VOICE AND DATA COMMUNICATION USING Li-Fi

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Abstract— This paper focuses on developing a light fidelity (Li-Fi) based system and analyzing its performance with respect to existing technology. Wi-Fi is great for general wireless coverage within a building, where as Li-Fi ideal for high density wireless data coverage in confined area and for reliving radio frequency interference issues. Li-Fi provides better bandwidth, efficiency and security than Wi-Fi. By leveraging low –cost LEDs lightings units there are many opportunities to exploit this medium, for public internet access through street light to auto-piloted cars that communicate through their head lights. This technology envisions a future where data for laptops, smart phones, and tablets will be transmitted in a economic and eco friendly medium of light in room.

Keywords— Power amplifier, Li-Fi transmitter and receiver, Buffers, Drivers, Relays.

I. INTRODUCTION

One of the most interesting technologies in industry today is the wireless technology. This statement is not founded on the "latest and greatest" in communications break through. All to often we hear how evolving technology will unshackle us from the traditional "pairs of wireless" which provide our present day communication. Wireless however has been around for decades in variations and techniques. Only recently have newer applications breathed life back into mundane services, sparking international interest in the applications, bandwidths and legality of wireless communication. Today everyone is buzzing about the future of the wireless world and our abilities to communicate in general.

Visible light is the form in which electromagnetic radiation with wave lengths in a particular range is interpreted by the human brain. Visible light is thus by definition comprised of visually-perceivable electromagnetic waves. The visible spectrum covers wave lengths from 380 nm to 750 nm. At the lower end of the spectrum there are violet-bluish tones and light at the other end of the spectrum is interpreted to be distinctly red. Note that some animals exist whose vision merges into the ultraviolet (< 380 nm) or the infrared (> 750 nm).

II. LITERATURE SURVEY

A fundamental analysis done on visible light communication came to the conclusion that visible light communication was expected to be the indoor wireless communication of the next generation due to the possibility of transmitting at a high data rate. Communication performance was degraded severely by intersymbol interference Intersymbol interference depended on the data rate and the Field of Receiver (FOV) because the LED lights were distributed within a room and the irradiance of light was wide for the function of the lighting equipment. Research done by Takakuni Douseki on the battery less optical-wireless system with white-led illumination showed the system's ability to transmit data at the speed of 100 Kbps with the distance of 40cm.In this research, they also discussed reflection and intersymbol interference.

This system successfully performed without a battery. This system used the white LED as the transmitter and the photocell as the receiver carried out the numerical simulations for an optimal lights layout scheme for the visible light communication to find the effectiveness of this communication system. There were two kinds of communication systems being proposed, an optical up-link and an optical down-link.

The up-link had a small, superficial area and narrow angle of irradiance like an electric torch whereby the LED could be lighted from the bottom to the top. Generally, the down-link system had a large superficial area and wide angle of irradiance because the light was located at the ceiling and lighted from the top to the bottom. The performance of the visible light communication was analyzed using the optimal lights layout scheme in terms of the received power and bit error rate (BIT). Based on the numerical simulation results, the received power was very large compared to the infrared wireless communication which could make broadband communication possible. The effectiveness of the light layout was analyzed based on the received power.

From the results of the simulation of the optimal lights layout scheme for visible light communication, they concluded that this technique could be applied to obtain an excellent performance. A study on the challenges and possibilities of visible light communications was done by which introduced the principles of VLC and outlined some of its major challenges. The research was an overview of the applications of visible light communication. In this study, problems with the implementation of these communication systems were highlighted

Existing technology

RONJA

The Reasonable Optical Near Joint Access (RONJA) Free Space Optics device developed in the Czech

Republic can transmit data wirelessly using beams of red visible light up to 0.87 miles (1.4 kilometres), or infrared light up to 1.25 miles (0.78 kilometres).

As with VLC systems, direct line of sight is important, with clear visibility helping to optimise data transmission rates. It has been noted that for RONJA conditions of dense fog or snow can detrimentally effect external transmissions.

Infrared (IR) Communications

Infrared devices are often used for data-transmission in devices such as notebook computers, television remote controls and even some newer mobile phones. To date the Infrared Data Association (IrDA) has standardized over 30 specifications that are widely implemented for cordless phones, printers, televisions and other devices. Its 2008 market-report indicated a prolific increase of IrDA infrared enabled devices, of which over 1 billion units have been shipped to date, and that demand for such units was likely to increase greatly, particularly with the development of Ir Simple version 1.0 and technological advances used for Giga-IR.

Whilst visible light from LED systems and infrared emissions share similar frequency ranges, it is acknowledged that there are potential visual safety problems with using infrared for high rates of data transmission due to both the large energy emissions it would create and its invisibility, making suitably developed LED light data transmission a safer option for human eyes.

