HIGH SPEED PARALLEL DATA TRANSFER USING LIFI

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in Electronics and Telecommunication Engineering

by

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(DEEMED TO BE UNIVERSITY)
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of V.Krithika (Reg. No.: 37250011), Isha Singh (Reg. No.: 37250006) who carried out the project entitled "**HIGH SPEED PARALLEL DATA TRANSMISSION USING LIFI"** under my supervision from November 2020 to April 2021.

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I, V.Krithika (Reg No. 37250011), Isha Singh (Reg No. 37250006) hereby declare that the Project Report entitled "**HIGH SPEED PARALLEL DATA TRANSFER USING LIFI"** done by us under the guidance of Dr. M.S GODWIN PREMI is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Telecommunication Engineering.

Date:

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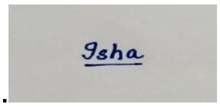
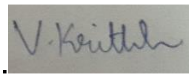
SIGNATURE OF THE CANDIDATE

1. 

2. 

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ABSTRACT

In recent years, there is a rapid development in the solid-state light-emitting diode (LED) materials which gave way for the next generation data communication known as visible light communication. VLC has a promising future and it acts as a complement to the present RF communication by achieving larger bandwidth and high data rate.

At present, the day-to-day activities use lot of LED based lights for illumination, which can also be used for communication because of the advantages like fast switching, high power efficiency and safe to human vision. Hence, this project presents about eco-friendly data communication bi- directionally through visible light which consists of the white LEDs that transmit image, audio and Video signals to the receiver. The receiver circuit consists of Light detector connected with the amplifier and Laptop to recover back the amplified version of original input signal.

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LIST OF SYMBOLS AND ABBREVIATIONS

$	-	Dollar
Mm	-	Milli meter
nm	-	Nano meter
MHz	-	Mega Hertz
KHz	-	Kilo hertz
THz	-	Tera hertz
VLC	-	Visible light communication
AES	-	Advanced encryption standard
BER	-	Bit error rate
CAGR	-	Compound annual growth rate
DD	-	Direct detection
FCC	-	Federal communications commission
GBPS	-	Giga byte per second
GHz	-	Giga hertz
IM	-	Intensity modulation
LAN	-	Local area network
LIFI	-	Light fidelity
LED	-	Light emitting diode
OOK	-	On off keying
RF	-	Radio frequency
TDD	-	Time division duplex
PSU	-	Power supply unit
WIFI	-	Wireless fidelity
WEP	-	Wired equivalent privacy
WPA	-	Wifi protected access
MBPS	-	Megabyte per second

CHAPTER 1

INTRODUCTION

1.1 VISIBLE LIGHT COMMUNICATION

Visible light communication is nothing but it is optical wireless communication system which is used for its dual role nature. In wifi we used medium as a radio frequency wave but in VLC we will use medium as light which is used for both communication as well as illumination. The light used in VLC is light emitting diode instead of fluorescent lamp which is used for both communication as well as illumination. By using this LED light, we can transmit the data at a very high speed. LED has many properties such as energy efficient, low cost, high brightness and long-life period. Hence, the conventional lightings such as incandescent lamps and fluorescent lamps are replaced by the LEDs in VLC. VLC offer secure communication when compare to the wireless fidelity. It can offer secure communication between the rooms because it can be easily blocked by the walls. These days LEDs are used in many places such as indoor and outdoor lightning, traffic lights and automobiles. On and off of transient time of LED is too short which offers high data rate transmission in VLC. LIFI is faster and cheaper version of WIFI because it can transmit the data at a very high speed. In this project we will demonstrate the transfer of video and image data using LED light where the ON and OFF transient time of LED is very small. RF based communication signals are very congested so in this system bandwidth of signals are less but in VLC it provides large bandwidth spectrum 380nm to 750nm.

Today, RF communication is mature, while a Bluetooth module provides the speed of 1mbps and its cost around $5. VLC module can transmit the data at 50mbps and its cost around $1.7. Therefore, the total cost is even less. LED (light emitting diode) is a semiconductor device which is highly efficient device that use at least 75% less energy and it is 25 times longer than incandescent lighting. In previous communication, light was used to transfer message using method like fire and smoke signals. To carry out long distance signal, the roman used polished metallic plates for sunlight reflection.

The idea of using light as a communication medium was implemented by Alexander Graham Bell in 1880, with his invention of the photo phone. It is a device that transmit a voice signal on a beam of light. Bell focused on sunlight with a mirror and then states a mechanism that vibrated the mirror. The vibrating beam was picked up by using the photo detector at the receiving end and it is decoded back into the voice signal, the same procedure in which the phone works with electrical signals. But Bell could not generate a useful carrier frequency, nor was he able to transmit the light beam from point to point.

