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Data Transmission Using Li-Fi System

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ABSTRACT: This paper introduced the concept of Li-Fi which is used for data transfer. Li-Fi is an LED based alternative that uses visible light instead of radio frequency spectrum. Simply, Li-Fi is nothing but Wi-Fi using light. In Li-Fi system we analyse its performance with respect to existing technology. With the help of light data can transmit. This is latest technology in which LED can transmit data faster as compare to Wi-Fi technology. Here we developed hardware of Li-Fi technology using microcontroller ATMEGA16 in which data can be transmitted through light and received by using photodiode or photo detector.

KEYWORDS: Li-Fi, Wi-Fi, LED, ATMEGA16

I. INTRODUCTION

At the time of using internet whether it is own or stealing from other, one has probably gotten frustrated because slow speed of the internet when more devices are connected to a same router. Due to increasing of internet users exponentially, Radio Spectrum is congested but the demand for wireless data double each year. Dr. Harald Haas has come up with a solution for those he calls "Data through illumination", Simply Li-Fi. Li-Fi is nothing but Wi-Fi using light. Li-Fi is now part of the VLC as is implemented using white LED light bulbs. Data transmission takes place from this LED bulb by varying the current at extremely high speeds which undetectable by the human eye. Li-Fi is a data transfer technique that uses light for data transfer. Light is analogous not only to illumination but also speed. Thus Li-Fi provides very high data rates. Also Li-Fi is very secure as light cannot penetrate through the walls. Li-Fi uses visible light spectrum, thus it is known as visible light communication (VLC). Visible light is unregulated unlike radio frequency spectrum. Hence it is cost effective. Here we developed application module of Li-Fi technology which transmits data through LED bulbs and receive by using photodiode.

II. PROBLEM FORMULATION

Data can be transmitted through air and water. Lot of technologies used for this purpose. These technologies are Wi-Fi, Bluetooth, etc. These technologies use electromagnetic wave for data transfer. Wi-Fi technology used higher frequency and bandwidth for under water communication. Electromagnetic wave causes high absorption of the transmitted signals. This type of communication needs big antenna, thus it affects design complexity and cost. To overcome this limitation we used Li-Fi technology for wireless and underwater communication because light can travel easily in water. Li-Fi technology solves the problem of radio frequency congestion. Visible light has very large spectrum and is safe for human. Thus it has very high data transfer rate.

III. LITERATURE REVIEW

Wireless communication is amongst technologies biggest contribution to the mankind. It has many advantages to the wired communication. These technologies are Bluetooth, Wi-Fi, etc. Bluetooth operates in the 2.4 GHz ISM (Industrial, Scientific and Medical) band and is based on a low-cost, short range radio link, and that facilitates ad-hoc connections for stationary and mobile communication environments. The disadvantage of this technique is slow data rate transmission and coverage area is very small. [2] To remedy on this problem, Wi-Fi introduced. Wi-Fi is a Wireless technology that uses the radio frequency to transmit data. With the rise of Wireless Fidelity (Wi-Fi), technology comes

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the rise of the hotspot -public access Wireless Local Area Networks (WLANs) that allow anyone with a Wi-Fi capable notebook or PDA to connect to the Internet. Wi-Fi gives us speed up to 150mbps as per IEEE 802.11n, it is still insufficient to accommodate number of users. To overcome these limitations of Wi-Fi, we are introducing the concept of Li-Fi. In Wi-Fi technology, users depend upon source like router, but Li-Fi is not. The Li-Fi uses light as source for data transfer while Wi-Fi uses radio frequency signal which is unable to use underwater for data transmission because of its low absorption characteristic for underwater communication. By using electromagnetic wave, the communication can be established at higher frequency and bandwidth. The limitation is due to high absorption or attenuation that has significant effect on the transmitted signals. Big antenna also needed for this type of communication which affects design complexity and cost. Due to absorption characteristics of water Wi-Fi is not used for underwater communication.[9] We have already know that light can easily pass through the water, hence Li-Fi is helpful for underwater data transmission. In Wi-Fi technology data can be hacked easily because radio waves can penetrate through the walls but in case of Li-Fi data is more secure as light cannot penetrate through the walls.[4]

TABLE 1: COMPARISON OF BLUETOOTH, WI-FI And LI-FI [1][4]

Parameter	Bluetooth	Wi-Fi	Li-Fi
IEEE Standard	IEEE 802.15.1	IEEE 802.11	IEEE 802.15.7
Development Year	1994	1990	2011
Range	Typically less than 10m to up to 100m	About 300m	Based on LED Light Intensity
Operating Band	Radio Frequency Band	Radio Frequency Band	Visible Light band
Frequency	2.4Ghz (GSM)	2.4-5Ghz	400-800 THz (Visible light)
Network Topology	Piconet: Startopology	Point-to-Multipoint	Point-to-Point
Data Transfer Rate	slow	Downlink speed:10.9Mbps Uplink Speed: 2.8Mbps	>1Gbps
Routing device	-	Access Point	LEDs
Environmental Impact	Low	Medium	Low
Usage Location	-	Within the WLAN range and Infrastructure	Anywhere, where LED light is easily available

