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A Communication System Development Approach Based on VLC for Short Range Data Transmission

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Abstract: **The main aim of the project is Li-Fi based data communication a new paradigm for short range wireless technology to provide unprecedented connectivity within a localized data-centric environment. Li-Fi is a transmission of data through illumination, sending data through a LED light bulb that varies in intensity faster than human eye can follow. Li-Fi is a new paradigm for short range wireless technology to provide unprecedented connectivity within a localized data-centric environment. Li-Fi is a transmission of data through illumination, sending data through a led light bulb that varies in intensity faster than human eye can follow. This sort of communication can be called as Visible light communication (VLC). Using this technique, the user can transmit the data through light from one device to another. Li-Fi technology works on a simple digital principle which is nothing but an led is ON a digital data 1 can be transmitted and if it is OFF digital data 0 can be transmitted. So, in this project work we are going to switching the LEDs very quickly. These fast switching can be achieved by PWM technique to transmit digital data stream containing strings. To acquire this, we are programming the microcontroller to varies the duty cycle of the PWM signal which has the task of regulating the current in the LED. The biased current is fed to LED driver unit. The power of LED is varied according to the waveform of data signal. At the receiver side photodiode sensor produces a current proportional to the received instantaneous power. From this data can be filtered and it can be displayed on PC.**

Keywords: **LED (Light Emitting Diode),Wi-Fi (Wireless Fidelity), Li-Fi (Light Fidelity),VLC (Visible Light Communication), RF (Radio Frequency).**

1. INTRODUCTION

Li-Fi is transmission of data through illumination of the LED by taking the fiber out of the fiber optics by sending data through the LED light bulb that varies in intensity. The light intensity can be manipulated to send the data by tiny changes in the amplitude.This technology uses visible spectrum of light, a part of the electromagnetic spectrum that is still not greatly utilized. Li-Fi is a new paradigm for short range wireless technology to provide unprecedented connectivity within a localized data-centric environment. Li-Fi (Light Fidelity) is an international standard for THz visible light communication (VLC) system. Recently due to wide spread use of LEDs in intelligent lighting fixture, the LED. Researchers pledge that by 2013, LEDs will reach 7W and 1000lm. This is brighter than a 60w bulb and yet draws a current provided by 4 D-size batteries. LEDs are the predominant choice for VLC transmitters. In addition there is a bottleneck competition among wireless utility providers to render new cost effective multipurpose consumer networking to build up brand-recognition. Meanwhile, over the past couple of year's power-line communications (PLC) has emerged as a reliable wired Ethernet alternative. The advantages over CAT 5/6 cabling are obvious in that no new cables are required; the existing mains power cables being used instead. In the context of a home networking environment, "no new wires" is the term applied to PLC that utilize the existing wiring systems to distribute high-speed data and video throughout the home (or small office). If we consider PLC combined with VLC, we may benefit from the mains infrastructure for the backhaul and use the Li-Fi for wireless connection to devices by a simple plug-and-play technique. One part of VLC is modeled after communication protocols established by the IEEE 802 workgroup. However, the IEEE 802.15.7 standard is out-of-date, it fails to consider the latest technological developments in the field of optical wireless communications, specifically with the introduction of optical orthogonal frequency-division multiplexing (O-OFDM) modulation methods which have been optimized for data rates, multiple-access and energy efficiency. The introduction of O-OFDM means that a new drive for standardization of optical wireless communications is required. None the less, the IEEE 802.15.7 standard defines the physical layer (PHY) and media access control (MAC) layer. The standard is able to deliver enough data rates to transmit audio, video and multimedia services. It takes into account optical transmission mobility, its compatibility with artificial lighting present in infrastructures, and the interference which may be generated by ambient lighting. The MAC layer permits using the link with the other layers as with the TCP/IP protocol the standard defines three PHY layers with different rates:

- The PHY I was established for outdoor application and works from 11.67 kbit/s to 267.6 kbit/s.
- The PHY II layer permits reaching data rates from 1.25 Mbit/s to 96 Mbit/s.
- The PHY III is used for many emissions sources with a particular modulation method called color shift keying (CSK). PHY III can deliver rates from 12 Mbit/s to 96 Mbit/s.[28]