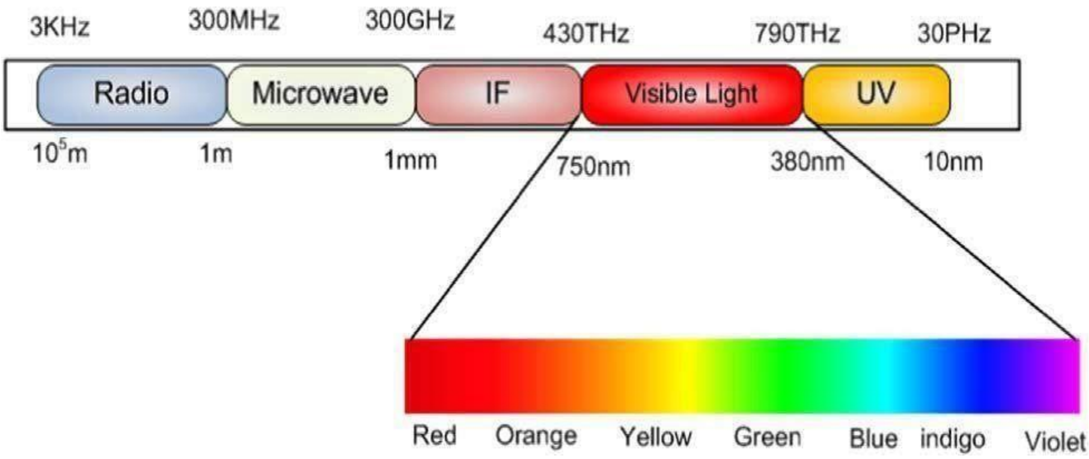


Fig.1.1. Visible light spectrum

1.2 FEATURES OF VLC

LI-FI offers a number of key benefits over Wi-Fi but is a complementary technology.

- **Bandwidth:** The visible light spectrum is 10,000 more than RF spectrum, unlicensed.
- **Data density:** Li-Fi can achieve about 1000 times the data density of Wi-Fi because the visible light can be well contained in a tight illumination area but RF tends to spread out and cause interference.
- **High speed:** Due to low Interference, high device bandwidths and high intensity optical inputs, very high data rates can be achieved.
- **Planning:** Capacity planning is simple since there tends to be illumination infrastructure where people wish to communicate, and good signal strength can be seen.

- **Low cost:** Lifi requires only fewer components than radio technology.
- **Energy:** The data transmission requires negligible additional power as LED Illumination is already efficient.
- **Environment:** Lifi works well in water but RF transmission and propagation in water is extremely difficult.
- **Safe:** Life on earth has evolved through exposure to visible light or the Sun. There are no known safety or health concerns for this technology Li-Fi.
- **Non-hazardous:** The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments.
- **Control:** Data may be directed from one device to another and the user can see where the data is going; there is no need for additional security such as pairing for RF interconnections such as Bluetooth.

1.3 CHARACTERISTICS OF VLC

There are various advantages to use the visible light communication as follows;

- Visible light is very safe for human. The data can be transmitted by the visible light communication even through a high voltage of home/office lighting.
- The lightings are set everywhere. The data wireless transmission system can be easily established through the visible light communication device attached to the lightings. On the other hand, the radio wireless communications have the following several problems and effects although they are widely in use of cell phones and wireless LAN.
- The electric transmission power cannot be increased because it has a bad effect on human body.
- Due to the radio wave restriction, there is no room to use more radio frequencies in industries and hospitals.
- The radio wave cannot be used in hospitals and space stations. Due to this bad effect of their precision instruments/devices, these radio wave problems above are easily solved by use of the visible light communications.

Table 1.1 Characteristics of VLC over RF communication

Property		VLC	RF
Bandwidth		Unlimited, 400nm~700nm	Regulatory, BW Limited
EMI		No	High
Line of Sight		Yes	No
Standard		Beginning (IG-VLC)	Matured
Hazard		No	Yes
Mobile To Mobile	Visibility (Security)	Yes	No
	Power Consumption	Relatively low	Medium
	Distance	Short	Medium
Infra to Mobile	Visibility (Security)	Yes	No
	Infra	LED Illumination	Access Point
	Mobility	Limited	Yes
	Coverage	Narrow	Wide

1.4 COMPARISION BETWEEN LIFI AND WIFI

LIFI gives the data transfer rate up to 10Gbps which is greater than the WIFI which has a data transfer rate 800Kbps to 11Mbps.The range of LIFI depend upon the light emitting diode whereas the range of WIFI is almost 100m. The data cannot penetrate through wall in the case of LIFI but in WIFI the data can be transmitted through walls.

Table1.2 Comparison between VLC and RF communication

LIFI	WIFI
1. Range of lifi depends upon LED light.	The range of Wifi is 100m.
2. Data transfer rate of LIFI is greater than 1GBPS.	Data transfer rate of Wifi is 800kbps to 11 Mbps.
3. Power consumption is low.	Power consumption is medium.
4. It is a high secure medium.	It is a low secure medium.
5. The medium used in Li-Fi as a carrier is LED light.	Whereas the medium used in Wi-Fi is radio spectrum.
6. Cheaper than Wi-Fi because free band does not need license and it uses light spectrum.	Expensive when compare to the Li-Fi because it uses radio spectrum.

1.5 WORKING OF VLC

In VLC, the part which is used for communication purposes is the visible part of the spectrum. The visible light spectrum is unlimited and 10,000 times larger than the range of radio frequencies between 0 Hz to 30 GHz as shown in Figure 1.1. In VLC, the LEDs source are used as transmitters; the air is the transmission medium, and the sensitive avalanche photodiode (APD) or intrinsic negative (PIN) are used for receivers. VLC may facilitate the low energy-per-bit required for data transmission in comparison to RF systems. The visible light spectrum extends from 380 nm to 780 nm in wavelength. The VLC spectrum creates no electromagnetic interference to RF systems and vice versa. VLC systems may also be envisioned to build hybrid radio-optical communication systems for higher throughput, better coverage, and higher energy efficiency in future heterogeneous networks solutions. VLC technology provided with LED devices which is characterized by high area spectral efficiency, high security, unlicensed wide bandwidth and dual-use nature. For example, Fig. 1.1 shows how VLC can reuse spectrum efficiently in a small area. Case a), shows a wifi channel in which three users share a 30Mb/s bandwidth, compared to Case b), a VLC enabled environment, in which three users utilize individual 10Mb/s VLC channels.

