Design and Modelling of VLC System for Indoor Environment

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ABSTRACT

With the radio frequency spectrum becoming crowded, an alternative means to wireless communication is necessary to accommodate the exponentially increasing wireless traffic demand. Visible light communication systems provide an alternative to the current standards of wireless transfer of information, using light from LEDs as the communication medium. In these systems, light-emitting diodes blink at a rapid rate.This project first analyzes various issues with current wireless communication systems, and discusses how visible light communications can resolve these issues. Then, the design and implementation processes of the visible light communication system are described in detail, including a value analysis of the parts used to build the prototype, as well as the necessary steps to wire and/or code each functional block of the design.

Keywords: Autonomous VLC System, Li-Fi, Wireless Communication, Industry And Medical Application, LED.

I. INTRODUCTION

With the exponentially increasing data demand but limited available radio spectrum, alternatives will be necessary to accommodate the needs of wireless communication systems. This chapter will illustrate the problems of current wireless communication systems and alternatives to these systems, as well as motivations and possible applications for visible light communications. As societal dependence upon wireless systems continues to grow, wireless technology needs to expand to meet the demand. Phones, laptops, and global positioning systems are all devices that implement certain forms of wireless communication to send information to another location. However, the availability of current forms of wireless is very limited, and it is not necessarily safe to implement wireless radio, making it necessary to explore other alternatives to wireless communication to allow continued expansion upon communication systems and to ensure safe use. The focus of this project will be Visible Light Communications (VLC). We aim to investigate this system by designing our own circuit to integrate with a computer, and then sending some form of data using visible light LEDs from a transmitter, and decoding it with a receiver.

Information will be converted into bits through some coding scheme by a microcontroller and will be transmitted with blinking LEDs. The blinking of these LEDs will not be visible to the human eye as they are blinking at a high frequency. Photodiodes on the receiving side will detect the fluctuation of the LEDs from the transmitter and will send signals to a microcontroller which is integrated with a computer to determine the originally transmitted message. The transmitting system will be powered from a wall outlet whereas the receiving system will be powered by batteries and the computer/microcontroller combination.

communication system will be used in hospitals, the transmissions will not occur in the Industrial, Scientific, and Medical (ISM) band, therefore not interfering with medical devices. On top of having a higher bandwidth, the frequency spectrum has less regulation than the radio spectrum. Visible light should be considered as the medium for wireless transmission because it has a few advantages over other standard wireless transmissions. The first reason to consider is visible light's frequency spectrum bandwidth, which ranges from 430 THz to 750 THz . The bandwidth is much larger than the radio frequency bandwidth, which ranges from 3 kHz to 300 GHz . With a larger bandwidth it is possible to accommodate more users and potentially achieve higher transfer rates because each user can be given a larger portion of the bandwidth to transfer information.

Lights in the visible spectrum are used everywhere, providing several opportunities to apply visible light communications. There are many applications in which data transfer via VLC systems could be useful including traffic lights, which could utilize systems to optimize traffic flow; television sets, which could supply a user with information on current show listings; and hospitals, which could utilize the systems for more secure transfer of data. There are many modern applications that use visible light to portray information. Using a visible communication system in tandem with these devices can increase the devices' functionality. An example of a device that can benefit from a visible communication system is a traffic or stop light. In a busy intersection, traffic lights use visible lighting to maintain the flow of traffic. Another piece of modern technology that uses visible light to portray information is a television. Unlike a traffic light, a television contains thousands of pixels that are constantly changing colours to project an image to its viewers. Because there are many individual LEDs in a television, it could be possible to allocate to a few of them the task of transmitting information through a visible light communication system.

II. RELATED WORK

Through research of a bunch of IEEE papers and a few other articles makes it evident that autonomous VLC system has a great potential in medical research and it is used in industrial applications.

Ecofriendly data transmission in visible Light communication

Project Desc : In recent years, there is a rapid development in the solid state light-emitting diode (LED) materials which gave way for the next generation data communication known as visible light communication. VLC has a promising future and it acts as a complement to the present RF communication by achieving larger bandwidth and high data rate.

A visible light communication link protection mechanism for smart factory

Project Desc : In recent years, wireless networks and applications have achieved marvelous successes in government, enterprise, home, and personal communication systems. The desired features of wireless communications draw lots of attention to the industrial communication and expected to bring benefits such as reduce deployment and maintenance after employed.

Separate Dimming Controlling and DataTransmission for an Indoor Visible Light Communication System

Project Desc : Simultaneous dimming controlling and data transmission are usually required in a white LED based indoor visible light communication system. However, the diming controlling LED normally interferes the data transmission due to the modulation nonlinearity of LED.

III. PROPOSED WORK

Working Of VLC System

The overall functional block diagram of our system. The transmitter side consists of a signal source, a microcontroller, and analog circuitry incorporating LEDs, all of which are powered in some fashion. The receiver side is similar, containing analog circuitry incorporating photodiodes, a microcontroller and a device capable of receiving and interpreting the output, all of which are also being powered in some fashion.