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The modulation formats recognized for PHY I and PHY II are on-off keying (OOK) and variable pulse position modulation (VPPM). The Manchester coding used for the PHY I and PHY II layers includes the clock inside the transmitted data by representing a logic 0 with an OOK symbol "01" and a logic 1 with an OOK symbol "10", all with a DC component. The DC component avoids light extinction in case of an extended run of logic 0's.The history of Visible Light Communications (VLC) dates back to the 1880s in Washington, D.C. when the Scottish-born scientist Alexander Graham Bell invented the photo phone, which transmitted speech on modulated sunlight over several hundred meters. This pre-dates the transmission of speech by radio. This research suggested that VLC could be deployed as a perfect last-mile solution in the future. In January 2010 a team of researchers from Siemens and Fraunhofer Institute for Telecommunications (Heinrich Hertz Institute in Berlin) demonstrated transmission at 500 Mbit/s with a white LED over a distance of 5 metres (16 ft), and 100 Mbit/s over longer distance using five LEDs. The VLC standardization process is conducted within IEEE Wireless Personal Area Networks working group (802.15). In December 2010 St. Cloud, Minnesota, signed a contract with LVX Minnesota and became the first to commercially deploy this technology In July 2011 a live demonstration of high-definition video
The first VLC Smartphone prototype was presented at the Consumer Electronics Show in Las Vegas from January 7–10 in 2014. The phone uses Sun Partner's wysips CONNECT, a technique that converts light waves into usable energy, making the phone capable of receiving and decoding signals without drawing on its battery.[29][30] A clear thin layer of crystal glass can be added to small screens like watches and smart phones that make them solar powered. Smart phones could gain 15% more battery life during typical day.This first smart phones using this technology should arrive in 2015. This screen can also receive VLC signals as well as the smart phone camera. The cost of these screens per smart phone is between $2 and $3, much cheaper than most new technology. The idea of integration of these two systems for indoor networking was pioneered by which was based on single carrier modulation then to improve their old system to overcome the effects of power-line noises they used multi-carrier modulation (OFDM) method [4]. In this paper the details of the system architecture. The discrete multi-tone (DMT) modulation using 16-QAM is applied for PLC and VLC channel with presence of noises and data in the foam of light.

2. ILLUMINATION EFFECIENCY OF SYSTEM

The vital part of Visible light communication (VLC) system are LEDs, which send data by flashing light at speeds undetectable to the human eyes. LEDs are more advantageous than the existing incandescent bulbs and fluorescent tubes in terms of long life expectancy, high tolerance to humidity, low power consumption, and minimal heat generation lighting. There are several advantages of Li-Fi based on white LEDs for communications over WiFi and IR for indoor access: LEDs are less expensive than laser sources used in IR. Li-Fi system is cheap, durable, robust, secure, aesthetic & fashionable with untrammelled bandwidth opportunities. The visible light occupies unregulated and unlicensed THz spectrum since it does not cause or suffer from any electromagnetic interference, whereas interference is common in using Wi-Fi or any other RF systems. Visible light communication does not have any possibility of leaking out when the light is isolated, which offers better security than wireless LAN, and does not suffer performance losses even when a variety of computers are connected at once. Shadowing effect is much less compared to IR case because LED light fixtures are distributed throughout the room.

3. PROPOSED WORK ADVANTAGES

By using Li-Fi communication we can avoid interference on RF signal and by using same system we can get Illumination and communication through Optical output is varied at extremely high speed light variation technique, So Unutilized electromagnetic spectrum can be used in more environment friendly andNo health problems.

4. MODEL WORKING AND ARCHITECTURE

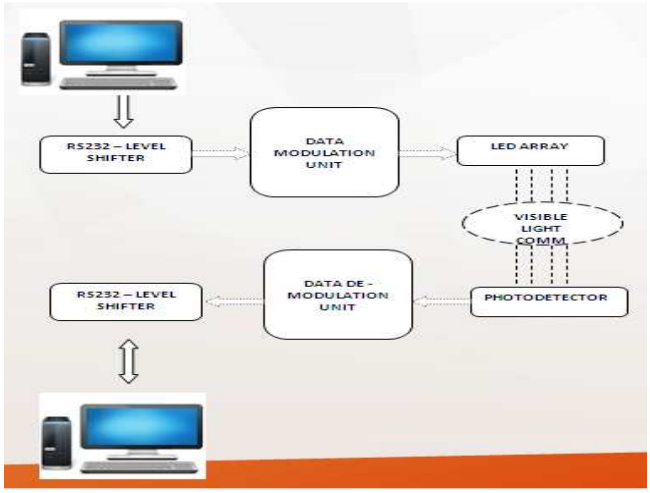

Fig.1.Visible Light Communication

Data communications medium which uses visible light between 400 and 800 THz (780–375 nm), Visible light communication approach of data transmission is a subset of optical wireless communications technologies. The technology uses fluorescent lamps (ordinary lamps, not special communications devices) to transmit signals at 10 kbit/s, or LEDs for up to 500 Mbit/s. Low rate data transmissions at 1 and 2 kilometers (0.6 and 1.2 mi) were demonstrated. RONJA achieves full Ethernet speed (10 Mbps) over the same distance thanks to larger optics and more powerful LEDs. Specially designed electronic devices generally containing a photodiode receive signals from light sources,[1]although in some cases a cell phone camera or a