Although the total band width allocated to the three users are the same in two cases, the outcome aggregated throughput of Case b) could be better than that of Case a), due to the contention effect on RF channel as we will see later.

The basic idea of the VLC is to add an information data into the light intensity changes and detecting the changes on the receiver side which is called as intensity modulated/ direct detected (IM/DD) method. The used modulation frequency is usually very much higher than that of the human eye can detect and therefore it does not cause noticeable altering in the lighting system. Both the baseband signals and pass band modulation schemes can be used with the VLC. Interest of wireless visible light communication (VLC) has increased rapidly with development and utilization of light emitting diode (LED) technology. LED provides a very high modulation bandwidth for communication purposes simultaneously with an energy efficient illumination. While the radio spectrum is limited, but the demand for wireless data transmission keeps increasing and will be increasing tremendously in future. For new kinds of wireless communication systems, we need to press the switch. Recently, visible light communication (VLC) has been proposed as an i.e., wireless communication. The dual use VLC with commercial lighting equipment used for both lighting and communications is the type of the VLC studied in this work. Li-Fi is a Visible Light Communications (VLC) system for data transmission. We can compare a VLC source to light emitting diode (LED) or a fluorescent lamp. Since a robust Li-Fi system requires extremely high rates of light output, LED bulbs are most ideal to implement it for Li-Fi.

LED is a semiconductor light source, as its light bulbs can amplify light intensity and switch rapidly. Therefore, LED cells can modulate thousands of signals with the range above human eye can ever notice. In turn, the changes in light intensity from the LED light source are converted as electrical current by the receiving photodiode device. Once the electronic signal is demodulated at the receiver end, it is converted into a continuous stream of binary data comprising of audio, video, web, and application information to be consumed by any Internet enabled device.

1.6 APPLICATIONS

- **Smart Lighting:** Any private or public lighting including street lamps can be used to provide Li-Fi hotspots and the same communications and sensor infrastructure can be used to monitor and control lighting and data.
- **Mobile Connectivity:** We can interconnect Laptops, smart phones, tablets and other mobile devices directly using Li-Fi. The short-range links provides very high data rates and also provides a lot security.
- **Hospital & Healthcare:** Li-Fi emits no electromagnetic interference and so does not interfere with medical instruments, nor it is interfered with by MRI scanners.
- **Aviation:** Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins in which LED lights are already deployed. In-flight entertainment (IFE) systems can also be supported and integrated with passengers own mobile devices.
- **Underwater Communications:** Due to strong signal absorption in water, RF is impractical to use. Acoustic waves have very low bandwidth and it disturbs the living marine life. Li-Fi provides a solution for short- range communications.
- **Vehicles & Transportation:** LED headlights and taillights are being introduced. Street lamps and traffic signals are also moving to Light Emitting Diode (LED). This can be used for vehicle-to-vehicle and vehicle-to-roadside communications. This can be applied for road safety and traffic management.

CHAPTER 2

LITERATURE SURVEY

SCOPE OF THE PROJECT

2.1 MOTIVATION FACTOR

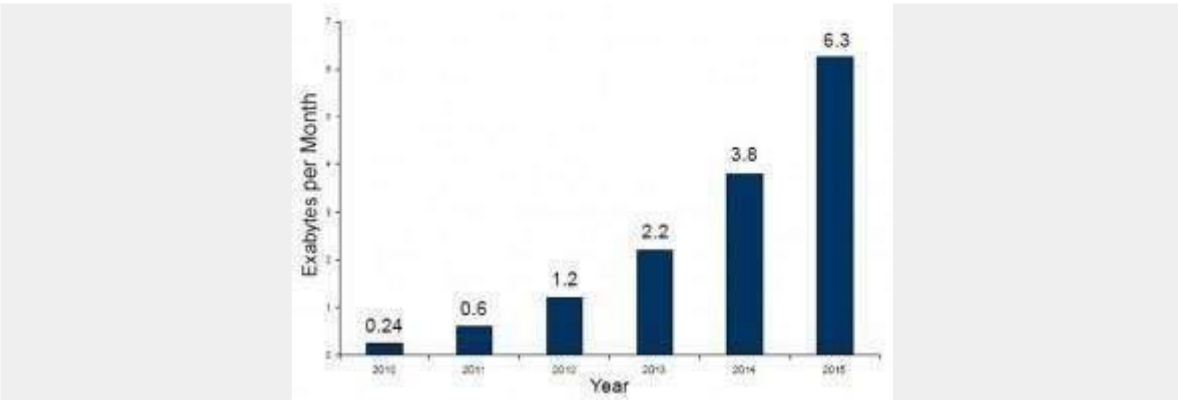


Fig. 2.1. Global Mobile Data Usage Taken per Month on an Average

The compound annual growth rate (CAGR) of mobile data usage per month for the next four years is estimated to be around 80% as can be determined from Figure 2.1. Assuming no extra additional radio frequency spectrum, this would mean that gains on spectrum efficiency have to be increased in the same manner through new technology, but it has been reported that the spectrum efficiency gains of cellular systems are slowing. In fact, they are saturating, as can be seen from Figure 2.2. One solution to the emerging problem is the release of additional radio frequency spectrum for mobile communications, but unfortunately most of spectrum of interest (in the 1 GHz – 10 GHz region) is already in use, and identifying new radio frequency spectrum to keep up with exploding wireless data demand is impossible.