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		used	
Carrier	-	Information carried over electric field	Information carried over optical intensities
Cost	Low	High	Low
Security	-	Less Secured	Highly Secured

IV. WORKING PRINCIPLE OF LI-FI

The working principle of Li-Fi was first proposed by Harald Haas from University of Edinburgh, UK, in his TED global talk on VLC. Li-Fi is typically implemented using white LED light bulbs. High brightness LED's is the heart of this technology. The working principle of Li-Fi is very simple, it is based on the transmission of digital data 0's and 1's. The logic is, if the LED is OFF, digital 0 is transmitted and if the LED is ON, digital 1 is transmitted, The LED can switched on and off very quickly to transmit the data with the help of light that can't be detected by human eyes. Hence all that is required is some LEDs and a controller that code data into those LEDs. This binary data is received by the receiver equipped with decoder that decrypts the data and convert it back into original data. This method of using rapid pulses of light to transmit data is called Visible Light Communication. The basic principle of VLC shown in fig.

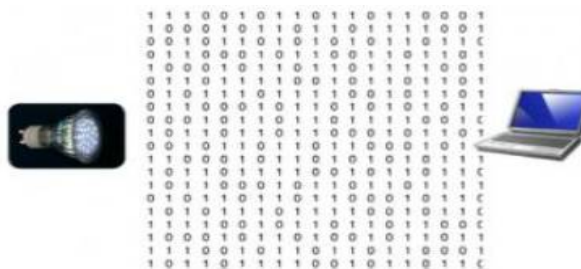


Fig. 1: Basic Principle of VLC[7]

Generally white LED bulbs are used for implementing the concept of Li-Fi which is used for illumination by applying a constant current. However, the light output can be made to vary at extremely high speeds by fast variations of the current. To build up a message we are flashing the LEDs numerous times. In order to obtain data rates in the range of hundreds of mega bytes per seconds we can use array of LEDs which also helps us for parallel data transmission or we can also use combination of three basic colours LEDs red, green, blue to alter the frequency of light. The VLC (Visible Light Communication) uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination. Light is safe and can be used in places where radio frequency communication is often seemed to be problematic, such as in aircraft cabins or hospitals. So visible light communication not only has the potential to solve the problem of lack of spectrum space, but can also enable novel application. The visible light spectrum not regulated, and can be used for communication at very high speeds.

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V. PROPOSED SYSTEM

Block diagram

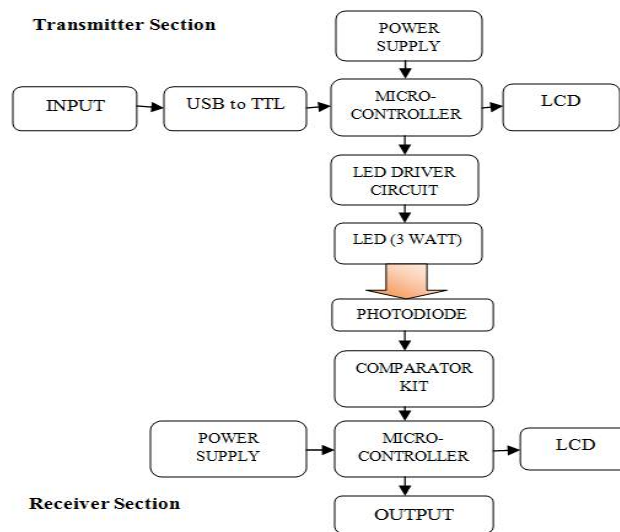


Fig 2: Block diagram of proposed system

The block diagram of proposed system is shown in fig. This system is divided into two parts-

Transmitter section

Transmitter section consists of microcontroller ATMEGA16 in which programming using AVR studio5 is done. The keyboard is used for transmitting the message. The measure data are store in ATMEGA16. LCD display is used to display the message which we are going to transmit. This data is been transfer using LED panel by light waves. When LED is ON microchip convert digital data in form of light. The operational procedure is simple. If the LED is on, we transmit a digital 1 and if it is off transmit a 0. The LED can be switched on and off very quickly, which gives nice opportunities for transmitting data.

Receiver section

Receiver section consists of photo detector, which detects the light. Then this light fed to the LED driver circuit. Using this driver circuit we drive the received data to the ATMEGA16, which stores this data and display on LCD Display in receiver section.

The proposed system mainly consists of

1. Microcontroller ATMEGA16
2. Comparator Kit
3. LED Driver circuit
4. LCD display
5. LED Array
6. Photodiode\Photodetector

Out of above parts working of first four parts has been done and discussed in this paper.

