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BACHELOR OF SCIENCE IN ELECTRONIC AND TELECOMMUNICTAION ENGINEERING

An Implementation On Bidirectional Text Communication Using Visible Light Communication Based On LI-FI Technology

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DECLARATION

I hereby declare that this thesis/project is based on the results found by ourselves. Materials of work found by other researcher are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

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CERTIFICATE OF APPROVAL

The project report on **"An implementation on bidirectional text communication using visible light communication based on LI-FI technology"** Submitted by **Mohaimen Islam Khan (T-163015), Md Shakil Azam (T-163004)** in partial fulfillment of the requirements for achieving the Bachelor degree of Science in Electronic and Telecommunication Engineering (ETE) and accepted as to style and contents by:

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The Caption of this Project is **"An implementation on bidirectional text communication using visible light communication based on LI-FI technology"**. This Project is Submitted by **Mohaimen Islam Khan (T-163015), Md Shakil Azam (T-163004)** to the department of Electronic and Telecommunication Engineering (ETE) of International Islamic University Chittagong (IIUC). It is the requirement for partial fulfillment of the Bachelor's degree of Science in Electronic and Telecommunication Engineering (ETE). It was approved by our supervisor for the examination which was held on -----------------------------

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Candidate Declaration

It is hereby declared that this work has been done entirely by us, and no part of the work contained in this thesis/project has been submitted elsewhere for the achieving of any degree or diploma.

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Dedication

We want to dedicate our project work to all of our honorable teachers of ETE department. Specially, we want to dedicate our works to our supervisor sir. Because he encourages and guides us to complete our works properly. Then, we want to dedicate our project work to our parents. Because they support us to complete our bachelor’s degree.

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ABSTRACT

visible light communication technology instead of wireless technology is a new invention in modern era which is become more easier our daily life and communication process. This paper illustrates the mounting of the create of visible light communication technology which conducted light emitting diodes as a transceiver module and the flourish status at home and abroad analysis its system advantages, limitations, key technologies, characteristics and existing lacking, looks forward to future research trends, and introduces visible light communication for applaudable speed data sending, intelligent transportation for vehicle to vehicle communication. However, multi-user interference is exploited with the use of non-orthogonal multiple access (NOMA) figure on successive interference cancellation (SIC) but the problem arises of frequency spectrum of this method which is highly power attenuation and more expensive. In lifi of consecutive process use orthogonal multiple access (OMA) for interference avoidance. The high SNR was attached with high order quadrature amplitude modulation (QAM) and orthogonal frequency division multiplexing (OFDM) to maximize the bandwidth ability. The residual interference happening for imperfect SIC in real implementation is depicted with a balanced model. Also in this work, focus on low intensity proportionally high data transmission and minimize the SNR. The bit error rate (BER) performance of DC optical orthogonal frequency division multiplexing (DCO-OFDM) is depicted to be considerably uplifted once assail is employed.

Keywords: LI-FI, OFDM, NOMA, VLC and QAM

LIST OF ABBREVIATIONS

LI-FI	Light Fidelity
ALU	Arithmetic Logic Unit
NOMA	Non orthogonal multiple access
OFDMA	Orthogonal frequency division multiple access
LDR	Light dependent resistor
LED	Light-emitting diode
SNR	Signal-to-Noise Ratio
TX	Transmitter
RX	Receiver

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CHAPTER I

Introduction

1.1 Overview

The potential of side communication, also known as visible-radiation communication (VLC), has been eliminated by recent technological advancements in solid-state electrical and communication devices such as light-weight out-flowing diodes (LED) [2]. White LEDs will eventually replace traditional fluorescent lighting in homes and offices due to their advantages over that technology, including their longer lifespan, reduced energy usage, and reduced health risks. Due to its unique characteristics, VLC is dominant in RF-restricted environments like hospitals and airplanes [3]. VLC has a variety of uses, including underwater communications, road-to-transport communications, patient monitoring in hospitals, aircraft diverting, and site-primarily basic communications. The Institute of Electrical and Electronics Engineers (IEEE) has various standards that VLC adheres to [4]. An early analysis of apparent radiation contact was released by the Appear-able Radiation Communications consortium in Asia and Europe. Currently, the LIFI project study is being conducted by Japan, Finland, and the wire-free world analysis committee [5]. In this study, a transmitter and receiver circuit is intended for a proposed wire-free and RF-free system that would operate under the impact of nearby low-weight interference sources, such as an interior lamp and indirect illumination from a window next to the system [6]. Additionally, the work mentions portions that are illustrated separately. The anticipated indoor visible radiation communication system's system style is defined in Section II; Section III specifies the key experiments and their findings. The performance metrics, obstacles, and potential for future expansion of potency and distance are discussed in Section

IV's conclusion. [7]. The influence of an electrical car is discussed in this study, along with the need for wireless charging methods for electric automobiles. Figure 1 depicts the key components of a wireless power transmission system. A nation's power grid will grow more powerful thanks to the rapid advancement of LED technology, which will offer more cost-effective opportunities than the previous candle power technologies. [8]. Though it is true that it has an increasing influence in the modern day, the pace of leadership has changed considerably in people's eyes. Because of improved communication and the elimination of all limitations associated with point-to-point connections, the future is impossible to imagine. [9]. We are all familiar with photodiodes, whose fundamental role is to modulate an incoming signal and offer a better signal for further modulation while doing so extremely effectively. The overall design allowed for both power transmission and communication mediums to be used. Due to ignorance of this VLC in previous decades, LIFI analysis did not occur, but in the modern day, the majority of individuals are working on it. The key justification for this is that IEEE 802.15.7 offers approximately gigabit speed. [10]. It concentrates since we couldn't afford more wifi and LED. Only LEDs are capable of both types of data transmission and light removal. Furthermore, visibility is better than it was before luminary light. Second, the creators of the mobile or cell phone already understood how much easier it is to communicate and grow a business. They are figuring out ways to reduce costs as a result. Statistics also indicate that availability is decreasing daily as a result of the increased demand for every second. [11]. The data transport method for visible radiation is complex yet offers us exceptional efficiency. Another advantage is that no one has ever stolen this data since light can never pass-through walls and transmit signals like RF. Data should be protected against phasing and other dangers as a result. Additionally, channel interference is less of an issue because of the communication system's absence of wireless signals that can penetrate the channel's low signal transmission distance. Utilizing the VLC system, it is possible to give low-cost users a reliable system with robust data transmission infrastructure. because it lowers costs before demand increases as we want. [12]. The possibility of VLC, which has grown in popularity among users of broadband companies, extends to all prospects. By using more modern communication devices and more advanced technology, it benefits both the user and the consumer by making things more accessible. The VLC concept has already been effectively demonstrated by various companies and is suitable for flawless data transport. When compared to its cost, the quality is unmatched. This project's infrastructure is set up for gigabit data transfer and has its primary intelligence installed. Additionally, the intensity of the vehicle's LED makes it more effective for data transfer. If light is employed for data transport, a larger area may be covered by lifi technology, which will save energy and benefit everyone.

1.2 Problem Statement and Identification

Wireless communication technology may soon include research into visible light communication. When installing a VLC system, a number of factors need to be taken into consideration, including line of sight, supply and destination distances, and high rate. When designing a VLC system, these criteria are crucial. The associate degree enhanced rate VLC system's price and range are its two biggest implementation-related problems [13]. The transmitter and receiver must be compatible for premium VLC. It is extremely difficult and expensive to plan a high-rate transmitter and receiver. In this work, the relationship between information rate, delay unfold, and signal distortion is examined as well as a simulation model of a high-rate VLC system.[14]. Several different reflection techniques were considered for this investigation. Numerous components of visible radiation transmission were looked at from the literature review. Using LEDs as a source, the fundamental concept of a visible-light communication system appears to be the key to an incredibly wide range of applications. The other issues that were examined cover a wide range of subjects, including the difficulties and potential of VLC, visible radiation communication system modeling software, and abuse of video and audio transmission systems. the visible spectrum Lightweight coding and communication with the topic of victimhood Vehicle-to-Vehicle Communication and LED [15] In addition, a number of difficulties encountered in the field of VLC systems for various applications were examined. Several of them are:

i. High Data Rate
ii. Up-link Issue
iii. Regulatory Issues
iv. Line of sight
v. Range (distance between transmitter and receiver)
vi. Interference from sunlight

1.3 Motivation

In 2018, there will be more than 200 million communication devices accessible for network use, according to traffic study from Cisco, the world's largest manufacturer of communication equipment. [16]. Megabit users will switch to gigabit users as a result. Additionally, it will reach zettabyte, but the spectrum cannot support this type of user [1]. I also think that most people will utilize wireless and that cellphones will make up half of all communication devices. In that situation, statistics have presented us with a serious obstacle to progress. No matter how many devices are added, the spectrum remains unchanged. In such scenario, we must once more reassess how to handle the matter. Figure depicts that in 2013 the maximum frequency was used and that some frequencies were repeatedly utilised.. However, there is no opportunity to add new frequencies or increase the frequencies already present in the spectrum.