Fig. 2.2. Spectral Efficiency Gains are Slowing

As a result of the problem I have highlighted, the Federal Communications Commission (FCC) has issued warning and has been speaking about a “looming spectrum crises”. This warning is underpinned by the recent report of GBI research in which they have shown a significant gap between required network capacity and the predicted available capacity. This gap is shown in Figure 2.3 where the forecast traffic per device is shown as well as the forecast available network traffic per device. If the expected trends prove to be true, we will see a shortfall of network capacity of about 97% in the year 2014. A spectrum crisis would be unavoidable.

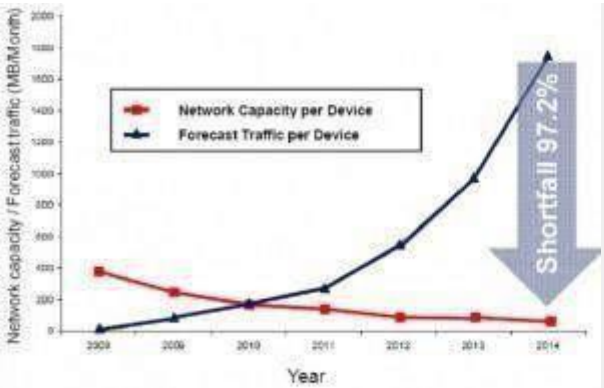


Fig. 2.3. Capacity per Device and Forecast Traffic per Device for a 3G Operator

I believe that it is the right time now to develop radically new solutions for future, post-LTE wireless networks. The approach taken is to consider an entirely different part of the electromagnetic spectrum – the infrared and visible light spectrum – that is largely unused for communication and more than 10,000 larger than the entire microwave spectrum.

2.2 OBJECTIVES

The objectives of Visible Light Communications Consortium is used to research, develop, plan, standardize the communication system which is a high speed and human safe ubiquitous system using LED through the home/office lightings, traffic signals, electronic advertising board, small lamps on home appliances, etc. The visible light communication is transmitted by its intensity modulation. The main aim of the project is to transfer the data from one device to another in a fast and an efficient way and hence providing a better security option.

2.3 LITERATURE SURVEY

K. Samarakoon, et al., (2010) has proposed the ability of smart meters to control domestic demand during system emergencies was investigated. Direct load control through the smart meters is unlikely to be able to provide primary frequency response because of communication delays. An alternative load control scheme that used a local frequency measurement from the smart meters was investigated. An experimental rig was developed, using commercially available components, to test and demonstrate the load control scheme.

E Piseketal, (2012) has proposed new optical/electrical front-end and baseband systems that achieve the required bit rate of 1 Gbps over free space. They also detail the implementation challenges of the low power VLC communication system for a mobile device. Specifically, they focus on the new VLC baseband system and propose new baseband scheme with state-of-the-art LDPC channel coder. Finally, they will present the results of the new proposed gigabit baseband system as well as lab results front-end running at 540 Mbps and 1080 Mbps.

J.E. Kim, etal., (2012) has proposed that, the recent trend of ubiquitous access to embedded physical devices over the Internet as well as increasing penetration of wireless protocols such as ZigBee has raised attention to smart homes. These systems consist of sensors, devices and smart appliances that can be monitored and controlled remotely by human users and cloud services. However, the lack of a de-facto communication standard for smart homes creates a barrier against the interoperability of devices from different vendors.

J. Tsang, etal., (2012) experimentally demonstrate a bi-directional transmission link using light emitting diode (LED) visible light communication (VLC) for both downlink and uplink paths. Time-division- duplex (TDD) is proposed and demonstrated to significantly eliminate the reflection interference in VLC. A free space bi-directional transmission of 2 m using simple on-off keying (OOK) modulation with bit error rate (BER) of < 10(-5) in both directions are achieved.

A. Jovicic, et al., (2013) describe high data rate downlink communication in homes and offices and high accuracy indoor positioning in retail stores are two of the most compelling use cases of this promising new technology. Large-scale commercialization of visible light communication devices will depend on both the development of robust and efficient engineering solutions, and the execution of incremental commercialization strategies.

Ciprian G., et al., (2014) describes the implementation of a prototype visible light communications system based on the IEEE 802.15.7 standard using low-cost Commercial off-the-shelf analog devices. The aim of this article is to show that this standard provides a framework that could promote the introduction of applications into the market. Thus, these specifications could be further developed, reducing the gap between the industry and research communities. The implemented prototype makes use of software defined radio platforms to interface between the analog devices and the computer where the signal processing is performed. The use of this concept provides the system with enough flexibility and modularity to include new features in the prototype without requiring long development time.

Ozgur Ergul, et al., (2014*)* have proposed the available radio-frequency (RF) bandwidth will not be sufficient to meet the increasing demand for wireless access. Visible light communication (VLC) is an alternative method to reduce the burden of RF-based communication and light emitting diode (LED) arrays are spreading for illumination purposes thanks to their low energy and higher lifetime. VLC can be realized as a secondary application in LED arrays that are placed for lighting. In this way, some of the wireless traffic can be sent using light, with less cost and less carbon footprint. We provide an extensive survey of the current literature by outlining challenges and future research areas in order to facilitate future research in this area.

Latif Ullah Khan, (2016), in this paper, The Radio Frequency (RF) communication suffers from interference and high latency issues. Along with this, RF communication requires a separate setup for transmission and reception of RF waves. Over- coming the above limitations, Visible Light Communication (VLC) is a preferred communication technique because of its high band width and immunity to interference from electromagnetic sources. The revolution in the field of solid- state lighting leads to the replacement of florescent lamps by Light Emitting Diodes (LEDs) which further motivates the usage of VLC. This paper presents a survey of the potential applications.