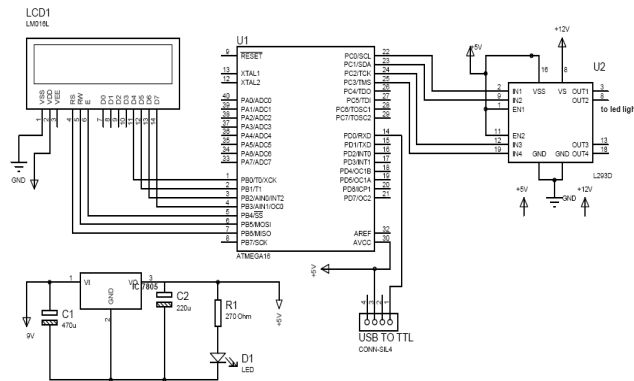


Fig. 3: Circuit diagram of transmitter

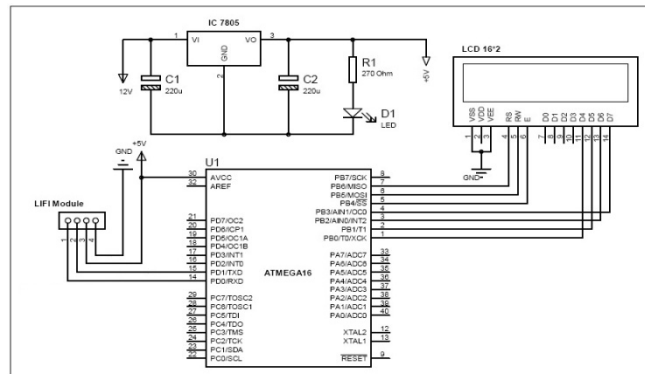


Fig. 4: Circuit diagram of Receiver

1. Microcontroller ATMEGA16

Microcontroller ATMEGA16 is an 8-bit microcontroller of Atmel's Mega AVR family with low power consumption. ATMEGA16 is based on RISC architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. ATMEGA16 can work on a maximum frequency of 16MHz. ATMEGA16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory is 10000 and EEPROM is 100,000. ATmega16 is a 40 pin microcontroller. There are 32 I/O lines which are divided into four 8-bit ports named as PORTA, PORTB, PORTC and PORTD. ATMEGA16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin works on alternative task related to in-built peripherals.

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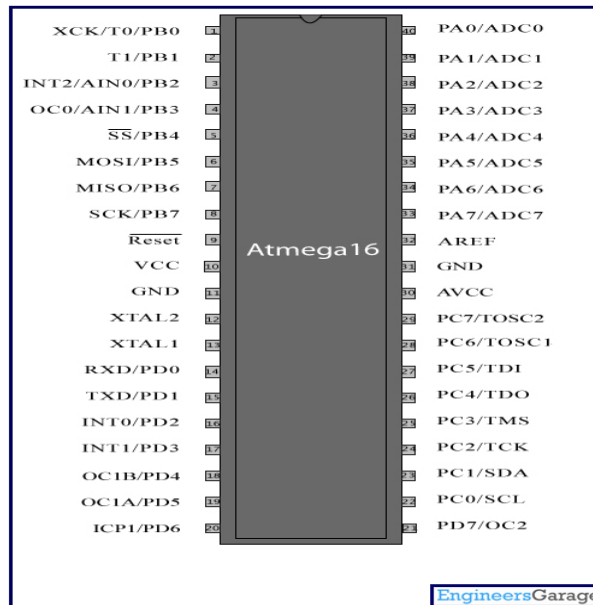


Fig 5: Pin diagram of ATMEGA16

2. Photodetector

Photodiodes or photodetectors are sensors of light .A photo detector has a p–n junction that converts light photons into current. The junction is covered by an illumination window, usually having an anti-reflective coating. The absorbed photons make electron-hole pairs in the depletion region. Photodiodes and photo transistors are a some examples of photo detectors. Solar cells convert some of the light energy absorbed into electrical energy.



Fig.6: Photodetector Circuitry

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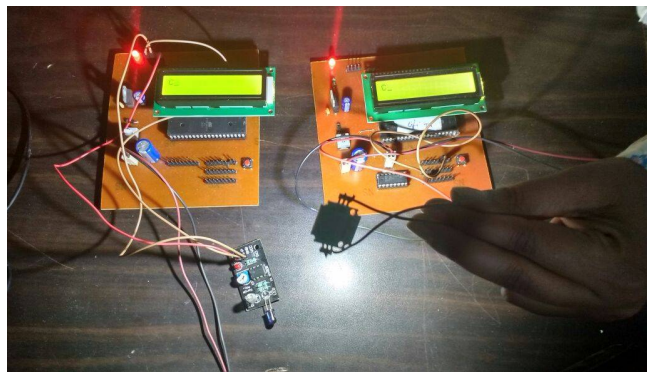


Fig. 7: Li-Fi Circuitry Module

VI. CONCLUSION

Though number of wireless communication system, these are time consuming, slow data rate and cost effective. Some of them have used router for communicating purpose.

Since we are using Li-Fi system for communicating purpose, since data transmitted through light. The size of this system will be reduced as compared to previous systems. Also this system is cost effective. The data transmission rate is greater than previous communication system. With the increase in the cellular networks, this newest technology has proven to be a milestone in communication systems. It uses the visible spectrum of light which is better than the RF. With the use of LEDs the information can be transmitted at very high rates with just the simple turning on and off of the LEDs. This technology is free to use as well as provides a safe and secure access of data.

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