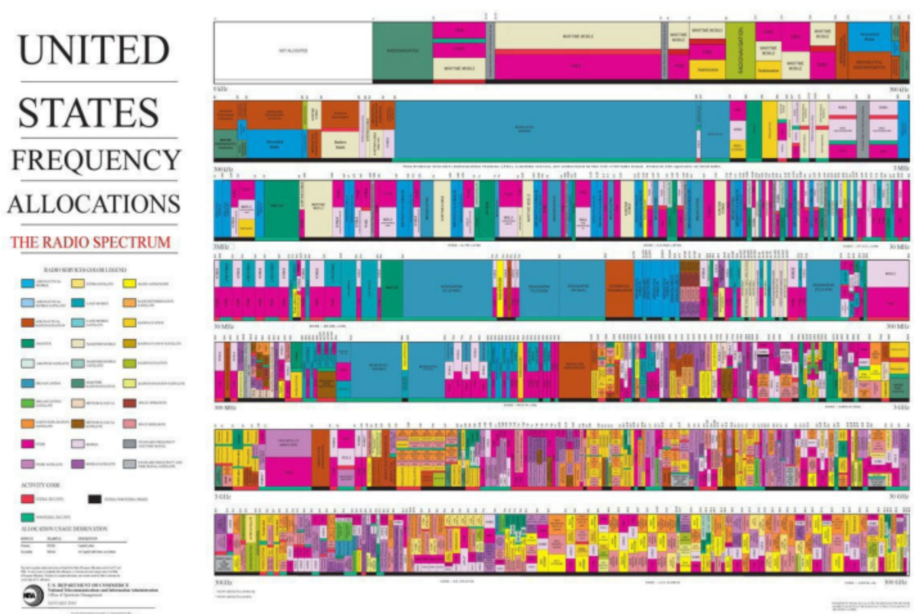

Figure 1.1: Allocation of frequency in US Chart 2016 a Radio Spectrum [1]

1.4 Assay question

This proposed model also answers the following questions:

a) What are the major challenges that have guided security in LI-FI?
b) Item What is the best attack detection way for LI-FI network model?
c) Is there any generalized approach for improving efficiency different environment?
d) What is the best way to reduce channel interference?

1.5 Objective

The goal of this research is to examine and comprehend the current VLC systems in order to look into ways to improve system performance in multiple access without disturbance. Another major difficulty is raising efficiency in low light. The specific objectives of this study should be stated:

a) Analyze LED frequency spectrum to improve low light efficiency.
b) Customize the LED frequency spectrum instead of laser light to improve visibility and avoid line of sight.
c) Extract features from the modern design where use NOMA instead of OFMA for improving multiple channel interference.
d) Design a transceiver circuit for high data transfer.
e) Strongly emphasize on cost minimization

1.6 Assumptions & Limitations

A centralized and effective model has been developed to boost LF-I efficiency, although it has drawbacks for which more research is needed:

i. Variation in outcome will show when source will be different like sunlight and others.

ii. Long distance transmission is not possible by using lifi technology.

iii. Visible light waves cannot penetrate walls.

iv. Lifi can't data transfer in dark.

v. No performance measure of used Classifier is evaluated here.

1.7 Research Outline

Most the things are not discussed yet which is given below: At **Chapter II** the parallel study on related work is given including explanations for the most important terms used in this thesis-basic concept and architecture of lifi technology and successful noise cancellation has been discussed through this chapter. **Chapter III** introduces different kind of parameter which is used on this project. **Chapter IV** explains the methodology with basic block diagram and logical circuit design. **Chapter V** discusses about the simulation and model performance, to analysis result of the model it describes the basic of li-fi technology and SNR through OFDMA. Lastly in **Chapter VI** future work and conclusion is mentioned.

CHAPTER II

Literature Review

2.1 Parallel Work

In the modern period, several models have been built for greater efficiency using LI-FI technology. Additionally, different teams place focus on different sources of media for more effective data transport. study on laser light, which is more effective for data transfer, from related studies. In such situation, efficiency was discovered to be high but various issues, such as line of sight, were raised. In place of QAM-OFDMA, NOMA technology is also explored. NOMA technology saw an improvement in channel capacity and a decrease in multiple access interference..

2.2 Non-Orthogonal Multiple Access

A significant transformation will occur in 5G, also known as fifth generation, employing NOMA technology. Additionally, the majority of businesses have made the decision to use NOMA in order to arrange radio access for improved multiple access. [16]. Technology is mostly used to improve multiple access without any SIC and decrease channel interference, for example, an interval [17][18]. Although it will offer efficiency, a variety of subcarriers, time intervals, and other benefits, the NOMA cost is high. In that situation, OFDMA is employed to achieve a cheap cost and high data rate. Despite providing a wealth of potential, the NOMA suffers from significant power attenuation that cannot be reduced and power loss, which is very unfavorable to any, telecommunication company. Most of company desire that power level has some threshold point but NOMA always exceed their point.[10]. Power allocation is not always same as previous but NOMA has no power to operate in triggered in low power as OFDMA can trigger very efficiently.[19]. OFDMA never sacrifice with power because it has some qualities like in low power it working well. But 5G generation some reputed companies' thing that it will not sustain and need to use OFDMA.

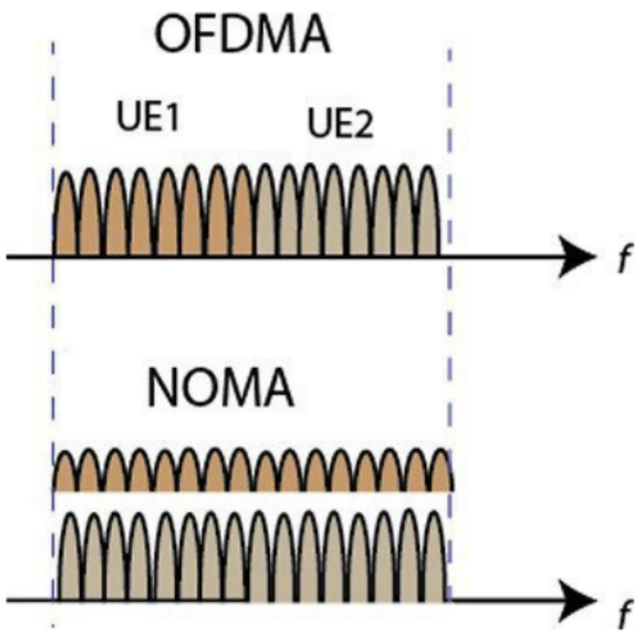

Figure 2.1: Spectrum depicting for (OFDMA) and (NOMA) simultaneously two users.

According to statistics, 5G operations require more power in order to operate well, although their major focus is on spectrum, which offers higher performance [20].

2.3 NOMA for downlink

NOMA mainly working between two parts as downlink work for good acceleration in client end service.[21]. NOMA used SIC for noise cancellation and which is built in with this signal equipment.[10]. IN mention figure 2.2 shows a base station and number channel tuner which performing receiving and transmitting signal [22]. Sometime figure may be drawn as signal of the network comes from base station and noise is can- celling at client end which totally wrong for NOMA user. The main problem is that signal allocation and from base station and divide wave form in right way. Because SIC is too much critical and more power consumer. For this reason, base station is closer to client location and SIC from base station is very easy to distribution.[23]. By this network, signal is received with main message for all user and provide means distribute to all transmitter as much as possible.[19]. Encryption and decryption are much more important during received and transmit signal. If SIC received some noise signal it continuous transmit this signal before another full message is received and transmit.[24]. Base station is established as near as client as line of sight and omni directional signal issue might be arises in that case.[25].