2.4 EXISTING SYSTEM

The existing system uses RF based communication, so the interference of signals and noise of the signal is high. Power consumption of existing system is high compared to proposed system. Installation cost and environmental hazards are high in this system because radio frequencies are used for communication. In existing system, users are using RF technology for transmission of data and are transmitted only to a short range. More data loss occurs because of the phenomenon called interference. Power loss is much higher as the system got heated up while communicating via radio waves. So, the chance of getting the destruction of the system is high due to prolonged use. We transmit wireless data through radio waves which are limited. Radio waves are scarce and expensive and we only have a certain range of it. With the advent of the generation technology as of like of 2.5G, 3G, 4G and so on we are running out of spectrum. There are 1.4 million cellular radio base stations which consume massive amount of energy. Most of this energy is not used for transmission but for cooling down the base stations. Efficiency of such a base station is only 5% and that raise a very big problem. Availability of radio waves or RF signals causes another concern as we have to switch off our mobiles in aero planes, it is not advisable to use mobiles at places like petrochemical plants, hospitals, defense areas and petrol pumps. Radio wave penetrates through walls and they can be intercepted. If someone has a knowledge and bad intentions than he may misuse it.

2.5 COMPARISON OF TECHNOLOGIES

Table 2.1 Comparison between LiFi and other technologies

Technology	**Connection**	**Security**	**Reach**	**Impact**	**Cost**	**Bandwidth Expansion**
Wi-Fi	Wireless-EMF	Good	Excellent	Unknown	Good	Limited
Hardwired	Cables	Excellent	Fair	None	Good	Limited
Li-Fi	Wireless-Light	Excellent	Excellent	None	Low	Exceptional

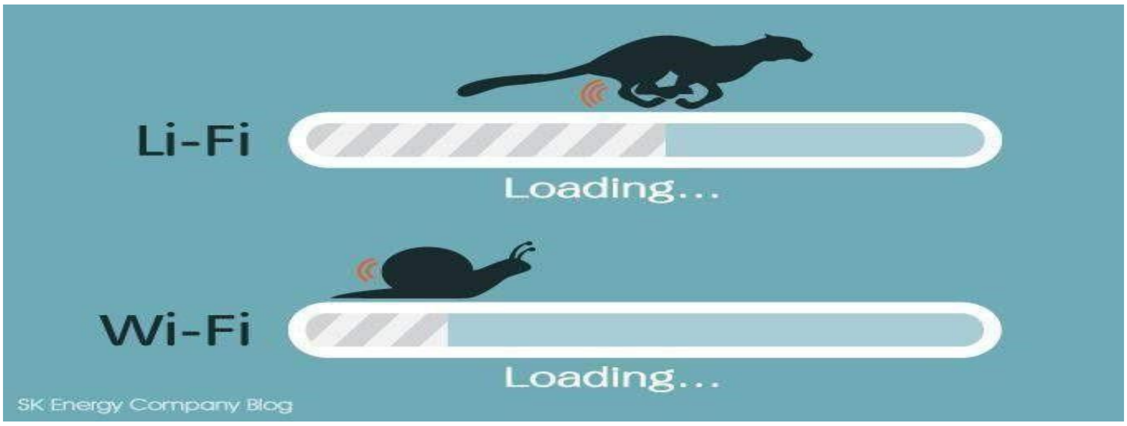


Fig. 2.4. Comparisons between LIFI and WIFI

2.6 LIMITATIONS OF EXISTING SYSTEM

- Uncontrolled radiation of RF affects pre-adolescent children, pregnant women, elderly humans, patients with pace makers, small birds, flora and fauna, small insects etc.
- The areas near RF cellular towers have been observed with more lightening compare to other areas.
- It also affects some of the fruits grown near the RF tower areas.
- It can be easily intruded by the hackers and crucial personal/official data can be decoded for malicious motives. In order to avoid it, RF is used with highly secured algorithms such as AES, WEP, and WPA etc.
- RF signal can also be modulated either using frequency hopping or spread spectrum techniques to avoid this kind of eavesdropping. Spectrum of RF communication is very congested. So, noise and interference are more in existing system.

2.7 CONTRIBUTION

Communicating in areas where there is risk of explosions can be a problem (e.g.in mines, petro-chemical plants, oil rigs etc.). VLC is inherently safe and provides both safe illumination and communications. Many cars already LED lamps. Traffic signal, traffic lights, and street lamps are adopting the LED technology so there are massive applications opportunities here. The ability to send data quickly and in a secure way is the key to many applications. The fact that the visible light cannot be detected on the other side of a wall had great security advantages. There are advantages for using VLC in hospitals and in healthcare. Mobile phones and Wi-Fi's are undesirable in certain parts of hospitals, especially around MRI scanners and in operating theatres.

Wi-Fi's have got faster over but cannot keep up with demand for wireless data. VLC can provide data rates greatly in excess of current Wi-Fi and this can be done at low cost since the RF components and antenna system have been eliminated. RF does not work underwater but visible light can support high speed data transmission over short distances in this environment. This could enable divers and underwater vehicles to talk to each other.