Radiofrequency/Microwave Communications

At present the multiple use in buildings of the three independent WLAN frequency bands can often compromise information networks. This is a problem that the adoption of VLC technologies could help resolve by providing alternative bandwidths.

Additionally, whilst the use of radiofrequency/microwave communications devices is becoming increasingly widespread, research indicates that some emissions and intensities may also interfere with sensitive electronic equipment (such as used in hospitals, some factories and on aircraft), cause health problems and/or biological damage. With sufficient development, it may prove possible for VLC to avoid such problems, and become a biologically friendly environmental asset. As it appears likely that VLC will not interfere with sensitive electrical equipment it could, in principle, be used in locations where current communications technology is often prohibited and where strong data security is required. An additional incentive at present is that, whilst free usage of radio wave and microwave wireless communications is restricted by law, VLC technologies do not, as yet, require licenses.

III. Li-Fi TECNOLOGY

The communication flow of today is very high. Many applications are operating at high speed and a fixed connection is often preferred. If the power utilities could supply communication over the Light to the costumers it could make a tremendous breakthrough in communications. Every household would be connected at any time and services being provided at real-time. Using the Light as a communication medium could also be a cost-effective way compared to other systems because it uses an existing infrastructure, wires exists to every household connected to the Light network.

The deregulated market has forced the power utilities to explore new markets to find new business opportunities, which have increased the research in Light communications the last decade. The research has initially been focused on providing services related to power distribution such as load control, meter reading, tariff control, remote control and smart homes. These value-added services would open up new markets for the power utilities and hence increase the profit. The moderate demands of these applications make it easier to obtain reliable communication. Firstly, the information bit rate is low; secondly, they do not require real-time performance.

Li-Fi can be used to switch appliances from any distance, overcoming the limited range of infra-red and radio remote control. A wide range of LI FI communication technologies are needed for different applications, ranging from home automation to Internet access. Electrical power is transmitted over long distances using high voltage transmission lines, distributed over medium voltages, and used inside buildings at lower voltages. Most PLC technologies limit themselves to one set of wires (such as premises wiring within a single building), but some can cross between two levels (for example, both the distribution network and premises wiring). Typically transformers prevent propagating the signal, which requires multiple technologies to form very large networks. Various data rates and frequencies are used in different situations.

Operation

In order to know the working of Li-Fi we need to know the necessity for Li-Fi .With the vast development in living the use of gadgets and invention of new gadgets is increasing which lead to the technological developments. There are many situations in which people get frustrated with the dull performance signals of Wi-Fi at a place with many network connections in seminars conferences Li-Fi fulfills these needs. LED's can be switched on and off very quick. For transmitting data this way all that we require is LED's and controller that code data into Led's. Parallel data transmission can be done by using array of LED's or by using red, green, blue LED's to alter light frequency with the frequency of different data channel. Advancements and enhancements in this field generate a speed of 10 gbps .But amazingly fast data rates and lowering band widths are not the only reasons that enhance this

technology. Li-Fi usually is based on light and so it can be probably implemented in aircrafts and hospitals that are prone to inference from radio waves. Unlike Wi-Fi, Li-Fi can work even under-water which makes it more advantageous for military operations. Radio waves are replaced by light waves in data transmission called Li- Fi. Light emitting diodes can be switched on and off very much faster than the human eye allowing the light source to appear continuously. The data transmission is done through binary codes which involve switching on LED can be done by logic 1 and switch off using logic 0.The encoding of information in light can therefore be identified by varying the rate at which the LED's flicker on and off to give strings of 0's and 1's.visible light communication is this method of using rapid pulses of light to transmit information wirelessly.

IV. ANALYSIS AND DISCUSSION

Visible light communication

Visible light communication (VLC) is a data communication Medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. Fast pulses are used for wireless transmission. Communication system components are, a high brightness white LED which acts as a communication source and silicon photo diode which shows good response to visible wavelength region.

LED illumination can be used as a communication source by modulating the LED light with the data signal. The LED light appears constant to the human eye due to the fast flickering rate. The high data rate can be achieved by using high speed LED's and appropriate multiplexing techniques. Each LED transmits at a different data rate which can be in-creased by parallel data transmission using LED arrays. Many different reasons exist for the usage of LED light in spite of fluorescent lamp, incandescent bulb etc which are available.

V. HARDWARE CONFIGURATION AND WORKING

Power Supply Unit

This section needs two voltages viz., +12 V & +5 V, as working voltages. Hence specially designed power supply is constructed to get regulated power supplies.