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digital camera will be sufficient. The image sensor used in these devices is in fact an array of photodiodes (pixels) and in some applications its use may be preferred over a single photodiode. Such a sensor may provide either multi-channel communication (down to 1 pixel = 1 channel) or a spatial awareness of multiple light sources.VLC can be used as a communications medium for ubiquitous computing, because light-producing devices (such as indoor/outdoor lamps, TVs, traffic signs, commercial displays and car headlights/taillights are used everywhere.[3] Using visible light is also less dangerous for high-power applications because humans can perceive it and act to protect their eyes from damage. Being transmitted from a standard LED lamp was shown at TED Global Recently VLC-based indoor positioning system has become an attractive topic. ABI research forecasts that it could be a key solution to unlocking the $5 billion "indoor location market". Publications have been coming from Nakagawa Laboratory, COWA at Penn State and other researchers around the world. Another recent application is in the world of toys, thanks to cost-efficient and low-complexity implementation, which only requires one microcontroller and one LED as optical front-end. VLCs can be used for providing security. They are especially useful in body sensor networks and personal area networks. Recently Organic LEDs (OLED) have been used as optical transceivers to build up VLC communication links up to 10 Mbps.

5. HARDWARE DESCRIPTION

ARM7 AND LPC2148 CONTOLLER:

LPC2148 microcontroller board based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontrollers with embedded high-speed flash memory ranging from 32 kb to 512 kb. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. The meaning of LPC is Low Power Low Cost microcontroller. This is 32 bit microcontroller manufactured by Philips semiconductors (NXP). Due to their tiny size and low power consumption, LPC2148 is ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

(ISP/IAP) via on-chip boot loader software, single flash sector or full chip erase in 400 ms and programming of 256 B in 1 ms Embedded ICE RT and Embedded 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package. 8 kb to 40 kb of on-chip static RAM and 32 kb to 512 kb of on-chip flash memory; 128-bit wide interface/accelerator enables high-speed 60 MHz operation. In-System Programming/In-Application Programming Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high-speed tracing of instruction execution. One or two (LPC2141/42 Vs, LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 ms per channel. Single 10-bit DAC provides variable analog output (LPC2148 only) Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog. Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbps),SPI and SSP with buffering and variable data length capabilities up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package. Up to 21 external interrupt pins available. 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 ms. On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz and Power saving modes include Idle and Power-down Individual enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization, Processor wake-up from Power-down mode via external interrupt or BOD, CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O.

LEVEL SHIFTER:

When a microprocessor communicates with the outside world, it provides the data in byte-sized chunks. In some cases, such as printers, the information is simply grabbed from the 8-bit data bus of the printer. This can work only if the cable is not too long, since long cables diminish and even distort signals. Furthermore, an 8-bit data path is expensive. For these reasons, serial communication is used for transferring data between two systems located at distances of hundreds of feet to millions of miles apart. The Figures shows serial versus parallel data transfers. The fact that in serial communication a single data line is used instead of the 8-bit data line of parallel communication makes it not only much cheaper but also makes it possible for two computers located in two different cities to communicate over the telephone. For serial data communication to work the byte of data must be converted to serial bits using a parallel-in-serial-out shift register; then it can be transmitted over a single data line. This also means that at the receiving end there must be a serial-in-parallel-out shift register to receive the serial data and pack them into a byte. Of course, if data is to be transferred on the telephone, it must be converted from 0s and 1s to audio tones, which are sinusoidal-shaped signals. This conversion is performed by a peripheral device called modem, which stands for “modulator/demodulator.”When the distance is short, the digital signal can be transferred as it is on a simple wire and requires no modulation. This is how IBM PC keyboards transfer data to the motherboard. However, for long-distance data transfers using communication lines such as a telephone, serial data communication require a modem to modulate (convert from 0s and 1s to audio tones) and demodulate (converting from audio tones to 0s and 1s).Serial data communication uses two methods, asynchronous and synchronous. The synchronous method transfers a block of data (characters) at a time while the asynchronous transfers a single byte at a time. It is possible to write software to use either of these methods, but the programs can be tedious and long. For this reason, there are special IC chips made by many

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manufacturers for serial data communications. These chips are commonly referred to as UART (Universal Asynchronous Receiver-Transmitter) and USART (Universal Synchronous-Asynchronous Receiver-Transmitter). The ARM chip has a built-in UART.MAX3232 is compatible with RS-232 standard, have dual transceiver. Each receiver converts TIA/EIA-232-E levels into TTL/CMOS levels. Each driver converts TTL/CMOS levels into TIA/EIA-232-E levels. The MAX3232 is characterized for operation from -40°C to +85°C for all packages.MAX3232 is purposed for application in high-performance information processing systems and control devices of wide application.