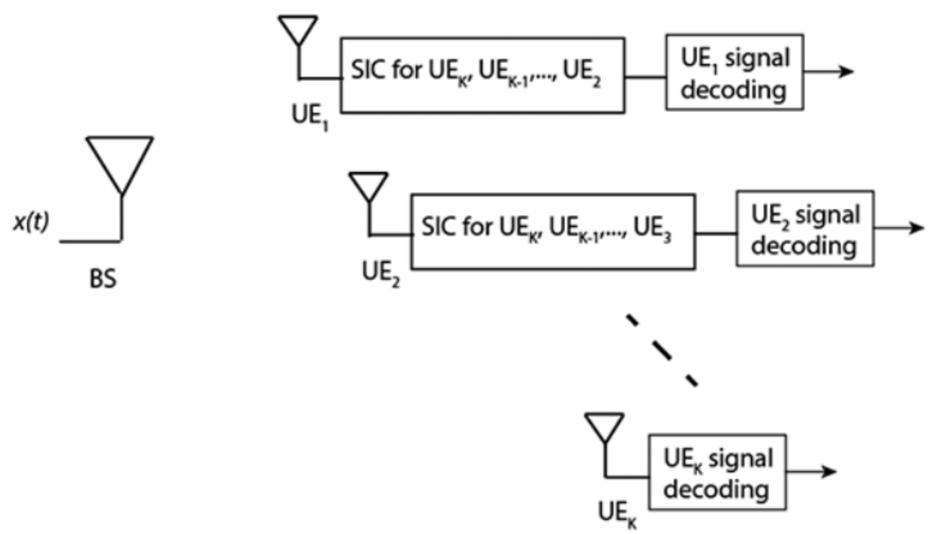

Figure 2.2: Block diagram of NOMA for n user

SIC mainly decode signal and encode to transmit which is written in equation:

$$m(g) = \sum_{p=1}^{P} \sqrt{\alpha_{\mathrm{p}}} P_{\mathrm{g}} x_{\mathrm{p}}(g) \tag{2.1}$$

where $x_p(g)$ is the individual information conveying OFDM waveform, α_p is the power allocation coefficient for the UE_p, and PT is the total available power at the BS [1]. The power allocated to each UE_p then becomes $P_p=\alpha_p P_T$. The power is allocated according to the distance of UE_s to the BS: UE_1 is the closest to the BS, so it is allocated the least power, whereas UE_k is the farthest one, therefore it has the highest power [26].

The received signal at the UE_p is

$$y_p(t) = m(t)g_k + w_p(t) \tag{2.2}$$

where g_k is the channel attenuation factor for the link between the BS and the UEk, and $w_p(t)$ is the additive white Gaussian noise at the UE_k with mean zero and density N_0(W/Hz) [3].

Consider the user who is the furthest away first. Since it is given the maximum strength in comparison to the other signals, its own signal will be the one it decodes first [20]. Other users will perceive the messages as interfering. The signal to noise ratio (SNR) for UE_p may be expressed as a result as [27]

$$SNR_{\mathrm{p}} = \frac{X_{\mathrm{p}} g^2{}_{\mathrm{p}}}{N_0 W + \sum_{t=1}^{P-1} P_{\mathrm{p}} g^2{}_{\mathrm{p}}} \tag{2.3}$$

where W is the transmission bandwidth. or the closest UE1, the last signal it decodes will be its signal [28].
Assuming perfect cancellation, the SNR for UE1 becomes

$$SNR_1 = \frac{P_1 {g^2}_1}{N_0 W} \tag{2.4}$$

In general, for the UE_k, the SNR becomes

$$SNR_k = \frac{P_k {g^2}_k}{N_0 W + \sum_{t=1}^{K-1} P_k {g^2}_k} \tag{2.5}$$

When NOMA is used, the throughput (bps) for each UE can be written as

$$R_k = W log_2 (1 + \frac{P_k {g^2}_k}{N + \sum_{t=1}^{K-1} P_k {g^2}_k}) \tag{2.6}$$

Contrarily, in OFDMA, UEs are assigned to a collection of subcarriers in order to get their data [29]. The throughput for each UE for OFDMA is equal to the total bandwidth and power shared by the UEs.

$$R_k = W log_2 (1 + \frac{P_k {g^2}_k}{N_k}) \tag{2.7}$$

Where W_k=— and Nk=NoWk. The sum capacity or both OFDMA and NOMA can be written as

$$R_t = \sum_{k=1}^{K} R_k \tag{2.8}$$

We further define fairness index as [4]

$$F = \frac{(\sum R_k)^2}{K \sum {R^2}_k} \tag{2.9}$$

This shows how fairly the system capacity is distributed across the UEs; specifically, when F approaches 1, the capacity of each UE approaches that of the other [30]. For NOMA systems, we may define the power allocation mechanism's goal as maximizing the sum capacity RT under a fairness constraint [31]. Next, the optimization issue is stated as

$$\begin{gathered} maximize \\ \alpha_k W log_2\Big(1 + \frac{P_k {g^2}_k}{N + \sum_{t=1}^{K-1} P_k {g^2}_k}\Big) \end{gathered}$$

where F' is the target fairness index in the network. The power allocation coefficients αk for each UEk can be obtained with exhaustive search [32].

2.4 NOMA for uplink

The way NOMA is implemented uplink differs somewhat from downlink. Figure 4 shows a network that use NOMA to multiplex K UEs in the uplink. This time, BS makes advantage of SIC to separate the user signals. The uplink received the received

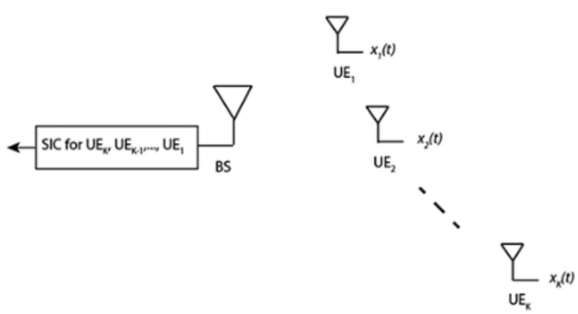

Figure 2.3: Up-link NOMA for K users. signal by the BS that includes all the user signals is written as

$$y_k(n) = \sum_{m=1}^{M} x(n) j_k + w_k(n) \tag{2.10}$$

where gk is the channel attenuation gain for the link between the BS and the UEk, xk(t) is the information waveform for the kth UE, and w(t) is the additive white

BS-level Gaussian noise with mean zero and density N0 (W/Hz) [31]. The UEs may once again optimize their transmit strengths in the uplink based on their locations as in the downlink. However, in this case, we presume that users are evenly dispersed within the cell coverage and that received power levels from various users are already clearly distinct. From a practical standpoint, this assumption makes more sense because power optimization calls on connections between all UEs, which might be challenging to assemble [1]. The receiver's BS puts SIC into practice. The signal from the closest user will be the first signal it decodes. The signal's SNR for the UE1 may be expressed as, with additional signals as interference:

$$R_1 = \frac{Pg^2{}_1}{N + \sum_{t=1}^{K-1} Pg^2{}_1} \tag{2.11}$$

where N=N0W and P are the UEs' transmission powers. The signal for the furthest user, UEK, is the final signal that the BS decodes [31]. The SNR for UEK can be as high as, assuming complete cancelling

$$SNR_K = \frac{Pg^2{}_K}{N} \tag{2.12}$$

Generally, for the kth UE, the SNR becomes,

$$SNR_m = \frac{Pg^2{}_m}{N + \sum_{t=m+1}^{M} Pg^2{}_t} \tag{2.13}$$

The throughput (psb) for each UE can be written as

$$R_k = W log_2(1 + \frac{P_k g^2_k}{N + \sum_{i=1}^{K-1} P_k g^2_k}) \quad (2.14)$$

n OFDMA, on the other hand, UEs are allocated orthogonal carriers in order to receive their information. When the total bandwidth and power are shared among the UEs equally, the throughput for each UE for OFDMA becomes

$$R_k = W_k log_2(1 + \frac{P_k g^2_k}{N_k}) \quad (2.15)$$

– and $N_k = N_o W_k$. The Sumi capacity for both OFDMA and NOMA can Be written as

$$R_T = \sum_{k=1}^{K} R_K \quad (2.16)$$

where _ is cancellation error term that represents the remaining portion of the cancelled Message signal [31]. In the previous section, the third term in the denominator is not included since perfect cancellation is assumed there [31].

2.4.1 Defectiveness in NOMA

We have been assuming complete cancellation in the SIC receiver in our talks thus far in the preceding sections [31]. In practice, it is quite challenging to accurately remove the decoded information from the received signal. We review the NOMA idea with cancellation mistakes in the SIC receiver in this part [1]. We just take into account the downlink here, but the subject may be readily expanded to include the uplink [31]. Remember that the SIC receiver repeatedly decodes each information signal one at a time until it finds the target signal. In SIC, one must recreate the original individual waveform after decoding the signal in order to remove it from the received signal. Although ideally this process might be finished without any mistakes, it is anticipated that there would be occasional cancellation mistakes in practice. [31].