CHAPTER 3

PROJECT OVERVIEW

3.1 PROPOSED SYSTEM

The proposed system can be used in situations where a household has many appliances with audio output such as TV, PC, Hi-fi radio and phone systems. It consists of transmitter, free space channel and the receiver. In the receiver side, Photodiode is used, which is used to target light easier. As the efficiency of multi crystalline solar panel is 10%, the output voltage achieved from the solar panel is less. Still an eco-friendly audio VLC is implemented with photodiode receiver and other power supplies. Thus, installation cost and environmental hazards are less in this proposed system. We are using LIFI technology to transfer image clips and video data. It has long range when compare to the WIFI. Light fidelity also consumes less power when we compare to the WIFI. No data loss occurs in LIFI. We are transmitting sensor data, video data and sound to a particular channel of the voice board using sound.

Sensor that recorded voice is being transferred via LIFI. Here, light is being emitted through stimulated emission and radiation. We propose LIFI transmission of 10 meters range.

The audio system in visible light communication includes the transmitter, free space channel and the receiver. The fundamental property of the VLC is to produce the receiver output signal as identical as the input signal transmitted. The experimentation is done in the laboratory and the circuit characteristics are analyzed. The basic circuit uses the high brightness LED in the transmitter side. Based on the amplitude of the audio signal being transmitted from laptop, the light from the LED will get modulated. The receiver consists of the Photodiode to detect the optical signal transmitted through the free space channel and the final output is received and heard through the Laptop. Thus, the electrical audio signals are converted as intensity modulated light pulses through LED as optical signal output from the transmitter. The same is propagated through the free space and received by a Photodiode receiver system. The electrical signals are produced when the blinking LED light hits the Photodiode. The signal detected from the photodiode is of few micro watts only. Hence the further amplification is done using power amplifier and the signals are fed to the Laptop. The proposed system employs line of sight (LOS) point to point link to eliminate multipath propagation and to achieve more data rate when compared to non- directed diffused systems. The operation and installation cost are less in Visible light communication system.

3.2 Overall Block Diagram:

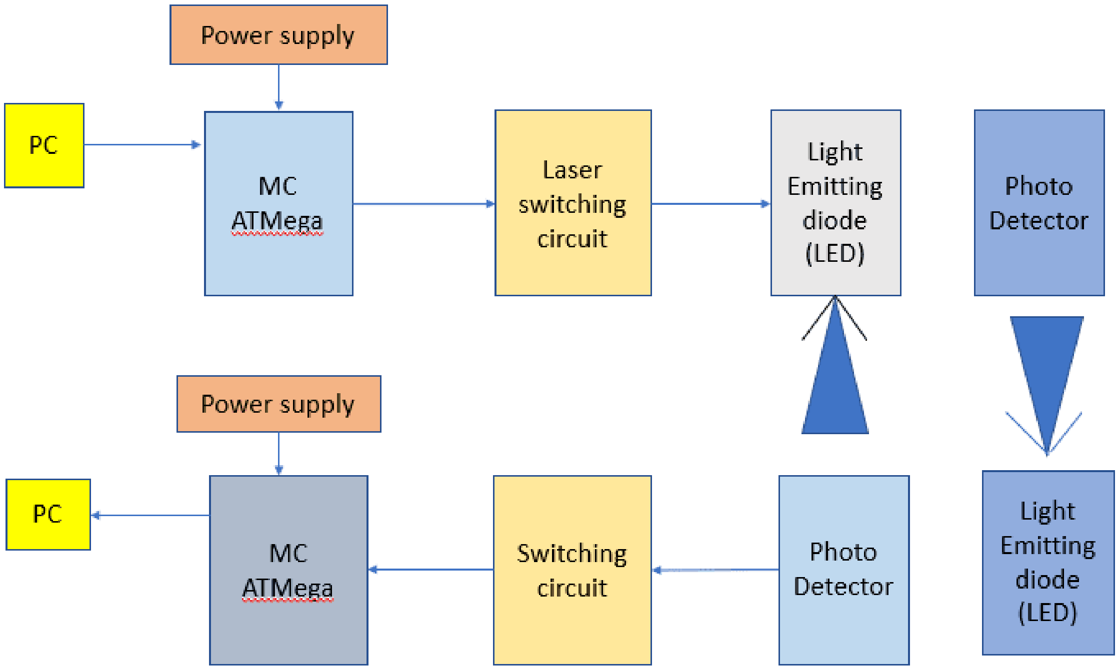


Fig. 3.1. Overall block diagram

3.3 Block Diagram Description

Li-Fi is a Visible Light Communications (VLC) system for data transmission. A simple VLC system has two qualifying components:

1) At least one device with a photodiode able to receive light signals and 2) A light source equipped with a signal processing unit. A VLC light source could comprise of a fluorescent or light emitting diode (LED) bulb. Since a robust Li-Fi system requires extremely high rates of light output, LED bulbs are most ideal for implementing Li-Fi. LED is a semiconductor light source, which implies that LED light bulbs can amplify light intensity and switch rapidly. Therefore, LED cells can modulate thousands of signals without the human eye ever noticing. In turn, the changes in light intensity from the LED light source are interpreted and converted as electrical current by the receiving photodiode device. Once the electronic signal is demodulated, it is converted into a continuous stream of binary data comprising of audio, video, web, and application information to be consumed by any Internet enabled device.

There is ample room for growing innovation in Li-Fi technology. Like conventional broadband and Wi-Fi, Li-Fi can also function as a bidirectional communication system. By interchanging visible light and infrared light from a photo detector, a mobile device connected to that photo detector can send data back to the light source for uplink. Also, multi-colored RGB (Red/Green/Blue) LEDs at retina size could be engineered to send and receive a wider range of signals than single-colored phosphor-coated white LED's. In transmitter side we have connected three input devices like laptop, temperature sensor and voice recorder. These input devices send the data to the microcontroller and it will transfer the data through led light. At the other side photodiode absorbs the light and decoding the signal it will pass to microcontroller. Microcontroller will identify the signals and send the signal to receiving devices.

