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Integrated Li-Fi (Light Fidelity) Communication for Smart Robotic Control

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***Abstract* - Li-Fi (Light Fidelity) is the transfer of data through lighting by sending data via an LED lamp. Li-Fi is a fast and inexpensive wireless communication system that is the optical version of Wi-Fi. Li-Fi technology uses the visible part of the spectrum of the electromagnetic spectrum to transmit information. This project involves developing and implementing a robotic control system using Li-Fi technology as a wireless infrastructure. Our goal is to create a Li-Fi communication system that can interact with a robotic system that can perform tasks using a user command. The light modulator circuit is designed at the end of the transmitter. A demodulator and a control circuit are designed at the end of the receiver.**

Keywords: Li-Fi, Robotic Control, VLC, Digital Communication, Smart Control, Light Technology.

I. INTRODUCTION

Visible Light Coupling (VLC) is the use of part of the visible light of an electromagnetic spectrum to transmit information. These contrasts with established forms of wireless communication, such as Wi-Fi, which uses radio frequency (RF) signals to transmit data [1]. With VLC, data is transmitted by modulating the intensity of the light so that it is not perceived by the human eye. The data is received by a photosensitive detector that demodulates the light signal electronically. VLC is a category of wireless optical communications (OWC) [2].

OWC includes infrared and ultraviolet communications, as well as visible light. However, VLC is unique in that the same visible energy used for lighting can also be used for communication. When a constant current is applied to the LED lamp, a constant photon flux, observed in the form of visible light, is emitted by the bulb. If the current changes slowly and slowly, the intensity of the luminous flux is weakened from top to bottom [3]. Since LED lamps are semiconductor devices, we can actually change the current and, therefore, the optical output at extremely high speeds, invisible to the human eye, but detectable by a device.

Using this method, high speed information can be transmitted from an LED lamp. RF communications require complex radio circuits, antennas, and receivers, whereas VLC is much simpler and uses direct modulation techniques similar to those used in low-cost infrared communication devices, such as remote control units.

Infrared communication has limited power due to eye safety requirements, while LED bulbs have a high intensity and can achieve very high data transfer rates. VLC providers provide components containing circuits and firmware for the transmitter and receiver [4]. These components can be integrated into the bulb and electronics of the consumer device, respectively. The transmitter includes a proprietary firmware to modulate the LED output. The receiver includes a photo sensor and firmware to demodulate the output of the photo receiver.

II. EXISTING SYSTEM

Li-Fi communication includes personal computer (PC) using RS232 communication, data modulation unit which consists of microcontroller to modulate data, LED array, photo diode and demodulation unit connected to another computer. This is a PC to PC Li-Fi communication [5].

III. PROPOSED SYSTEM

The proposed system uses digital modulation technique with RC5 encoding technique to reduce error rate in data transmission. A high power LED modulator is designed to work based on PWM modulation providing high output power at LED light transmitter.

A robotic control application is developed with a remote light modulator and demodulator attached to robotic control unit. High speed data communication of baud rate 1200bps. Real time application for robotic control is implemented. RC5 Encoding PWM based Digital Modulation technique [6]. Error rate is less. High transmitter beam power (250 lumens).

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a) Block Diagram of Proposed System