6. LI-FI MODULATOR AND DEMODULATOR SETUP

The Tx side will transmit the data It is connected to arrays of led through which data is transferred This data will be received by the receiving side(Rx) side. The receiver side will receive the data that is transmitted through the led panel this led can be displayed to the hyper Terminal of the Pc by connecting a serial UART. Li-Fi is transmission of data through illumination of the LED by taking the fibre out of the fiber optics by sending data through the LED light bulb that varies in intensity faster than the human eye can follow. The LED blubs will hold a micro-chip that will do the job of processing the data. The light intensity can be manipulated to send the data by tiny changes in the amplitude. This technology uses visible spectrum of light, a part of the electromagnetic spectrum that is still not greatly utilized. In fact this technology transfers thousands of streams of data simultaneously in parallel in higher speed with the help of the special modulation using a unique signal processing technology. The light used to transmit the data is called D-light by herald hass, the inventor of LiFi.

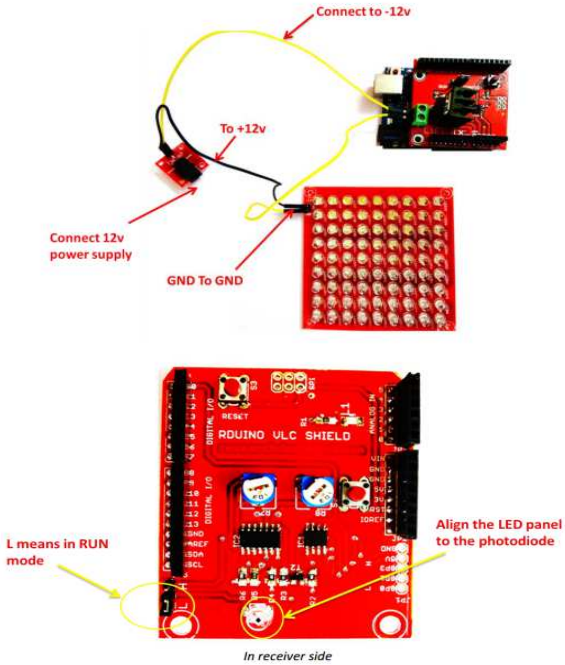

Fig.2.Modulator and Demodulator

6. RESULT AND CONCLUSION:

Li-Fi technology works on a simple digital principle which is nothing but an led is ON a digital data 1 can be transmitted and if it is OFF digital data 0 can be transmitted. So, in this project work we are going to switching the LEDs very quickly. These fast switching can be achieved by PWM technique to transmit digital data stream containing strings. To acquire this, we are programming the microcontroller to vary the duty cycle of the PWM signal which has the task of regulating the current in the LED. The biased current is fed to LED driver unit. The power of LED is varied according to the waveform of data signal. At the receiver side photodiode sensor produces a current proportional to the received instantaneous power. From this data can be filtered and it can be displayed on PC.

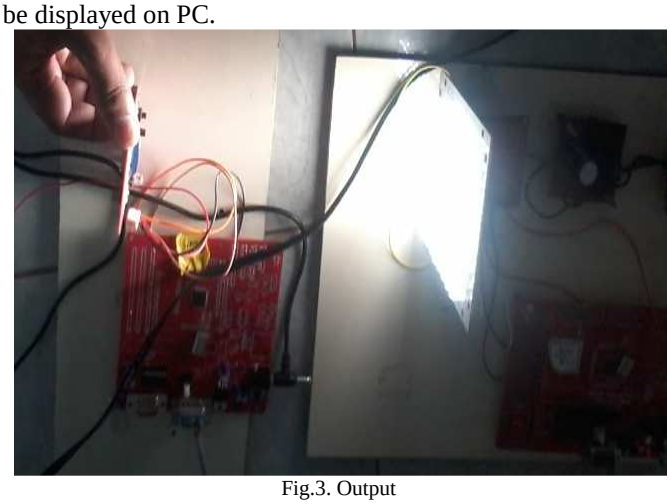

Fig.3. Output

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