Li-Fi based data transmission and analysis using IoT platform

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Abstract—To transfer the basic information radio communication technologies, like Bluetooth, global positioning system (GPS) and Wi-Fi are used. The need to transmit the data wirelessly and more efficiently is must even so radio communication technologies are universal, limitations of Radio communication technology relies on overpopulation and interference with many other radio applications. For transferring the data through a wireless medium a study has been organized proving the use of visible light. So instead of using a basic radio waves as a communication medium we use visible light and this new technology is called Light fidelity (Li-Fi). The research community has been attracted by the Li-Fi technologies. Because of the modernity there is a need to support the technology. Many leading companies are working on manufacturing of light fidelity (Li-Fi) projects precisely many surveys and research has been organized on this Li-Fi technology. Data is collected from multiple environments through visible light and enhance services in many sectors by making intelligent decisions obtained data are evaluated and processed.

Keywords—LI-FI (Light Fidelity), Wireless communication, IOT (Internet of things).

1. Introduction

Many radio communication technologies like Wi-Fi has been operated in radio frequency (RF) spectrum. To transfer data in radio frequency (RF) band it sometimes works as an electromagnetic spectrum. The important activity is to transfer the data from one place to another place. The internet becomes slow when multiple devices are connected to the radio network due to which Li-Fi technology has been introduced. Compared to the usage of radio frequency systems, Light fidelity (Li-Fi) an optical version of Wi-Fi are being offered with more advantages. There are some favourable benefits of Li-Fi that includes high bandwidth, good energy efficiency, deployment with light emitting diode(LED). To connect a secured network and extent the required data it is very difficult with a high bandwidth. Li-Fi is the wireless communication system through which data is transmitted by an light emitting diode(LED). To get the various data that is being transferred different coloured LED’s are used such as red, blue, green. Human eye detection is slow when compared with the switched on and off method of LED. To transfer the data Li-Fi adds a new and unutilized bandwidth of a visible light. A small portion of a electromagnetic spectrum is called Visible light ranging from 390 to 700nm. Radio frequency congestion is reduced by visible light. To handle novel applications and problems in spectrum space visible light communication is used. Very high speed data communication uses unregulated visible spectrum. Visible light communication (VLC) is used because light is used rather than radio frequency (RF) signals. There are many applications that are particularly suited for Li-Fi technology such as downloading of audio and video files from laptops, smartphones, tablets. Li-Fi technology uses the light in aircrafts and hospitals by avoiding the interference of radio waves. The internet traffic is reduced in...
the RF channels due to the requirement of minimal uplink capacity and downlink bandwidth. The reason behind the noticeable growth of Li-Fi industries is changing the business from off-the-shell products to service-oriented lighting solutions. Li-Fi technology determines the Medium access control (MAC) and physical layer protocols. Li-Fi technology has been drastically improving since it is safer for human use with a high data transmission data rates and can be accessed by everyone using an internet of things (IoT) platform.

A. Abbreviations and Acronyms

GPS-global positioning system, Li-Fi-Light fidelity, Wi-Fi-wireless fidelity, RF-radio frequency, LED-light emitting diode, VLC-Visible light communication, MAC-Medium access control, IoT-internet of things, DSL-Digital Subscriber Line, EM-electromagnetic, IDE-integrated development environment.

2. LITERATURE SURVEY

A. DSL Technologies

Earlier days, digital data is transmitted over the telephones by using Digital Subscriber Line(DSL) technology.

![Fig. 1: Internet access using DSL modem](image)

Out of all the forms of internet connection DSL is the most prevailing form a single telephone line can be used to deliver DSL service as well as wired telephone service. For data transmission DSL technology uses high frequency band. DSL service provides a bit rate from 256kbps to 100Mbps, bit rate of 1Gbps can also be reached depending on line conditions and DSL technology. Using digital modems over ordinary phone lines DSL provides high speed networking.