In downlink, the SNR for the kth user with cancellation error is written as [5]

$$SNR_k = \frac{P_k {g^2}_k}{N_0 W + \sum_{t=1}^{K-1} P_k {g^2}_k + \epsilon + \sum_{t=k+1}^{K} P_k {g^2}_k} \tag{2.17}$$

where the remaining text from the cancelled message signal [31] is represented by the cancellation error word, t. The third term in the denominator is left out of the preceding section since complete cancellation is expected there [31].

2.5 Spectral and energy efficiency

The network's throughput performance was taken into account in the majority of analyses thus far. In this part, we investigate the energy efficiency (EE) of NOMA systems in addition to the spectrum efficiency (SE) of NOMA systems [31]. We include both the power used for the information waveform and the network's static power usage as a result of the power amplifiers in our study [31].

The sum of the power used by the circuits (mostly power amplifiers) and the power used by the information signal may be used to indicate the total power used at the transmitter [31]. Taking into account the downlink, the overall power used by the BS may be expressed as

$$M_{\text{total}} = M_{\text{t}} + M_{\text{static}} \tag{2.18}$$

where Pt is the previously indicated total signal power and MP static is the circuitry's power consumption [31]. Energy efficiency (EE) is defined as the rate over the base-total station's used power [6].

(2.19)

$$EE = \frac{R_t}{M_{\text{total}}} = SE\frac{W}{M_{\text{total}}}(bit/joule)$$

where SE is the spectral efficiency (RT/W) in terms of bps/Hz [?]

Since the power consumption of the circuit is not taken into account by the energy efficiency and spectral efficiency connection (EE-SE) in Shannon theory, it is monotonic, with a higher SE always translating into a lower EE [31]. The EE changes in the low SE area and decreases in the high SE zone when the circuit power is taken into account. The system is most energy efficient near the peak of the curve (or the equivalent derivative of the EE-SE connection). Green Location is the name given to this point [6–8]. The EE-SE connection is linear for a fixed Mtotal and has a positive slope of RT/Mtotal, where a rise in SE causes an increase in EE at the same time. As we show in the next section, Compared to OFDMA, NOMA offers greater energy efficiency.

2.6 Research Gap

When examining related studies in this subject, it can be seen that some extremely costly and short-range technologies is utilized. First of all, no centralized detection technique is given; instead, each layer has its own unique detection method. However, because LI-FI is evolving into a heterogeneous network, a centralized model should be suggested in the controller in order to manage the traffic of each network segment. Second, while noise cancellation using NOMA is fairly simple, multiple access is a difficulty. Thirdly, there is no special low light efficiency design. Fourthly, there is still no concrete design for an omni-directional system that avoids lines of sight for the aforementioned issue.

CHAPTER III

Background Technology

3.1 Hardware Requirement

The reduction of noise and increased channel interference is the major goal of this endeavor. There are several items utilized in this work that are fully described below.

3.2 Analog to Digital Converter

Receiving analog signals and converting them to digital is the basic function of analog to digital signals [21]. Diode is one type of ADC since it transforms signals or electricity into

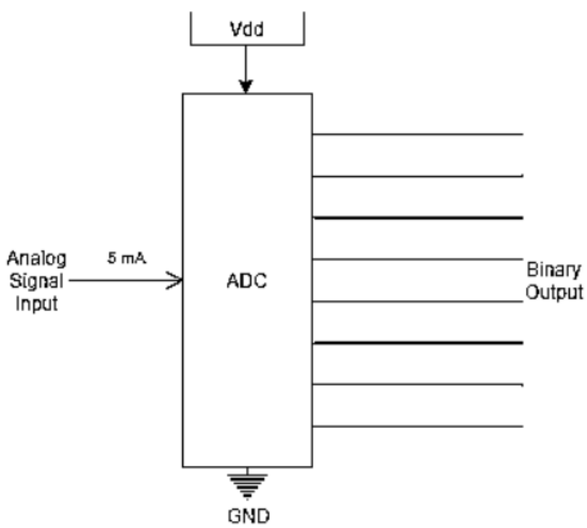

Figure 3.1: Analog to Digital converter

After reaching its threshold voltage, a diode triggers and produces voltage. The analog to digital converter would then just accept the signal and convert it to bit [3].

The fundamental function of a digital signal is to receive a signal and convert it to an analog signal. When a digital signal, such as a bit, is received, it changes into an analog signal, or phrase signal. [4]. Because of their features, certain common diodes in electronics are used primarily to transform analog data to digital. Additionally, it could not be required [5].

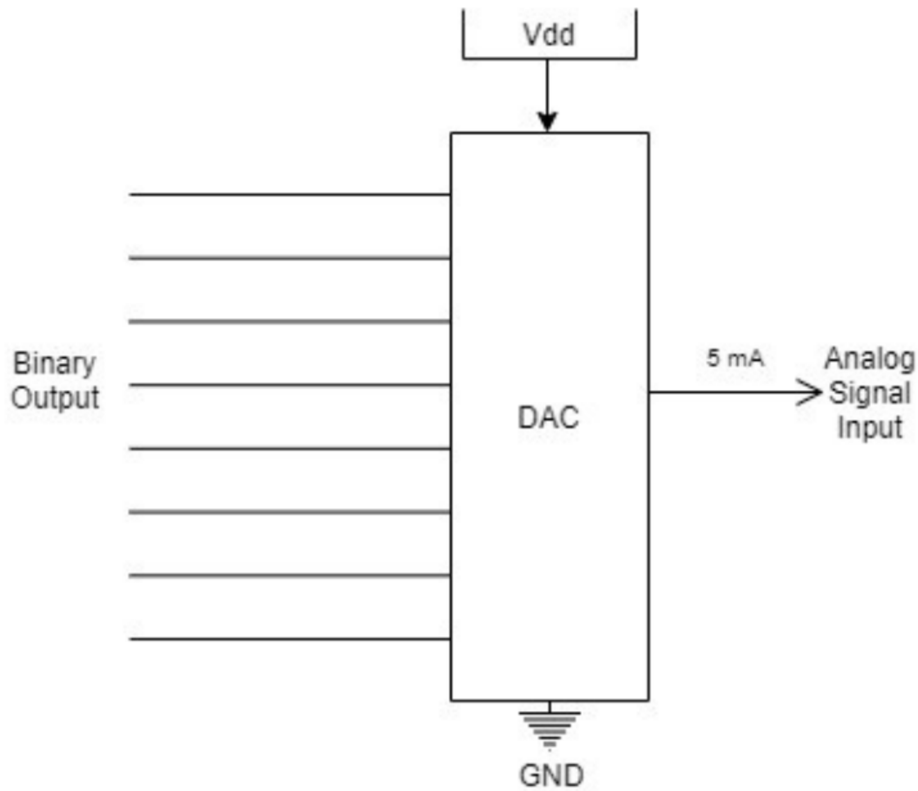

Figure 3.2: Digital to Analog converter

3.3 Micro-controller

The microcontroller primarily works in a variety of ways. It is made up of several components that each perform a distinct function and provide output [13]. In that scenario, a microcontroller is employed in this project since the board has an integrated ADC and DAC. Additionally, a bit converter for character display can be found in this circuit. electrical component is

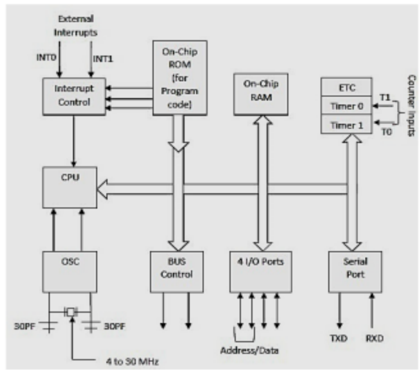

Figure 3.3: ALU of Micro controller

Also, dc voltage can be provided from this circuit, and it has another function that is easily stopped by using a timer. [3][13].