Microcontroller

The Atmel AT89 series is an Intel 8051-compatible family of 8 bit microcontrollers (µCs) manufactured by the Atmel Corporation. Based on the Intel 8051 core, the AT89 series remains very popular as general purpose microcontrollers, due to their industry standard instruction set, and low unit cost. This allows a great amount of legacy code to be reused without modification in new applications. While considerably less powerful than the newer AT90 series of AVR RISC microcontrollers, new product development has continued with the AT89 series for the aforementioned advantages

Preamplifier

A preamplifier (preamp) is an electronic amplifier that prepares a small electrical signal for further amplification or processing. A preamplifier is often placed close to the sensor to reduce the effects of noise and interference. It is used to boost the signal

FIG1: TRANSMITTER

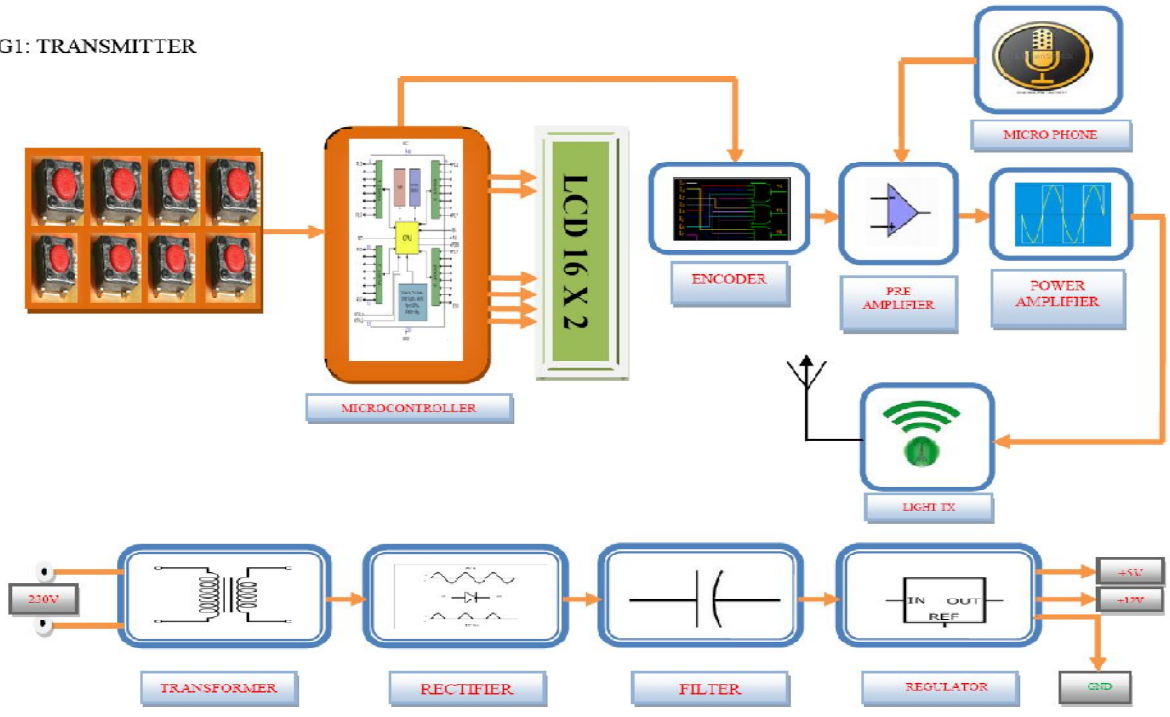
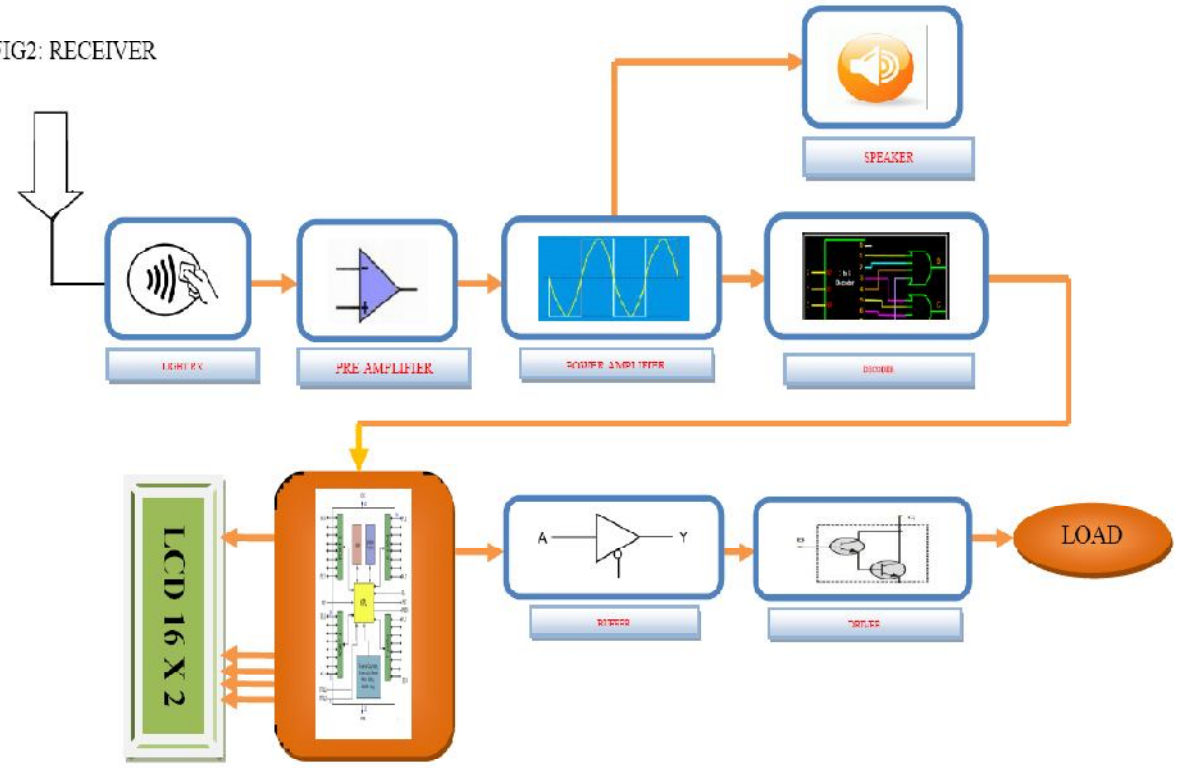


