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Paper Authors
Madhu Kumar Vanteru, A.Jyothika, G.Varsha, B.Gayathri, M.Tejaswini, E.Shiva Kumar

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Design of Li-Fi (Light Fidelity) Technology Based Underwater Data Transmission System

Madhu Kumar Vanteru[1], A.Jyothika[2], G.Varsha[3], B.Gayathri[4], M.Tejaswini[5], E.Shiva Kumar[6]
[1]*Assistant Professor, Dept. of Electronics & Communication Engineering, Balaji Institute of Technology and Science, Warangal, Telangana, India*
[2,3,4,5,6]*UG Student, Dept. of Electronics & Communication Engineering, Balaji Institute of Technology and Science, Warangal, Telangana, India*

Abstract **- Efficient exploration of**
Techniques for underwater communication are still needed to reduce energy consumption, transmission losses and should also provide high speed communication. Light Fidelity (Li-Fi) is a fast, remote correspondence utilizing visible light. In this we presented a simple yet high speed communication system based on visible light communication, also recognized as light fidelity (Li-fi), for underwater applications. The transmission of data like Text, audio and voice transmission takes place through the white LED. In the form of binary transmission, where '0' indicate the 'OFF' state & '1' indicate the 'ON' state. The system is capable of transmitting text data to indicate the navigation direction, voice data and the audio data.

Keywords **- Underwater communication, Li-Fi, LED, Arduino, Solar cell, Transmitter, Receiver**

I. INTRODUCTION

The utilization of light as a way to transmit information has been authored Li-Fi. The high-speed By swapping glowing bulbs with LED's which have electronic properties [1]. Li-Fi could bring Internet access to more regions. It could reform the media communications industry.

II.SYSTEM DEVELOPMENT A. Hardware

Architecture

The transmission block diagram consists of Arduino Nano which operates with 5V/12V power supply. It also contains 4x4 Keypad, Audio Jack, Mic, Audio Amplifier, and output LED. 4x4 Keypad is used to take the data in text form [2]. Audio Jack is used to send data which is in mobiles, laptops etc[3]. Mic is used to send directly the voice signals [4] and the audio amplifier is used to amplify the voice signal. LED is used to send data in light format using Li-Fi technology.

Light Fidelity (Li-Fi) is a fast, remote correspondence utilizing visible light. It falls under the classification of optical remote communications. Information transmission happens through Light Emitting Diode (LED) bulbs whose intensity changes (varies). During this variation in light intensity, communication takes places digitally. This innovation has huge applications [5] where the utilization of Wi-Fi is restricted or prohibited. It likewise takes out the unfavorable wellbeing impacts of utilizing electromagnetic waves. Except light is seen, information can't be hacked; thus, data transmission is secure. Innovation is like Wi-Fi but is quicker, enabling you to send and get more data in less time [6].

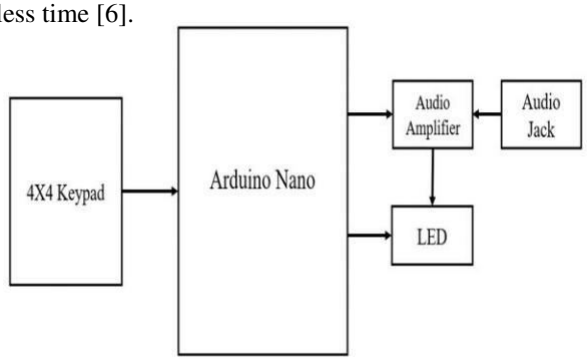

Fig 1: Block diagram of Transmitter

The receiver block diagram consists of Arduino Uno which operates with 5V/12V power supply. It also contains Solar Panel,

LCD 16x2 with I2C interface, Audio Amplifier and Speaker. Solar Panel is used for collection data which is in light form. LCD is to display the data which is in text format. Speaker is used to listen the audio signals[20] and the amplifier is used to amplify the audio signals.

