. SUMMARY

Dimmers have the capacity to improve the quality and function of our environment. They provide cost savings as well as convenience. With improvements through R & D and a lowering in the cost of manufacture, lighting controls are destined to become an invaluable part of many of our everyday lives.

TABLE I
Table shows the comparison of power consumption with and without dimming control [1]
THE POWER CONSUMPTION OF DIFFERENT LIGHT SOURCES

	Fluorescent	Incandescent	LED PWM	LED Halftone
Power Consumption without Control	16.83 W	87.61W	4.5W	5.12 W
Power Consumption of Sensor & Control	466mW	466mW	329.6mW	368.3mW
Total Power Consumption	17.3W	88.07W	4.83W	5.48W

We use fluorescent lamp (21W), incandescent lamp (100W), LED PWM (5W) and LED array (5W) as the test samples which are commons used in a home.

The design implemented here points to the method of brightness control in different light sources used nowadays. The whole system implemented here is divided to a master and a slave section. User interface is done with the help of MATLAB. Control from the GUI in PC is given to the ARM board and sent to the slave side using Zigbee. At the other side, the transmitted signals are received and sent to the PIC controller. Using this data, the intensity of specific light source is controlled.

Implementation of this design methodology will lead to high efficient light dimming applications in day to day life.

VII. FUTURE SCOPE

The dimming control provided to the light sources can also be extended to speed control of fans. [5] The same principle is carried out for fan regulators. In the same way as the light intensity is controlled, speed of fan can be varied. Almost all equipments can be controlled from a distance using this implementation. Thus, if the applications of the whole system extend this way, then in future, we can think of a home automation system that will reduce the need for house wiring by about 40%. This will also lead to energy conservation up to a certain extent. Statistically about 20% electricity can be saved by using efficient dimming controls.

VIII. CONCLUSION

The dimming control of three different light sources is designed and implemented with PIC, ARM and Zigbee in between. The Graphic User Interface is implemented using MATLAB.

Dimming of incandescent as well as LED is done. Also the status of light source and the on/off control is possible. Since the principle of fluorescent light is different, the control of brightness of fluorescent lamp is not possible. So, only the on/off control is implemented. The on/off control of three individual LEDs is also done. The light dimming of LEDs is designed using PWM. The communications within the modules are carried out by ZigBee.

Our design provides digital control for home light sources. So, it upgrades and is compatible with the control mechanism for traditional light sources.

REFERENCES

[1] Chi Hung Hung, Ying Wen Bai-"*Digital control for home lighting system using Zigbee*"

[2] Anshul agarwal,Mukesh Agarwal,Manju Vyas, Richa Sharma- "*A STUDY OF ZIGBEE TECHNOLOGY*"

[3] "*Facts about Dimming "- Light based technologies-better light*." As published in LED professional Review Jan/Feb 2011 | Issue 23

[4] *LITTLE FUSE Application note-Controlling LED Lighting Using Triacs and Quadracs*

[5] Dr. C H Vithalani-" *REMOTE-CONTROLLED FAN REGULATOR*"