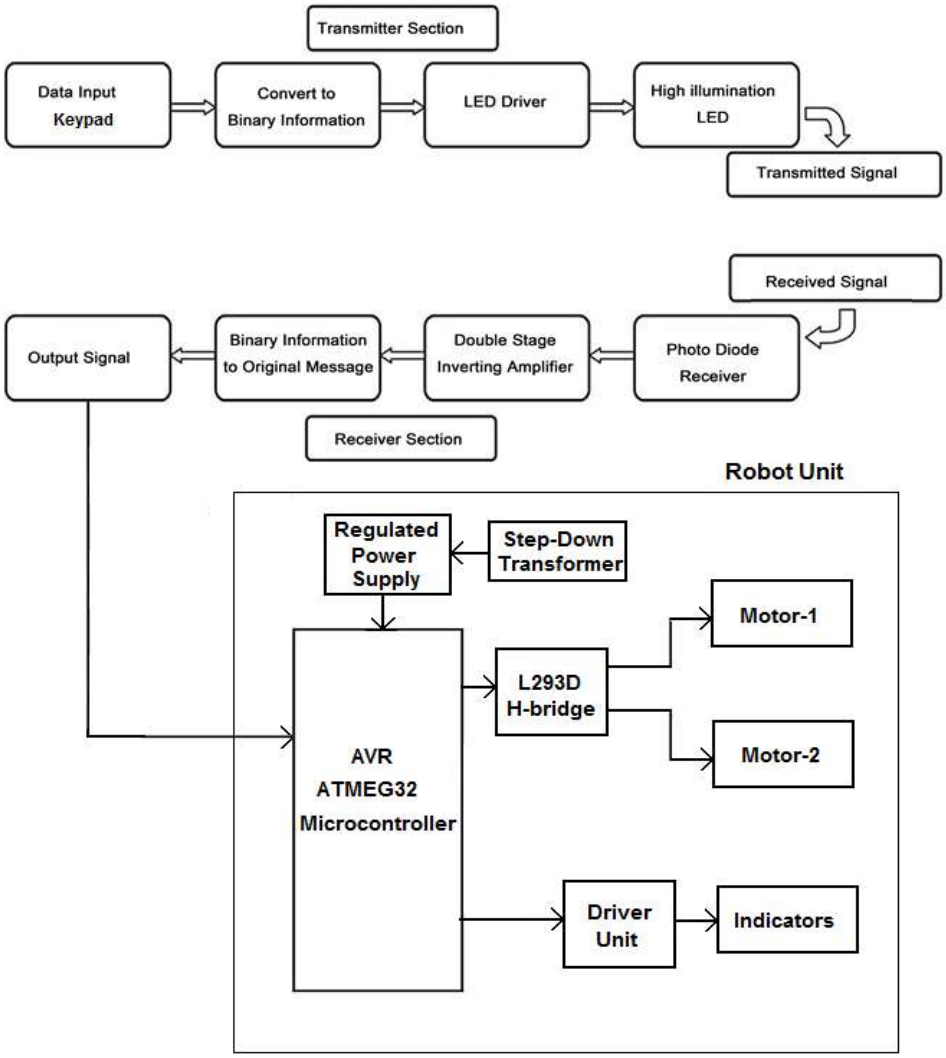

Figure-1: Block Diagram of Proposed System

b) Li-Fi Transmitter

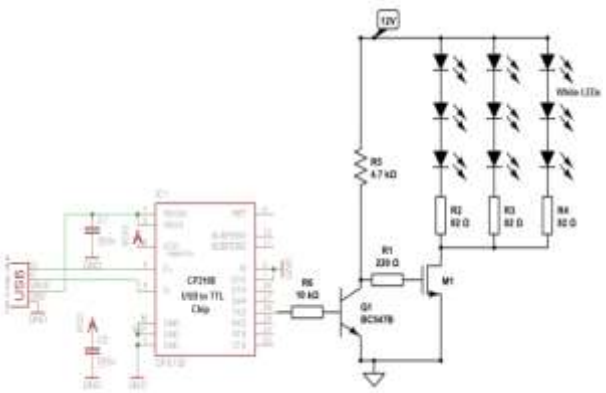

Figure-2: Li-Fi Transmitter

c) Li-Fi Receiver

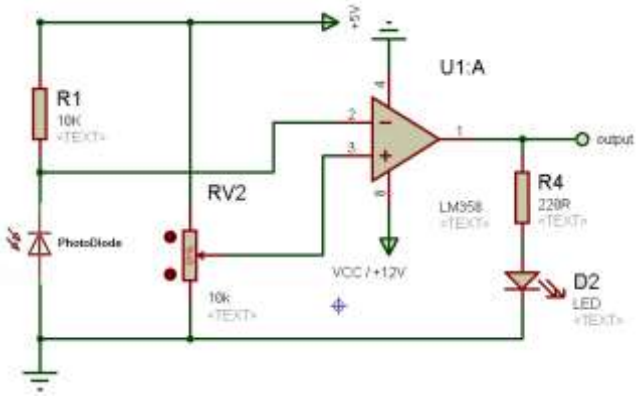

Figure-3: Li-Fi Receiver

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d) Microcontroller Robot Control Circuit