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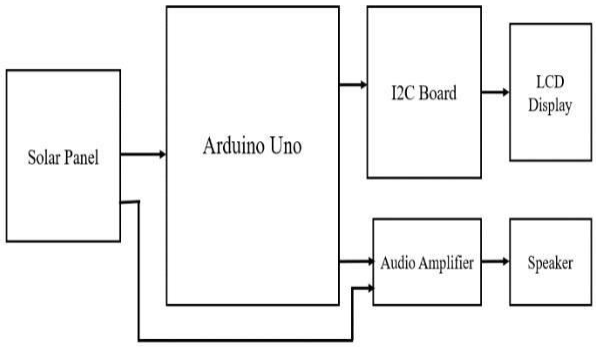

Fig 2: Block diagram of Receiver

B. Arduino UNO

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. The unit comes with 32KB flash memory that is used to store the number of instructions while the SRAM is 2KB and EEPROM is 1KB. The operating voltage of the unit is 5V which projects the microcontroller on the board and its associated circuitry operates at 5V while the input voltage ranges between 6V to 20V and the recommended input voltage ranges from 7V to 12V.

C. Arduino Nano

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software)
Provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins0 and 1).

D. LASER Diode

A Laser Diode is a semiconductor device similar to a light-emitting diode (LED). It uses p-n junction to emit coherent light in which all the waves are at the same frequency and phase. This coherent light is produced by the laser diode using a process termed as “Light Amplification by Stimulated Emission of Radiation”, which is abbreviated as LASER. And since a p-n junction is used to produce laser light, this device is named as a laser diode.

E. White LED

White light emitting diodes are the next big thing in lighting[7]. An LED cannot emit white light naturally. However, use of certain technologies makes an LED to emit light. There are three prevalent technologies to produce white light in LED and they are Wavelength conversion, Color Mixing, and Technology referred to as Homo-epitaxial ZnSe.

F. Solar Cell

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. Solar cells are described as being photovoltaic, irrespective of whether the source is sunlight or an artificial light. In addition to producing energy, they can be used as a photo detector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.

G. Software Requirement

Arduino IDE is an open-source software, its easily available for operating systems like MAC, windows, Linux, and runs on JAVA platform that come with inbuilt functions and commands that helps for debugging, editing and compiling [11] the code environment. Arduino UNO contains microcontroller on the board that is programmed and accepts code in form of codes/bits. Arduino IDE supports both C and C++ language [21].

H. Work Flow

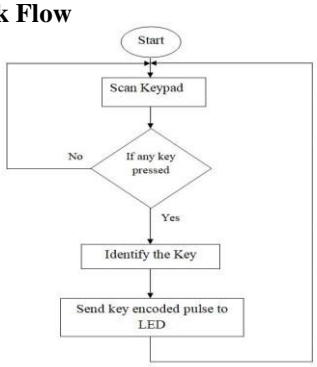

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Fig 3: Flowchart of Transmitter

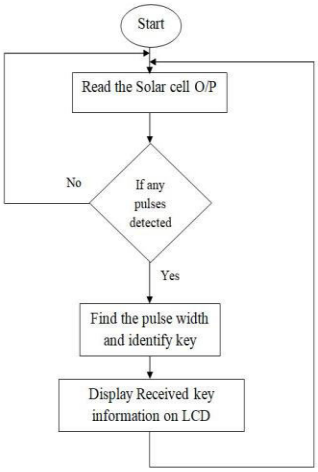

Fig 4: Flowchart of Receiver

III. PROPOSED METHODOLOGY A.

Working Principle

In digital transmission system, data will be converted in to binary bits in the form of zeros and ones equivalent to 'on' and 'off' states. Visible light is an ultra-fast electromagnetic wave with unlimited bandwidth to utilize. High-speed switching of light can't be detected by human eyes but highly sensitive photodiodes can efficiently detect the modulation of light interact with the detectors.

Compared to radio waves used in conventional wireless systems, visible light has thousand times higher bandwidth. If very high-speed current passed through LED which vary the intensity and with ON-OFF activities of LED data transmitted using binary codes. When the LED is ON, logically it represents the '1' is transmitted and when the LED is OFF, logically it represents the '0' is transmitted. This method is called as Visible Light Communication (VLC) and uses rapid pulses of light to transmit data.