3.4 Light Emitting Diode

The major uses of LEDs are their versatility and low power consumption. LEDs require two different sorts of bits, such as 0 and 1. Depending on its size and kind, LEDs come in a range of colors and have different wave lengths. However, light is focused and darkness is dispelled using the same platform shared by all LEDs. However, inventors in the coming period are probably going to utilize LEDs for data transport. Led data transfers are already successful for the majority of businesses. [5]. Every lead can

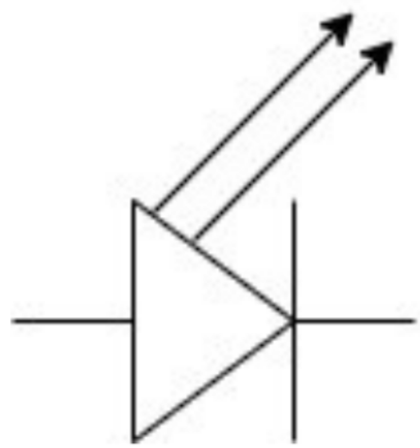

Figure 3.4: Light emitting diode of LI-FI

not be used for data transmission because of their wavelength. In table discuss about some led for better understand [16][17].

Table 3.1: Characters tics of Various LEDs

Types	Necessity	Outcome	Lacking
luminosity	10	> 10000	$< 1000 mcd$
Speed	2	$> 1 MHz$	$< 100 KHz$
Price (Unit Cost)	10	5 Taka	10 Taka
Type of Color	3		

When chose led it's very difficult to choose right one because all characteristics almost similar. Some comparisons are mention below.

Table 3.2: Comparison of LED

Number Of parts	YSL-R542G5CA14	09855-04	LW514
Brightness	10000 - 13000 mcd	200 mcd	35000 mcd
Viewing Angle	10^0	Unlisted	15^0
Frequency Supported	>1 MHz	Unlisted	>1MHz
Price	>30	25	>5
Color	Pure Green	Green Plastic	White
Max Current	20 mA Peak: 30mA	20 mA	350mA Peak:100mA

3.4.1 LED Driver

LED drivers are typically employed in driver circuits to direct or correct power [14]. Some lead drivers on a lifi project work in this way. main power rectifier for LED drivers

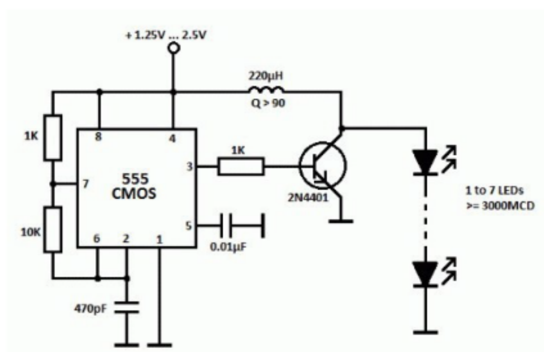

Figure 3.5: Light emitting diode Driver

utilized to simultaneously boost the lead driver's stability and modify the power. Led drivers, on the other hand, may be switched from one state to another [6].

3.5 Photo detector

The primary function of a photo diode is to convert various light impulses into electrical signals.

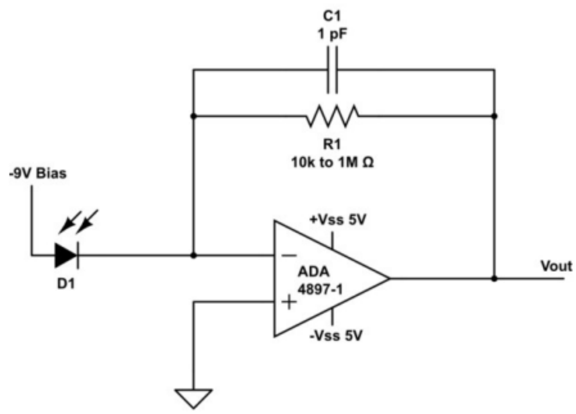

Figure 3.6: Photo detector

3.6 Operation Amplifier

The primary function of an OP-AMP in a VLC circuit is to regenerate power signals and enhance signals after indicating that a specific voltage is needed to activate an OP-AMP [31].

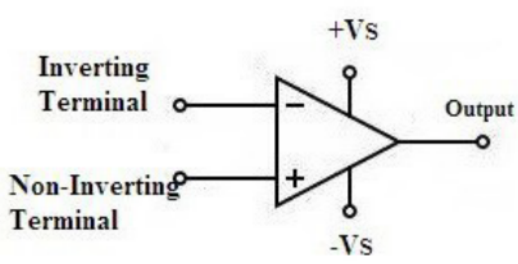

Figure 3.7: Basic diagram of OP-AMP

3.7 Transistor

To lessen the strain on the MCU driver, transistors are mostly employed to provide external power to leds. A transistor produces 3.3 volts, which is mostly used to activate the LEDs' route. In this method,

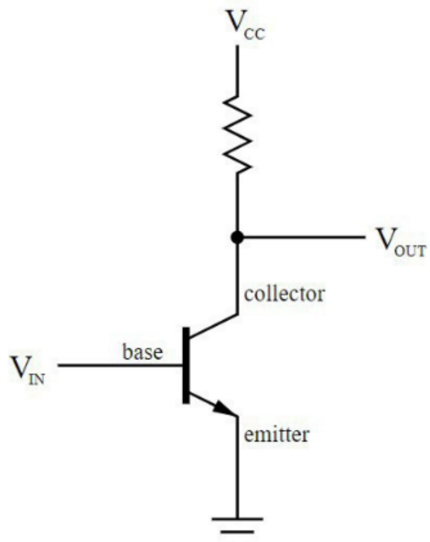

Figure 3.8: Basic diagram of Transistor

The LEDs would get more power and current than the MCU was capable of providing. As a result, LEDs could get brighter and have a wider broadcast range. The electrical transistor would turn on if it detects a logic high, or 3.3V signal, at the bottom, allowing current to flow from the external power source to the LEDs to ground [43]. The transistor junction electronic transistor electronic transistor semiconductor device—semiconductor unit semiconductor would be controlled by the MCU, and the electronic transistor would activate whenever it received a logic high, or 3.3V signal, at the bottom. Once it was off, no current would flow.

3.8 Light Dependent Resistor

A device whose resistance might be a function of the incident nonparticulate radiation could be a light dependent electrical device (LDR) or a picture electrical device [1]. They are therefore small, delicate devices. They are also referred to as photocells, image conductors, and picture conductive cells. They are made of highly resistant semi-conductor materials [31]. There are numerous different symbols used to denote an LDR; one of the more used ones is seen in the figure below. The arrow denotes a piece of light material falling on that [11].

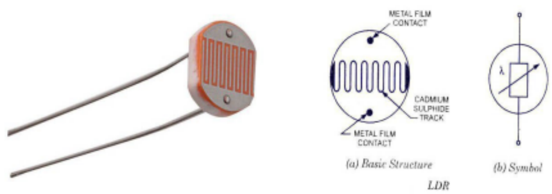

Figure 3.9: Basic Structure of L

3.9 Power supply

A power source is a device that supplies electricity to another device's electrical load [3]. An impact supply's initial function is to transform current from

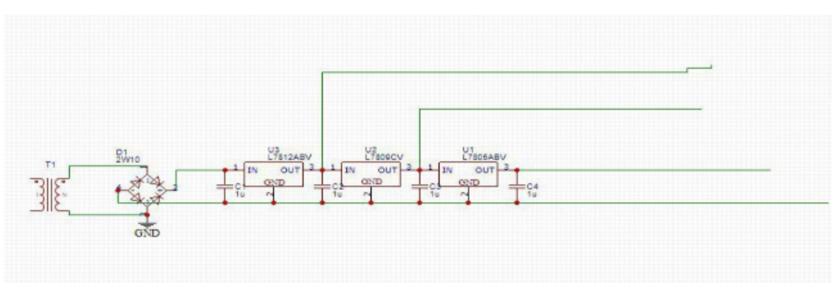

Figure 3.10: Basic Structure of power supply.

a supply with the appropriate frequency, voltage, and current to power the load [5]. Power sources are hence frequently referred to as electrical power converters. While some power supplies are independent, stand-alone pieces of equipment, others are built into the load appliances they power. Power supplies seen in desktop computers and consumer natural philosophy gadgets serve as examples of the latter [7].The load's current can be limited to safe levels, the load can be switched off in the event of an electrical fault, power can be acquired to block electronic noise or voltage surges from the input from reaching the load, power-factor correction can be performed, and energy can be stored so the load can continue to be powered in the event of a brief interruption in the power supply (uninterruptible power supply) [9].

All power sources include at least one power output connection that transmits current to the load and at least one influence input connection that receives energy in the form of electrical phenomena from a source [10]. An electrical power system outlet, a battery or fuel cell, a generator or alternator, a converter for alternative energy, or another power source [12] might serve as the supply's energy source. The input and output are often linked via hardwired circuits, despite the fact that some power suppliers elect to power their populations wirelessly rather than through cable connections. Some electricity still generates a variety of inputs and outputs for things like external monitoring and management [6].