The microcontroller is used as the signal source for our design by utilizing a binary system to transmit text. Each voltage maximum corresponds to a single binary 'high' digit and each voltage minimum corresponds to a single 'low' digit. This scheme is used in conjunction with the ASCII binary values, to encode a text message which is sent to the receiver side of the design utilizing LED flashes.

A power MOSFET is used to amplify the strength of the signal for increased transmission range. This particular MOSFET includes a built-in gate driver which is necessary for applications involving low-voltage logic such as the microcontroller used in this design. The device works in a way such that the signal is transmitted exactly as intended, however the logic highs and lows are inverted. To make up for this voltage inversion, the output data signal from the computer will also be inverted to produce the correct signal after the MOSFET block.

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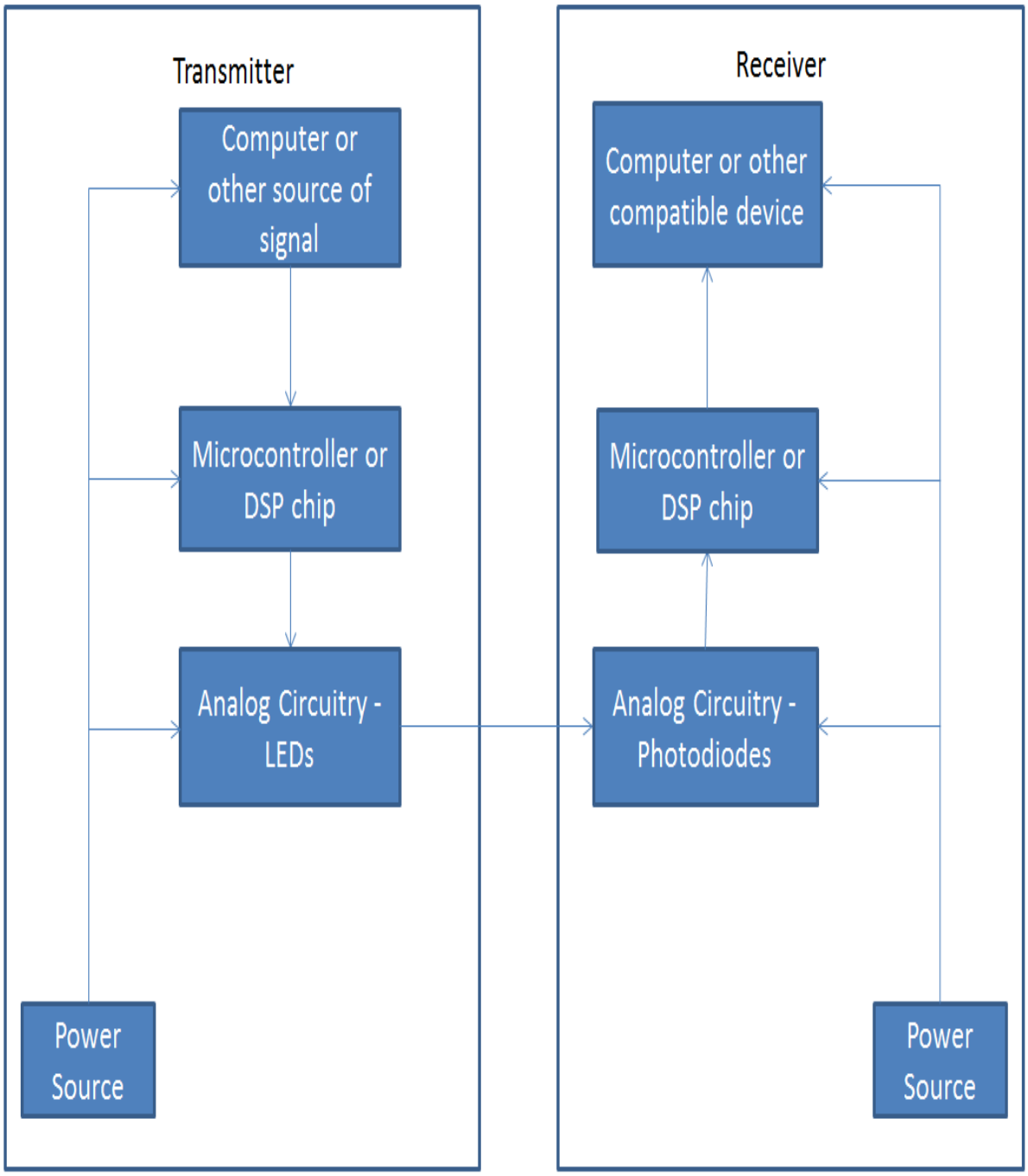

Fig 1:Block Diagram

THE HARDWARE SETUP

The difference in the transmitter is that it has an array of twenty-two white LEDs connected in parallel. Because the devices are connected in parallel, there is no guarantee that each LED will draw the same current. This means that the brightness of the transmitter block does not necessarily increase proportionally with an increased number of LEDs. In order to rectify this issue the MOSFET shown was implemented to provide enough current to each LED to reach their maximum brightness.

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On the receiver side, the analog block has an array of seven photodiodes to increase the current flowing through the receiver block. Each photodiode was placed along the board and aligned to the transmitter to maximize the amount of light captured from the LEDs and increase the current provided from the photodiodes. The AD848JNZ Op-Amp is connected with a resistor so a voltage can be passed through the Op-Amp, outputted to the receiver MCU, and processed.