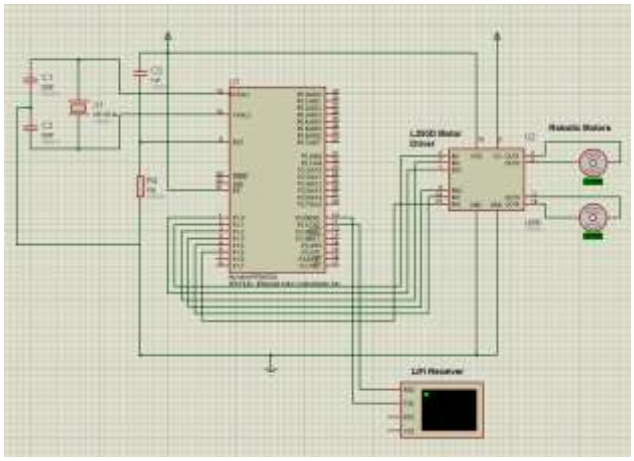

Figure-4: Microcontroller Robot Control Circuit

e) Description

The transmitter unit consists of a light modulator and an LED transmitter circuit. Converts a digital data signal into a modulated PWM light signal. The receiver includes a light sensor and a PWM demodulator circuit. The demodulator extracts the data signal from the light signal and sends it to the UART microcontroller. The microcontroller receives digital data and controls the robotic motor accordingly. The Li-Fi modulator is based on digital modulation using PWM technology. The demodulator uses an LM358 Op-Amp based circuit that detects the voltage signal of the photodiode and demodulates it into digital data bits. The motor control scheme based on the L293D is used to control the robot motors.

IV. Li-Fi TRANSMITTER RECEIVER MODULE

Li-Fi is technology which means Light Fidelity. Li-Fi technology ensures the transmission of data via lighting, the sending of data via LEDs whose intensity varies more rapidly than the human eye can follow.

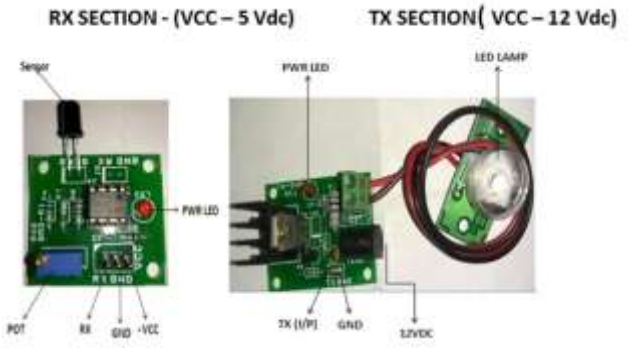

Figure-5: Li-FI Module Connection Details

This module focuses on developing a Li-Fi system and analyzing its performance compared to all existing technologies. The heart of this technology is a new generation of high brightness LEDs.

The module comprises a transmitter with a light source and a receiver circuit which receives the data transmitted via light waves. The same system can be used in industries that make industrial automation an existing light source a reality. A biomedical sensor is also introduced, which helps diagnose the patient's medical conditions and quickly becomes available for all emergency stations through light.

a) Connecting Procedure:

- Connect Power supply 5v DC to Receiver and 12v DC to Transmitter
- Set baud Rate 1200bps or 2400 bps in the serial communication terminal and microcontroller.

b) Features:

- It can transmit data 38400 baud rate serialy.
- 5-15 feet distance, distance can be increased by changing the LED wattage.
- High intensity LED Light.
- Domestic Ceiling / wall mounting focus LED light can be used for communication.
- High quality PCB FR4 Grade with FPT Certified.

c) Applications:

- Indoor wireless open optical communication.
- Indoor navigation.
- Under water visible light communication.
- Smart indoor blind assistive application.
- Vehicle to vehicle communication.
- Depends on the LED power.

V. RESULT AND DISCUSSION

This proposed system output data has been monitored in terminal software. This terminal software is general purpose usage of ports in PC. The Li-Fi data's are received in Rx and that data given to monitor in terminal link through this COM port software has verified for data transmitting and receiving through light technology. Terminal Data Logger is a terminal emulation program for RS-232 to USB. A terminal is a simple serial port terminal (COM) emulation program. It can be used to communicate with various devices, such as modems, routers, embedded CPUs, GSM phones, and USB devices. It is a very useful tool for debugging applications for serial communication. Generally, your system automatically assigns

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a new COM port number. In the future, if you connect the device to the same USB port, the COM port usually does not change.