B. Proposed System

Fig 5: Proposed System

Fig 5 shows the proposed system. The speed of the transmission for a single micro-LED is of 8 Gbps. We are transmitting the two different data they are transmission of audio and text signal using Li-Fi. It is less cost than other. Speed of the data transmission is high compared to the existing model and it is unshakable. LiFi technology [8] uses LED for transmitting data. It is derivative of optical wireless communication technology using light from Led to deliver high speed communication. Visible light communication works by switching the Led off and on at very high speed, it can't be noticed by the human eye. The intensity of the LiFi LED emitter is kept low enough so that it cannot be seen by the human eye but high enough to carry out the communication easily [13]. These fluctuations in the light intensity were caught on the solar panel that behaves as a photo detector it captures all the LED fluctuations. The light signals are transmitted via wireless channels to the receiver. The detector in the receiver converts the optical signals to recover the message[9-13]. It overcomes the disadvantages of the existing system. It is safe as light doesn't affect the marine animals and there is no data loss while transmission.

IV. RESULTS AND DISSCUSION A.

Transmission of Text data

Fig 6: Transmission of text data

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A 4x4 hex keypad is used to type the data to be sent and it is interfaced along with the LED to the Arduino Nano microcontroller at the sender's end. At the receiver's end, there will be a photodiode receiver to detect the incoming light from the LED. When a key is pressed on the hex keypad, it is immediately converted to binary via Arduino code running in the microcontroller. At the same time, that value is sent from the LED at a very high speed by the flickering of the LED to achieve a fast rate of transmission. The LED will be ON for binary value '1' and OFF for binary value '0' and this way, transmission occurs. We won't be able to see this flickering as it occurs at a very high speed and it appears as just a flash of the LED. At the receiver end, the photodiode receiver bulb detects this light energy and converts into electrical energy in the form of binary. The same process is done in reverse at this end and analog text data is obtained from the binary and displayed in the LCD as output.

B. Transmission of Audio Signal

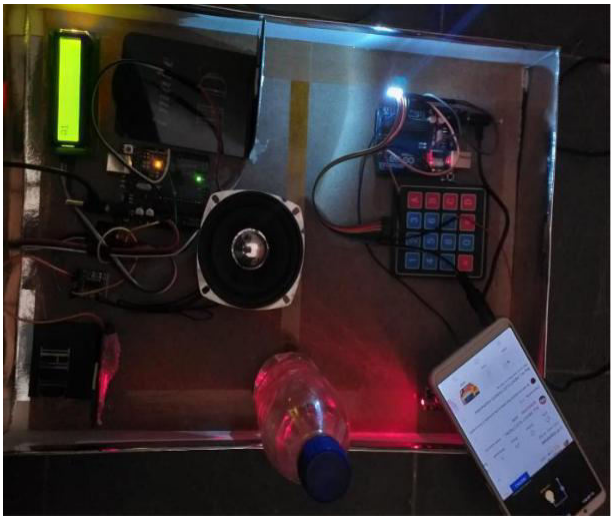

Fig 7: Transmission of Audio Signals

In audio segment signal transmission was taken place through the phone which is placed at the transmitter end, it converts analog to digital signals this converted signal is now amplified and transmitted in the form of beam of LED light. LED is provided with power supply. These fluctuations in the light intensity were caught on the solar panel that behaves as a photo detector it captures all the LED fluctuations and transmits the signal to pre amplified speaker and the audio signals in receiver are heard through speaker.

V. CONCLUSION

Light Fidelity (Li-Fi) is a fast, remote correspondence utilizing visible light. It falls under the classification of optical remote communications. Information transmission happens through Light Emitting Diode (LED) bulbs whose intensity changes (varies). During this variation in light intensity, communication takes places digitally. In the transmitter section based on the key pressed on the keypad it is first converted to binary form and based on the binary data the variation of light changes. The Pulse Width Modulation is used for the encoding data. For audio signals the signal is converted from electrical signal to binary form. Then it is encoded into light for transmission. The transmission of data is done using LED bulbs. In the receiver section the data which is in light form is collected by solar panel. Then it is decoded by the Arduino and it is sent to LCD for the display of text data. The audio signals are received by speakers. The speed of data transmission is high and it is unshakable. It has unlimited bandwidth for data transmission. It is safe as light doesn't affect the marine animals and there is no data loss while transmission.

VI. FUTURE SCOPE

As light is everywhere and free to use, there is a great scope for the use and evolution of Li-Fi technology. As the Li-Fi technology becomes popular, it will lead to a cleaner,
greener, economical, and safer communication system. The advancement of project can be: For the secured data transmission, the data can be encrypted and transmitted. The light intensity can be amplified for the longer distance data transmission. This technology can be used to make every LED bulb into a Li-Fi hotspot to transmit data wirelessly.

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