B. Satellite Internet system

A satellite internet is a wireless connection system that comprises three satellite dishes placed in the hub, space and other one to customer property. A modem and cables are needed along with the satellite dish for efficient running of the internet. Satellite internet will be considered to be faster if the customer is on dialup. A poor quality of internet is expected due to the weather effects such as bad wind or rain storms. Due to the satellite connections, online games, online services, broadband routers may not work efficiently.
C. WIRELESS FIDELITY

The wired internet connectivity isn’t a compatible mode to transfer data through several personal devices.

3. Li-Fi

Li-Fi is a high speed connection for fixed and mobile optical communications. For illumination and data transmission Li-Fi technology uses VLC technology employing no of LED blubs. Due to limited bandwidth, high data rates and high demand of wireless communication, RF band lead to several struggles. To overcome the limitations of RF band VLC technology uses visible light spectrum that is 10,000 times greater than RF spectrum. By overcoming all the disadvantages of RF band Li-Fi technology proved to be a prominent one for data communication. When the user is stationary the channel gain is not fluctuated in the Li-Fi technology. Without any electromagnetic interface Li-Fi has a huge set of application in the fields of electromagnetic sensitive areas such as aircraft cabins, nuclear power plants etc. Li-Fi is expected to be significantly cheaper than Wi-Fi due its low reliability at short range.
A. Li-Fi in various fields

Li-Fi transfers the data to an IOT platform through LED that is fixed in any mode of transport wherever and whenever the accident occurs. To predict the traffic in certain areas, traffic lights passes the data to central hub IoT platform which is processed by visible light communication (VLC). Li-Fi is used to predict the climate change by comparing the previous data base. Whenever a misconception occurs this technology collects information from various fields and transfers to a hub which can be accessed by everyone.

4. PROPOSED SYSTEM

Li-Fi is used to transmit data’s and can be used as an alternative for Wi-Fi technology. In this project we have used internet of things which is one of the emerging technologies now a days. Li-Fi plays a major role in health aspects which is radiation free. It also analyses and transfers data faster than any other technique. Therefore in this Li-Fi technology is coupled with the hierarchical structure of IOT.

5. BLOCK DIAGRAM

In this the server is used to stream the data's where when the power button is switched off '0' bits are transferred and when it is switched on '1' bit is transferred.

![Block diagram](image)

Fig. 4: Block diagram

Then it is connected to the lamp driver where the LED Lamp uses light as the medium and transfers the data to the Li-Fi dongle which then is seen in several electronic gadgets. Li-Fi dongle consists of Photodetector which is amplified and processed and sent as the output received data. The data is gathered from several nodes, preprocessed and the features are extracted. They analyze the inputs and predict the future points and accuracy.

A. Li-Fi dongle

Li-fi dongle is being developed and manufactured by Pure Li-Fi to provide high speed, radiation less, fully networked and highly secure wireless data transmission in the form of bits through light. It consists of the following parts as in the block diagram.
B. Photodetectors

Photodetectors are the light sensors which has EM radiation. It has a positive and negative junction which has the ability to convert photons to electric current. In the depletion region the absorption of photons results in the increased rate in electron-hole pairs. We use photodetectors in this project to convert light energy for processing the data’s available. The power in the beam is proportional to its response.

C. Amplifiers

It is an electronic device which raises the power of the signal. It is used in transmitting all the data’s with a small input signal. In this project this helps to increase the power intensity of the visible light communication.

D. LED lamps

Led lamps play a major role in data transmission. In this light spectrum is the initiative for the transmission and also it exceeds the RF waves by 100 times. Led consists of an aluminum jacket within which the components are present. In this the LED acts as a router.

6. INTRODUCTION OF HARDWARE COMPONENTS

The physical components that are interfaced with the software to provide the expected output are Arduino Uno, sensors, Led bulb, microcontroller and Li-Fi dongle.

A. Arduino UNO

Data transmission takes place when Arduino acts as the transceiver through digital means. In this the led when switched on transmits the bit ‘1’ and when switched off has the bit ‘0’. In this the receiver part consists of solar panel which stores the energy for later use. The integrated development environment (IDE) helps the code to be understood by the physical board and run it.