3.3.1 Block Diagram

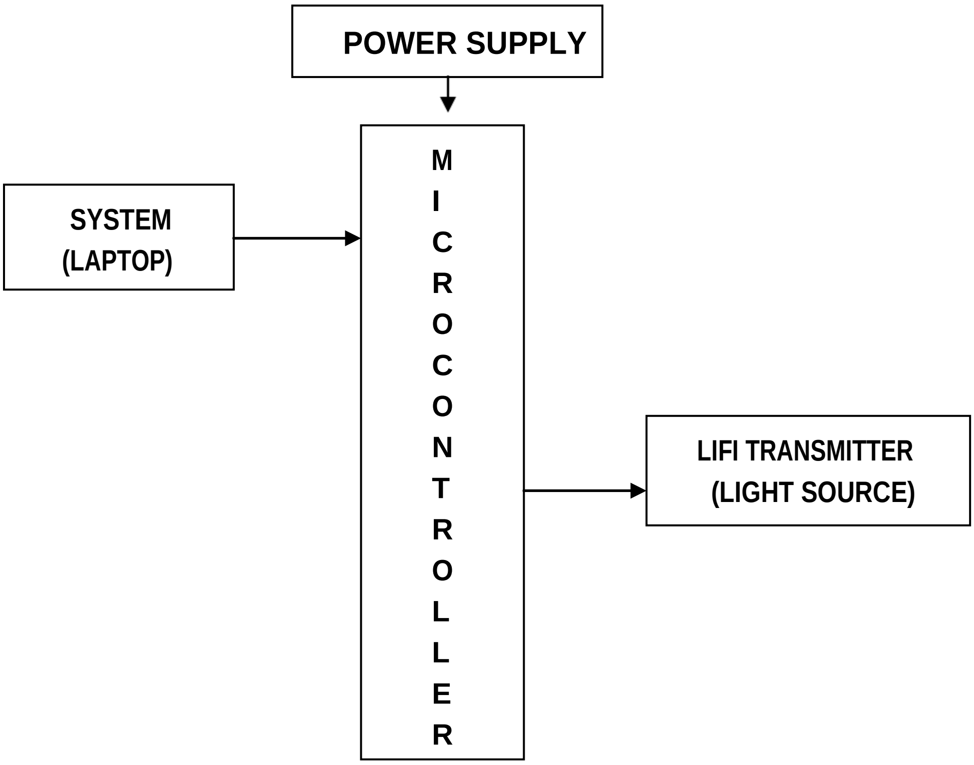


Fig. 3.2. Block diagram of the transmitter side

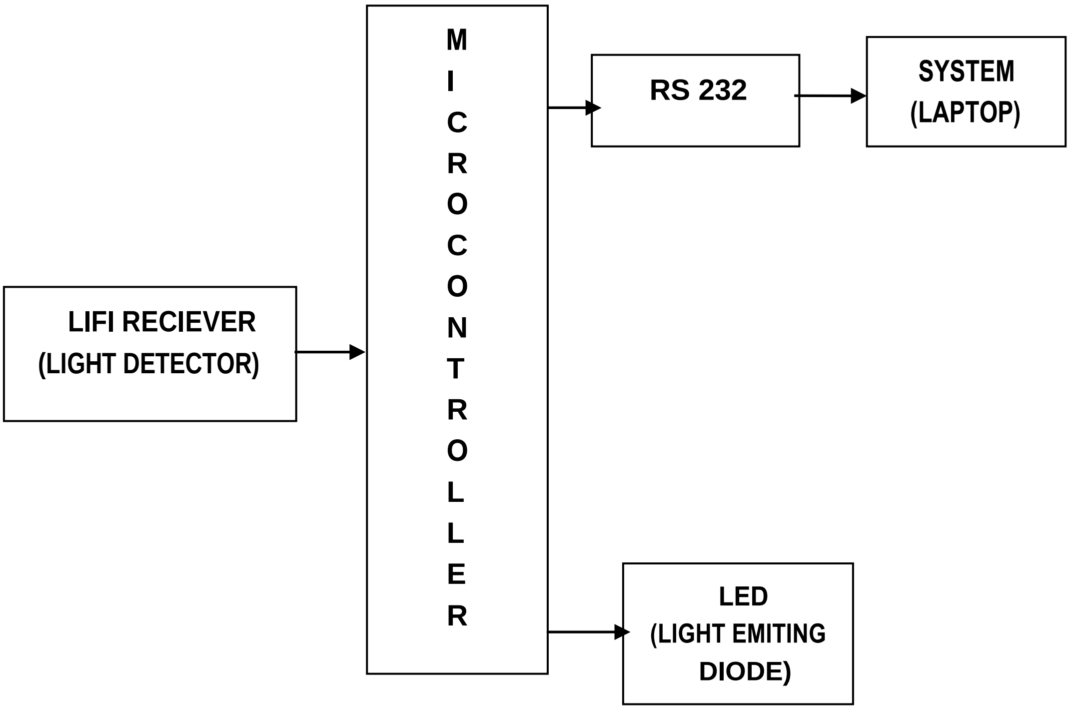


Fig. 3.3. Block diagram of the receiver side

3.3.2 VLC TRANSMITTER DESCRIPTION

The transmitter is a main component in the process. It has many components like LED, microcontroller, and LED driver circuit. There are different possible light sources used for illumination. However, Laser Diodes (LD) and LEDs are the two most popular ones among these especially preferred for optical data communication. Since the purpose of this study is about VLC, that is the concept of maintaining illumination and data transfer simultaneously. That is, in the LED structure photons are emitted spontaneously with different phases. However, with LEDs, a photon stimulates another photon that is radiated with a phase correlated with the previous which is called coherent radiation. The main component in a transmitter section is the visible light source. The LASER is used as the light source to transmit the data transmission is performed using the serial communication technique of the computer. The serial port communication is performed to and fro using the RS 232 pin. For the easy and proper analysis, we transmitted data from one PC to another. LASER light is the main component in the transmitter section. The output of the computer is taken using the serial communication port. As the modern computers and laptops have a serial output port, here we have used a USB to Serial port converter. The output of the computer is made to a constant output by using a MAX 232 IC. While the LASER is in ON condition, it's considered to be as 1 at the receiving end else 0. In this study, the serial communication is performed to transfer the data. This circuit mainly consists of Max 232 IC. DB9 Pin receives the data towards the Max 232 IC. MAX 232 IC converts RS 232 logic input to TTL logic output which is used to drive the LASER diode. The data is transferred as binary data. Here the LASER diode is made on and off simultaneously according to the received input using switching circuit.

3.3.3 VLC RECEIVER DESCRIPTION

Photo detectors are the receiver entity of an OWC system that absorbs the photons impinging on its frontend surface and over against generates an electrical signal. The conversion of photonic energy to the electrical energy can be achieved in alternative way. For example, in vacuum photodiodes or photomultipliers, the absorption of photons created photoelectric effects and free electrons emerge as a result that are used as carriers. Another way is that, by the falling of the photons into the junction area of a semiconductor photodiode such as p or pin diodes, an electron and holes pair is released. Flowingly, these released carriers move to the corresponding regions such as conductance and valance bands in order to release their excessive energies.