CHAPTER IV

System Model

4.1 Design Approach

A sophisticated communication system carries out transmission by encoding the information to be transferred into a set of symbols that are appropriate for transmission. For instance, the data may be understood as a lengthy string of logical ones and zeroes, and the transmission would be carried out by alternately turning on and off the LED to suitably communicate a 1 and a 0. However, the information must be provided in the way described in the next section in order to establish reliable and efficient communication. This section describes the hardware and software that the VLC driver use to deliver packets.

4.2 Basic design of LI-FI Technology

Diagram of the visible light communication system. The OFDM signal processing unit converts data bits into OFDM symbols, which are then filtered to create the OFDM signals needed by each semiconductor diode cluster. Each line driver dips current into the associated group of serially linked LEDs. However, there is just one semiconductor diode for power transmission and reception indicated in this picture. The case of three semiconductor diode teams, each with four free-floating data-carrying subcarriers, for a total of twelve free-floating data-carrying subcarriers within the original OFDM signal, is illustrated, along with the OFDM image structures of the initial OFDM signal and the filtered OFDM signals. In order to synchronize and boost efficiency in low light, variable resistor was employed in this instance. As demonstrated in figure 4.1 below, when a resistor is tuned, efficiency rises but intensity falls in a manner that is reversely proportional.

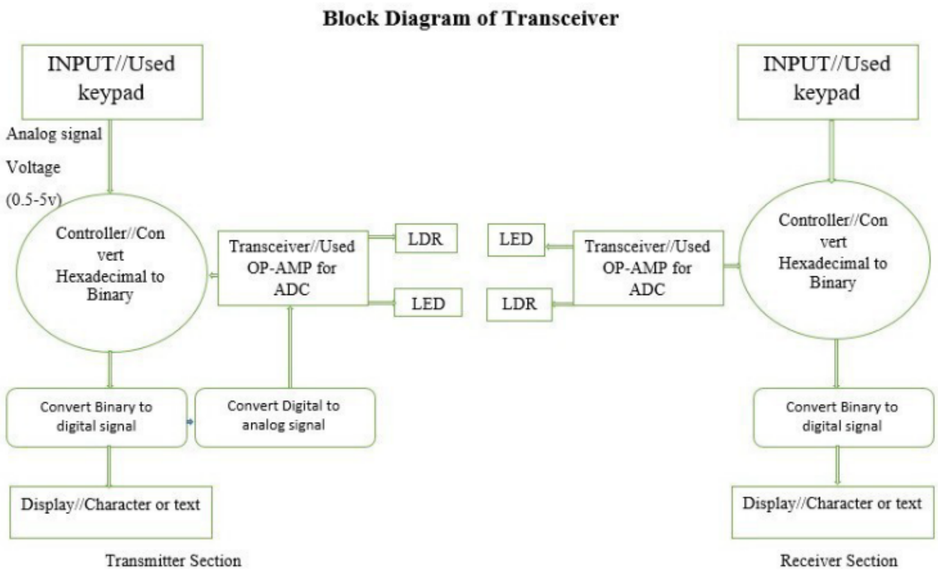

Figure 4.1: Block diagram for LI-FI technology

4.3 Transmitter section

The transmitter is configured to wait for data after initialization. A preamble is provided before data is sent to synchronize the receiver before transmission may begin. The length of the packet and the sequence number come next. The data is then transferred after the checksum. In the final condition, shown in figure 4.2, the transmitter is awaiting a confirmation mention from the receiver side. The transmitter side returns to wait for data if the transmission was successful; else, the packet is retransmitted. The key issue on the transmitter side that has to be resolved for effective data transfer is listed below:

i. Using reasonable price LED which is provide good efficiency and intensity.

ii. Delay response in low intensity is optimized.

iii. Voltage found in the distance between 12cm is properly whereas powerful failure in previous case.

iv. Rectifying receiving signal by OP-AMP which reduced attenuation.

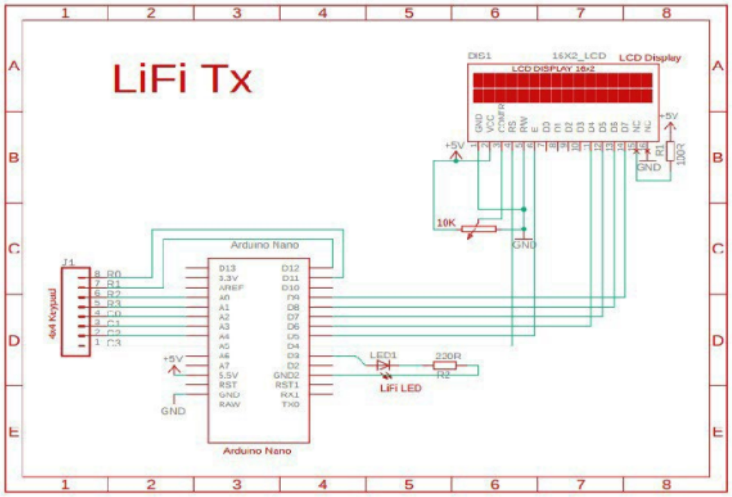

Figure 4.2: Circuit design of TX.

4.4 Receiver section

Until the preamble is detected, the receiver is on standby. The data transmission starts after the sequence number and data length are read, as indicated in figure 4.3, and subsequently the CRC. The transmitter side receives a confirmation signal from the receiving side if the broadcast was successful.

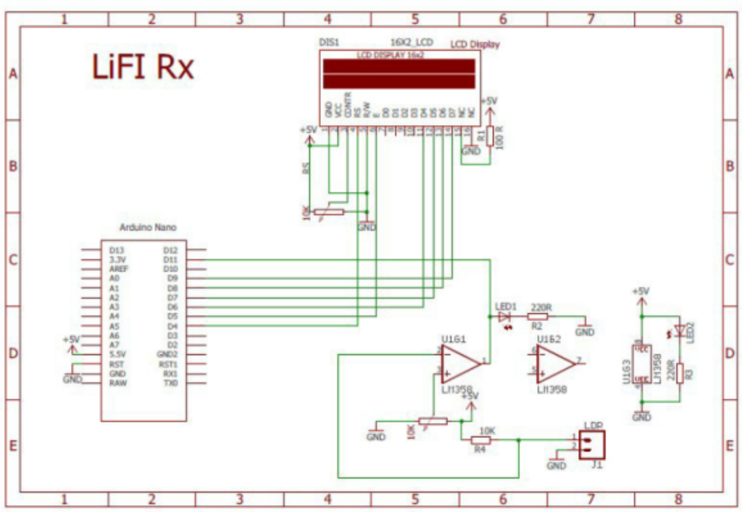

Figure 4.3: Circuit design of RX

4.5 Implementation of Framework

The VLC driver must be considered in all phases of the software implementation because it is implemented as a Linux network module. By means of the VLC driver,

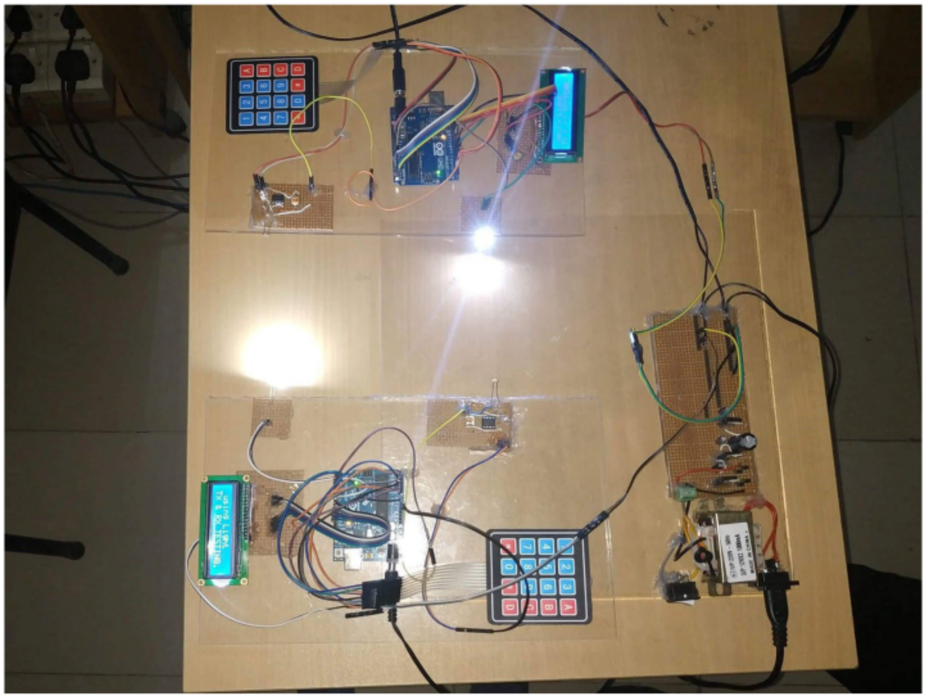

Figure 4.4: Circuit diagram of transceiver

It is to be considered in all components of the software system implementation illustrated in figure 4.4 as a UNIX operating system network module. The decision to use it in this approach was made because it enables any program running on a laptop with a UNIX operating system to transfer information through light. This frequently occurs because the VLC driver can smoothly connect with the UNIX operating system kernel and may be shown as a network card within the OS, which greatly improves the implementation. Additionally, address resolution and transport protocols can be handled by the current TCP/IP protocol suite. The negative is there some flexibility lost? Since the UNIX operating system modules' standards must be followed, some practicality must be abandoned. However, in transmitter side,