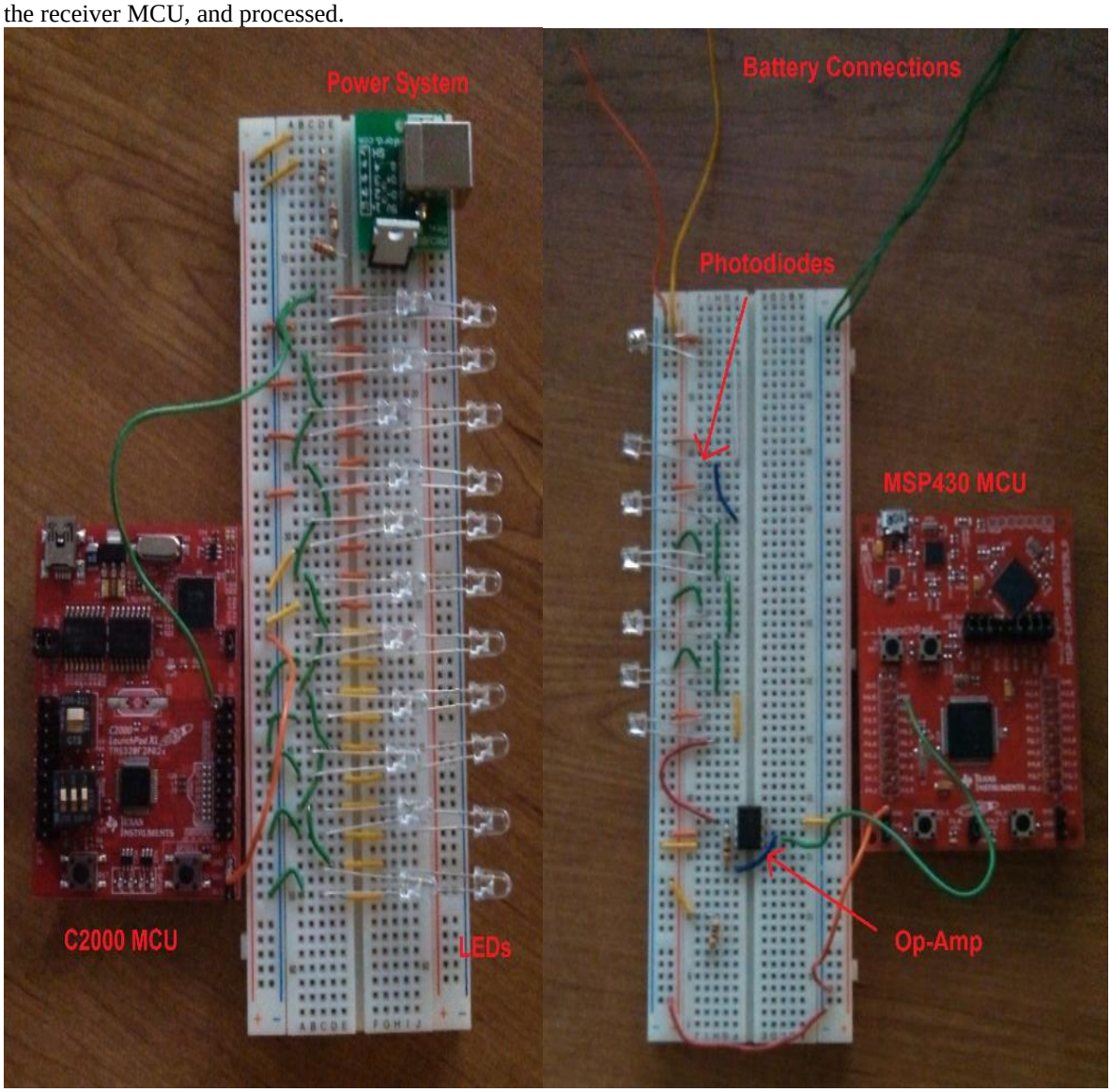

Fig 2. Hardware setup

IV. HARDWARE AND SOFTWARE REQUIREMENTS

Table:

HARDWARE REQUIREMENT	SOFTWARE REQUIREMENT
1. ATMEGA LM328 2. LCD 16 x 2 3. LiFiTx , LiFiRx 4. Computer for storage 5. Temperature sensor	1. Program in "C" 2. Software Arduino IDE

VI. CONCLUSION

The goal of this system is to ultimately be able to send data from one point to another using only visible light. Ideally, this system would be able to transfer any type of data at a high speed. However, the success of this design does not depend on the creation of a new type of communication system that will instantly replace all other means of data transfer. The objective of this system is to be able to send data reliably and accurately over a short distance at a fair speed.

Initial goals for the functionality of this system include being able to send text or pictures over a distance of approximately one meter at a data rate of at least 1 Mbps. To do this, the transmitter portion of the design would receive a signal from a computer and control the flashing of an LED to send bits to the receiver which would, with the help of another microcontroller, decode the signal and present the data back in the original format.

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