FIG2: RECEIVER



HARDWARE REQUIREMENTS: MICROCONTROLLER (89C51), LCD, Relay Driver, Relays, Resistors, Capacitors, LEDs, Crystal, Diodes, Transformer, Voltage Regulator, Push Button.

strength to drive the cable to the main instrument without significantly degrading the signal-to-noise ratio(SNR)

Power amplifier

An audio power amplifier is an electronic amplifier that amplifies low-power audio signals (signals composed primarily of frequencies between 20 - 20 000 Hz, the human range of hearing) to a level suitable for driving loudspeakers. It is the final electronic stage in a typical audio playback chain.

Li-Fi transmitter and receiver

Li-Fi is implemented using white LED light bulbs at downlink transmitter. These devices are used for illumination only by applying a constant current. By fast and subtle variations of the current, optical output can be made to vary at extremely high speeds. This variation is used to carry high speed data.

Buffers

Buffers do not affect the logical state of a digital signal (i.e. a logic 1 input results in a logic 1 output whereas logic 0 input results in a logic 0 output). Buffers are normally used to provide extra current drive at the output but can also be used to regularize the logic present at an interface.

Drivers

This section is used to drive the relay where the output is complement of input which is applied to the drive but current will be amplified

Relays

It is a electromagnetic device which is used to drive the load connected across the relay and the o/p of relay can be connected to controller or load for further processing.

Working

The process of data communication through the visible light on the transmitter side Keypad is used as the input signal. The microcontroller receives the signal from the keypad and generates two outputs and gives that signal to the DTMF Encoder. The encoder will generate one tone and one frequency for every pressed key. That frequency is amplified by the amplifier circuits and fed into the power LED. At the receiver side light dependant resister will receive the light signal and correspondingly generate an electrical signal proportional to it. This electrical signal is processed by a demodulator circuit(DTMF Decoder), and the output of decoder is then fed to a microcontroller and the microcontroller activates the corresponding load for the pressed key. In the process of voice communication through the visible light on the transmitter side voice is used as the input signal.

This signal is converted to an electrical signal through a condenser or microphone. This electrical signal is amplified by the amplifier circuits and fed into the power LED. The light signal from the LED varies according to the intensity of the voice signal. The

louder is voice the glow of the LED will be more. At the receiver side light dependant resister will receive the light signal and correspondingly generate an electrical signal proportional to it.
This electrical signal is processed by a demodulator circuit, which is then fed to a speaker and it produces the audio signal which was at the input of the transmitter side.

VI. EXPERIMENTAL RESULTS

Upon detailed investigation of VLC research, it was found that not a lot of research has been done to develop this technology for commercial use. But because research into VLC is relatively new, the possibilities are wide open. From our review of the literature, it became evident that work should be done to look into the possibility of designing a new model that could fit the present infrastructure for indoor applications.
Therefore, the results of the research presented in this paper can be summarized as, successful development of a prototype on VLC and demonstrating its efficiency by using commercial LEDs.Suggesting a guideline for the design and implementation of future development of the prototypes.
The proposed system was segmented into two parts with different interface protocols and was demonstrated practically.

CONCLUSION

The concept of Li-Fi is currently attracting a great deal of interest. It offers a genuine and very efficient alternative to radio-based wireless. As there is a rapid growth in population, hence the number of devices accessing wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. Li-Fi may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.

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