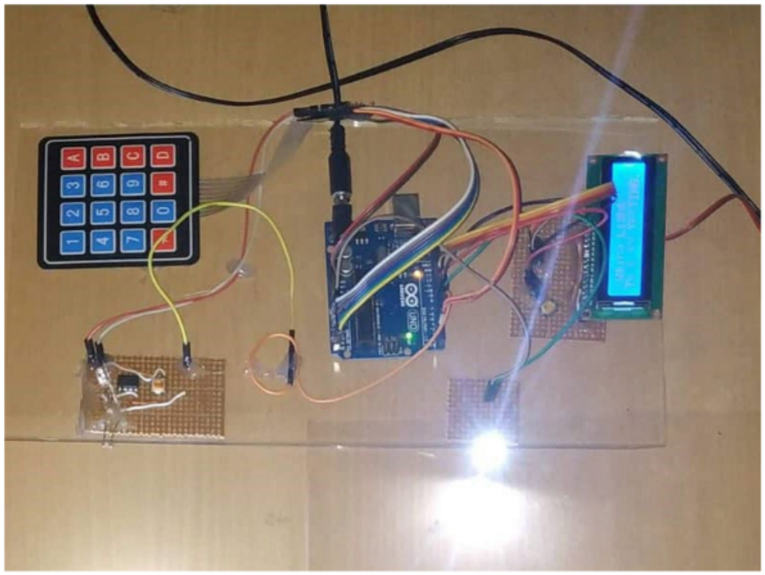

Figure 4.5: Circuit diagram of transmitter

in **receiver** side,

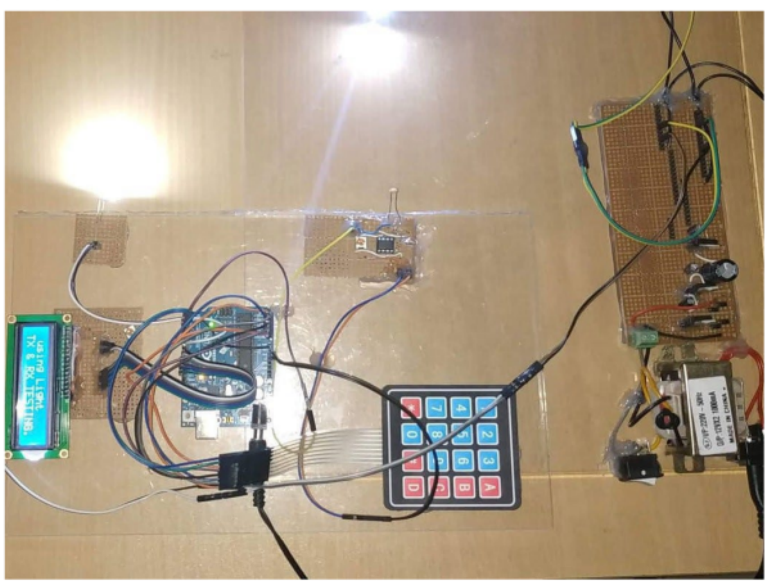

Figure 4.7: schematics design of Transceiver

4.6 Design verification

Tests were run to confirm the planning and determine if the desired attributes were obtained. These studies were mostly conducted using electrical apparatus and a running generator. Causation square waves via the systems made it easy to examine circuit components and see how the signal travels through the components. The complete system, including the transmitter and receiver, was used for the final style verification, as seen in figure 4.7.

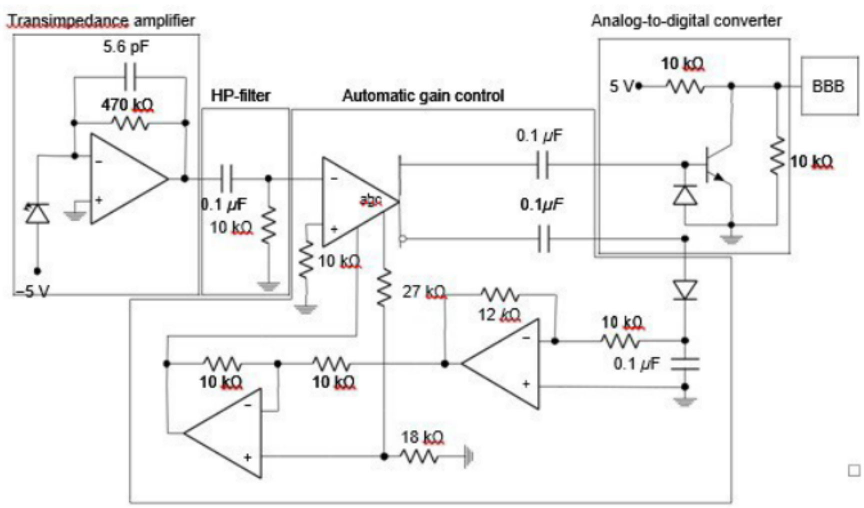

Figure 4.7: schematics design of Transceiver

CHAPTER V

Implementation and Performance Analysis

5.1 Analog Results

Finally, a clear signal from the transmitter was received after careful preparation and receiver testing, as seen in the image below. All analog findings were recorded during testing under standard close indoor light circumstances, with the transmitter and receiver placed one foot away. At one inch and one foot, there was barely any difference in the output of the receiver electrical equipment.

5.1.2 Distance VS Time:

Distance vs time graph shows that when distance increased time is proportional. But after mentioning distance like 1 feet or 13cm rapidly fall due to lack of power. It’s mainly proved that data speed is constant before drop power.

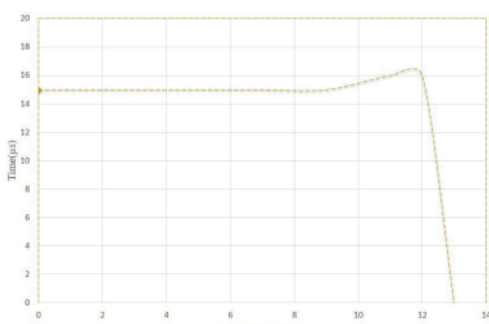

Figure 5.1: Distance VS Time

5.1.2 Distance VS Output:

Distance vs output graph shows that when distance increased output remains same. After certain period of later it also fallen down.

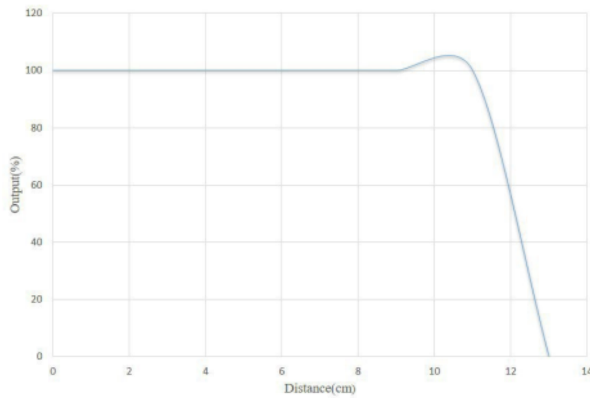

Figure 5.2: Distance VS Output

5.1.2 Distance VS Current:

Distance vs current graph shows that when distance increased current also increased. After certain period of later it also fallen down.