![Arduino Uno board](image.png)

Fig. 5: Arduino Uno board

B. Sensors

A sensor is used to measure the physical quantities by responding to the electrical signals. In this project many sensors are connected where the data’s are analysed and stored in a hub and the information can be collected whenever it is necessary.
A. **Humidity sensor**

Humidity sensor is also known as Hygrometer. With the help of this sensor we can measure the moisture level in our environment and also temperature of air.

![Humidity Sensor](image)

**Fig. 6: Humidity Sensor**

Texas instruments humidity sensors are said to be the most accurately measuring sensor. When we set a threshold value, if the value is less than that we can information about that by means of visible light in this project.

B. **Moisture sensor**

Moisture sensor measure the quantity of water content in soil and so on.

![Moisture Sensor](image)

**Fig. 7: Moisture Sensor**

When the soil is having water shortage it gives information where there is a high level module output else it has allow level module output. It is being widely used agriculture, land irrigation and so on. The working voltage should be equal to 5V. The working current should be less than 20mA. It is interfaced as analog type where it is converted to digital using microcontroller in the module. There are two pins in this sensor whose flat surface has little or no sensitivity at the edges.

C. **Proximity sensor**

Proximity sensor is used to detect nearby object's presence without any physical contact. It emits Electromagnetic radiation and expects for the return signal to come. The object that gives back the return signal is known as Proximity sensor's target. Proximity sensors have high reliability and is used in many applications such as smartphones, car parking and so on.

D. **Temperature sensor**

A Temperature sensor is a type of resistance temperature detectors or thermocouple that is used in the measurement of temperature using electrical signal. The temperature is determined by the radiation of thermal heat source. In this RTD is the most efficient and stable temperature sensor which is also accurate. It is used to monitor the battery temperature of a device. Thus it collects these data from the surrounding environment with the help of IOT. This can also detect the temperatures of solid, liquid or gas.
ADVANTAGES

As we look forward to the future of technology, we are at the pinnacle of technology development but, there is more than what meets the eye. Light fidelity has its own short comings and also is one off the biggest futuristic discoveries we can look at. Some of the advantages are,

A. Efficiency
The more the presence of lights are, the network through the light will be easily consumable. We have lights at our homes and offices and other public places. So, the production of this network is going to have lesser components and high efficiency

B. Availability
The light provides the internet connectivity. As the source is everywhere in the space, it is easily available to provide a huge layout the access of internet connection.

C. Security
The light fidelity has the biggest advantage called “Security”. Since light cannot pass through walls or travel longer distances, Li-Fi works only to the users within a specified distance and cannot be accessed by people from other buildings like how you could access Wi-Fi.

D. Speed
Visible light communication provides the speed up to 100 times that off the Wi-Fi. Thus providing customers best speed and sustenance.
8. OUTPUT

Fig.9: Hardware setup

A. Hardware implementation

This is the hardware set up of the hierarchical architecture of a LI-FI based IOT implementation. We have a transceiver which accepts light waves. The dongle gets activated by the light waves and receives signal. Once the light is detected by the dongle the data is transmitted through binary codes 0’s and 1’s. The data thus sent is received processed and further amplified to send through individual applications. The hardware uses Arduino uno to load the instruction set onto the microcontroller, this microcontroller is then set with the LI-Fi dongle and then the respective signal processing is done.

B. Software implementation

The software used here is by Arduino to load the instruction set onto the microcontroller. The signal process of the project is focused with matlab. Here we have used Matlab 2017 R to implement the signal flow and the neural network processing.

Fig. 10: Neural Network Pattern
This is neural network pattern while implementing the code and explains what happens at the receiving end of the dongle to the LED bulbs to process the signal source information.