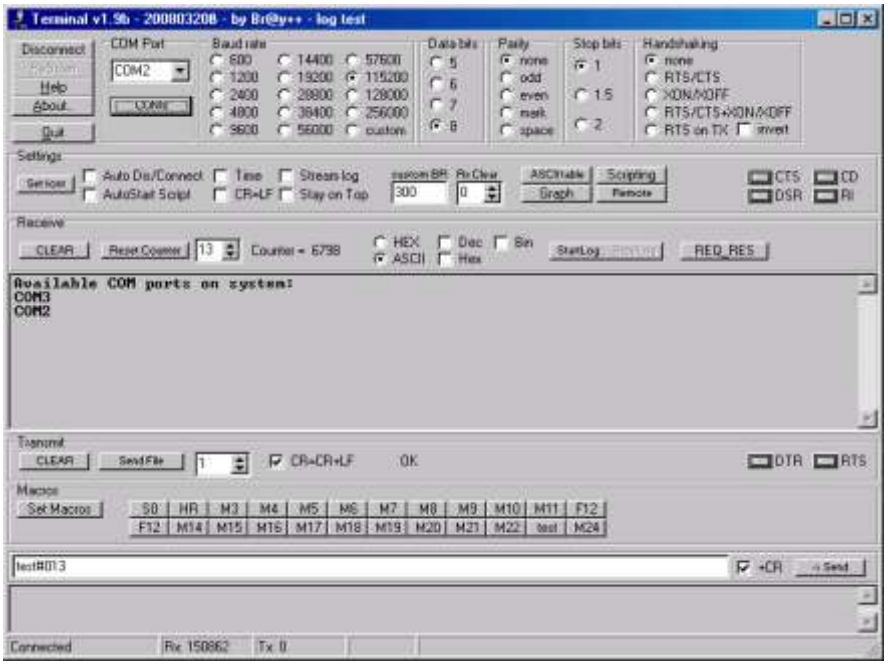

Figure-6: Terminal Software

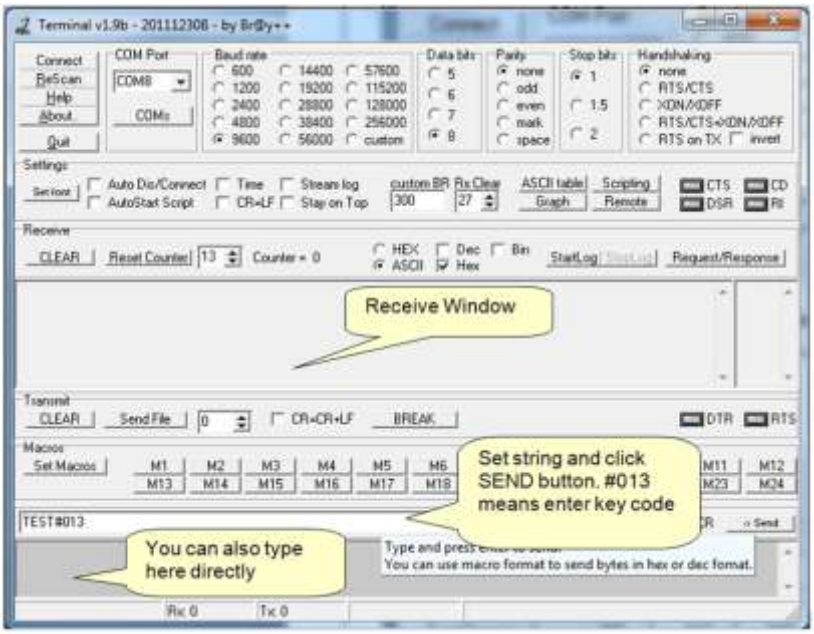

Figure-7: Execution in Terminal Software

If you want to change its COM port number, then go to device manager, properties of particular com port and right click> advanced and select a COM port to change. You can select any COM port even though it shows in use. A wider range of bandwidth is available to the users due to the broad range of visible light spectrum. It will also provide a secured mode of communication link due to line of sight mode of communication in which no intruder can interfere with the light data communication.

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VI. CONCLUSION

This project will be able to provide a secured, low cost, easy data transmission and will provide a reliable communication using Li-Fi. It can also be used in industrial, medical, military applications for robotic controls where wireless technology is needed. LEDs do not induce any health hazards since there are no harmful radiations produced in the light beam. A wider range of bandwidth is available to the users due to the broad range of visible light spectrum. It will also provide a secured mode of communication link due to line of sight mode of communication in which no intruder can interfere with the light data communication.

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