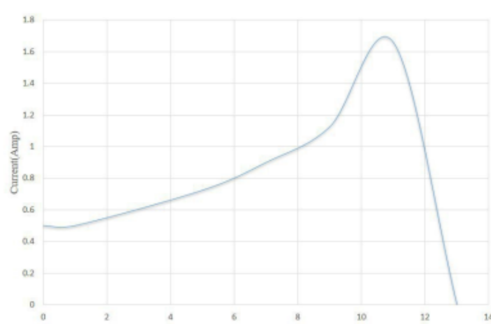

Figure 5.3: Distance VS Current

5.1.2 Distance VS Voltage:

Distance vs Voltage graph shows that when distance increased voltage is proportional. But after mentioning distance like 1 feet or 13cm rapidly fall due to lack of power.

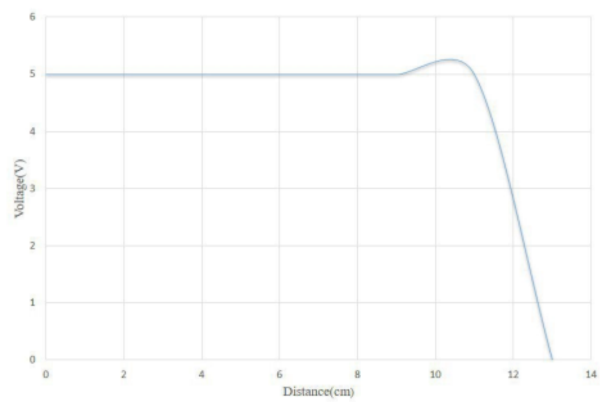

Figure 5.4: Distance VS Voltage

5.1.2 Distance VS Resistor:

Distance vs resistor graph shows that when distance increased resistor decreased.

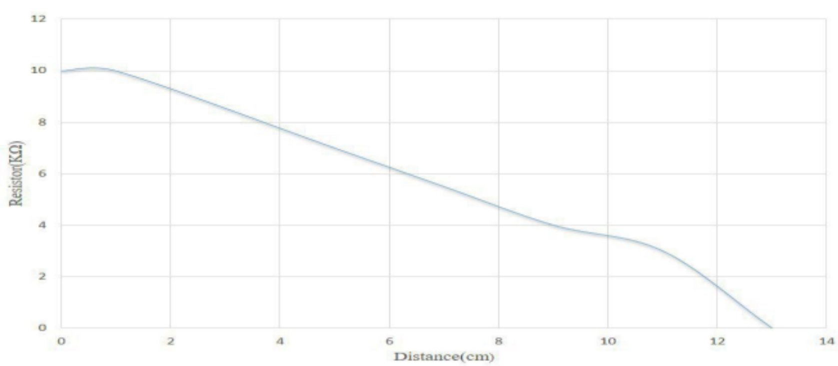

Figure 5.5: Distance VS Resistor

5.2 Digital Results

Two different types of digital tests were conducted using the same test setup as the analog test. The initial examinations were conducted using a brief text message with a preamble.

Transmitting Text

A hard coded message of "123456789" on the transmitter end of the MCU was used for some preliminary testing. Utilizing a dial pad on both the sending and receiving sides, the results are as follows:

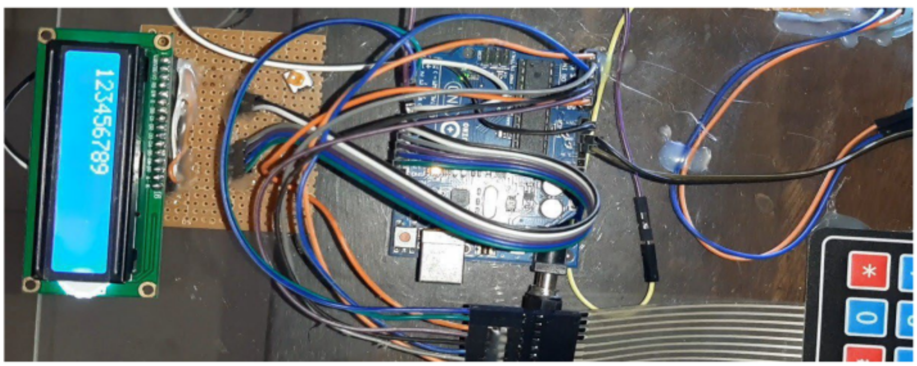

Figure 5.6: Transmitting text

5.2.1 Simulating Output:

Li-Fi is frequently referred to as a light-based kind of Wi-Fi. In other words, data is sent through lightweight means rather than radio waves. Li-Fi uses transceiver-equipped diode lights that can lightweight a space while also transmitting and receiving data in place of Wi-Fi modems.

5.3 Cost Analysis

In the system, the transmitter/receiver microcontroller is undoubtedly one of the most significant bottlenecks. A rapid digital board will get around this by digitally processing the input and delivering accurate results, but analog electrical equipment may create quite a deal of noise and be difficult to tune effectively.

Table 5.1: Output of VLC

	LI-FI
Speed	1-2Gbps
Range	13cm
Spectrum Range	1000 time then WI-FI
Network Topology	Point to point
Data transfer Medium	Use light as a carrier

The boards that are at different points in the value range for the system we would want to produce are less effective than the ideal configuration. We typically identified the MCU's primary demands and assigned them a weight before evaluating the board to be used. However, the roles of the transmitter and receiver are completely different, and as a result, their standards diverge.

5.3.1 Transmitter

The transmitter has a couple of key roles:

i. Convert data from 1s and 0s to a logic high and logic low voltage
ii. Control switching of the LED array

In order to best satisfy these purposes, we identified what aspects of a microcontroller we would be most interested in, and assigned them numerical weights. The ranking was organized in the Table:

Table 5.2: Required data Selection for TX

Types	Necessity	Expectation	Unexpectation
Noise	1	As many different types of I/O ports as possible	Very limited or not having USB, the very least
Expense	2	Less than 20 Taka	More than 30 Taka
Clock Pulse Rate	3	> 5 MHz	< 1 MHz

5.3.2 Receiver

Based on its goal, the recipient has a completely different set of requirements: The rankings below were developed based on the fact that the demands made on the receiver encompass a wider range of needs and are significantly more intense than those placed on the transmitter.

Table 5.3: Required data Selection for RX

Types	Necessity	Expectation	Unexpectation
Noise	1	As many different types of I/O ports as possible	Very limited or not having USB, the very least
Expense	2	Less than 20 Taka	More than 30 Taka
Clock Pulse rate	3	> 5 MHz	< 1 MHz

CHAPTER VI

Outcome & Future Outline

6.1 Conclusion

In this study, we tend to talk about the drawbacks of multiuser access and the diminished power of low-light LiFi networks. Using constant time and frequency resources, our systems allow OFDMA with power domain multiplexing to send multi-stream information to numerous users. Due to incomplete interference cancellation in realistic scenarios, a balanced model is used to identify the main interference. Results reveal that single LEDs deliver high power and high potency as compared to bulbs, which increases the equivalent SINR and, as a result, raises the overall output of LiFi networks. These findings show that LiFi technology, which we have already demonstrated in our study, may be a potential option when it is widely adopted. They also ensure that LiFi work is much more suitable for next gigabit wireless networks. Furthermore, value is diminished at the binding level, where it is simpler for low-hierarchical people to obtain it.

6.2 Aspects

In addition to its many other applications, Li-Fi technology is important for information transmission through LEDs, so all screens that emit light will serve as platforms for digital communication. The portable television's screen will serve as a source of sunlight. On the other hand, a portable camera will take the place of the receiving platform's exposure detector for scanning and knowledge retrieval. Other apps are available for it. desktop Wi-Fi and smart cards Li-fi, Li-fi for hospitals, Li-fi in cities, practical guides, museums, hotels, fairs, indoor events, and LBS (location-based services), access control and identification crises, landing fields, and hazardous areas like thermal power plants Additionally, it doesn't cause magnetic interference and is useful in environments where magnetism is sensitive, such as aircraft cabins, hospitals, and nuclear power plants. Because it couldn't be adjusted very efficiently with incandescent or fluorescent light sources, it is not feasible to use them. As a result, the digital information was conveyed in an efficient way with minimal complications using junction rectifier bulbs. The intended result was achieved. Both the space's lighting and the text message transfer went off without a hitch. The transmission gap is affected by the bulb's brightness. By incorporating a related concept into smart phones, this work will be increased even further. It will be possible to transmit any files to the nearby devices by creating a humanoid program to control the junction rectifier flash light used for cameras. The same hardware that is used for flashing may also be utilized for extremely fast information transfer. LEDs are ubiquitous, incoherent, and incredibly easy to adjust. A shockingly low rate of modulation will be used for the junction rectifier. These gadgets are just intended for illumination, not communication. You don't have to think that synchronizing carriers, phases, or anything else works.

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