1) Training Neural Network

Open network training option. Train for 30 epochs. Set the initial rate to 0.0001 and lower the rate after 20 epochs. Observe the network accuracy during training by describing the validation data and validation frequency. It trains the network on the training data and it calculates the accurate data at regular intervals of time. The data is not used to update the network weights. Then, turn on the training progress plot and turn off the command window output.

2) Deployment

The “genFunction” function is a unique productivity function which allows stand-alone MATLAB tool functions for a neural network. The code which is being generated to simulate a neural network will contain all the information including settings, bias values and the weight. Some off the unique information also includes the module functions and calculations. The further acquired processed matlab function is used to inspect the simulated calculations at maximum accuracy that a specific neural network works and makes it less complex to deploy the network for many applications with various elements.
of MATLAB deployment tools. The particular function “genFunction” has been introduced in the panels of deployment under the specific tools nftool, nctool, nprttool and nstool. So, for further information over specific tool features, one needs to view the Fit data along with a shallow neural network. The classification of the patterns with the SNN have also been implemented along with cluster data with a self- organizing map and the time series shallow network prediction and modelling can be played along and implemented disruption free respectively.

9. CONCLUSION
The light has been an important part of the previous century. Light is a source of several energy producing elements? This technology can be a game changer and an alternative to the current internet providing alternatives. The technology which provides the range occupancy by the light is going to give many people the access of internet. Light Fidelity is going to be a vast mode of internet alternative providing many industries and the educational centres. This paper gives an insight about the multiple architecture layout of internet providence of several applications.

10. FUTURE ADVANCEMENTS
The future of this field is going to be promising and also be looked forward towards a huge industrious growth. Li-fi is going to replace the wireless fidelity in several areas. In the future autonomous driving may use the assistance of light through the front bulbs to produce internet connectivity to the car. The next application would be industrial IOT and automation at the factories. Not only to the applications mentioned, this is the future of internet connectivity and will replace other wireless alternative for an environmental friendly better tomorrow.

11. REFERENCES
[1] K. Latif Ullah "Visible light communication: Applications architecture standardization and research challenges" in Digital Communications and Networks Elsevier July 2016.
[2] O.D. Alao J.V Joshua A.S Franklyn O. Komolafe "Light Fidelity (LiFi): An Emerging Technology for The Future" IOSR Journal of Mobile Computing &amp; Application (IOSR-JMCA) vol. 3 no. 3 pp. 18-28 May.-Jun. 2016.
[3] S. Dimitrov H. Haas Principles of LED Light Communications: Towards Networked Li-Fi Cambridge U.K.:Cambridge Univ. Press Mar. 2015.
[4] H. Haas C. Chen "What is LiFi" Proc. 41st Eur. Conf. Opt. Commun. pp. 1-3 Sep. 2015.
[5] D. Tsonev S. Videv H. Haas "Light Fidelity (Li-Fi): Towards All-Optical Networking" SPIE 9007 Broadband Access Communication Technologies VIII 900702 2014.
[6] R. Sharma A. Sanganal S. Pati "Implementation of A Simple Li-Fi Based System" IJCAT - International Journal of Computing and Technology vol. 1 no. 9 October 2014.
[7] M. Noshad M. Brandt-Pearce Can Visible Light Communications Provide Gb/s Service? Harvard School of Engineering and Applied Sciences Cambridge Publication 2013.
[8] Jyoti Rani Prerna Chauhan Ritika Tripathi "Li-Fi (Light Fidelity)-The future technology In Wireless communication" International Journal of Applied Engineering Research vol. 7 no. 11 2012.
[9] Hongseok Shin S.-B. Park D.K. Jung Y.M. Lee Seoksu Song Jinwoo Park "VLC Transceiver Design for Short-Range Wireless Data Interfaces" International Conference on ICT Convergence 2011.
[10] H. L. Minh, D. OBrien, G. Faulkner, L. Zeng, K. Lee, D. Jung, and Y. Oh, “80 Mbit/s visible light communications using pre-equalized white LED,” 34th European Conference on Optical Communication (ECOC), 2008.