However, photodiodes are the most preferred devices as a photo detector due to their small size, high sensitivity and fast response. P-I-N (PIN) and Avalanche Photo-Diode (APD) are the favored type's photodiodes as a photo detector Photodiode is used as the receiver. The photodiode is directly connected towards the Max 232 IC to retrieve it into RS 232 logic. Then it is directly given to the computer. This input can be processed easily.

3.4 FLOW CHART

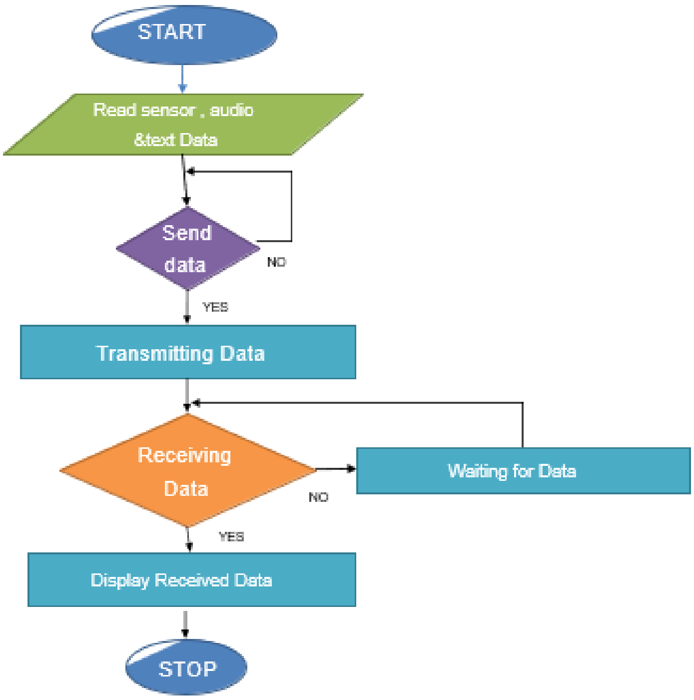


Fig. 3.4. Flow Chart

3.5 MODULE EXPLANATION

3.5.1 Transfer of hyper text

At first the text will be typed to the source like computer /laptop/palmtop/mobile in order to keep the things to be transmitted ready. Then the transmitting side will work in accordance with the text that is needed to be transferred. The text will be sent to the microcontroller of the transmitter side. There the text will be coded in a form to proceed for the further processing. Once the code is ready, it will be transferred to the converter where the text that is in coded form is converted to the light form. Then the data is transferred to the receiver side when it is being placed within the range of the light. From there the coded text is decoded and then sent to the receiver output. And then the output is obtained on the source present on the receiver side.

3.5.2 Transfer of voice recording

At first the voice will be recorded by the help of a voice recorder in order to keep the thing to be transmitted ready. Then the transmitting side will work in accordance with the recorded voice that is needed to be transferred. The voice will be sent to the microcontroller of the transmitter side. There the voice will be coded in a form to proceed for the further processing. Once the code is ready, it will be transferred to the converter where the voice that is in coded form is converted to the light form. Then the data is transferred to the receiver side when it is being placed within the range of the light. From there the coded voice is decoded and then sent to the receiver output. And then the output is obtained on the speaker present on the receiver side.

3.5.3 Transfer of detected temperature

At first the temperature that is detected will be recorded by the help of a temperature detector in order to keep the thing to be transmitted ready. Then the transmitting side will work in accordance with the recorded temperature that is needed to be transferred. The temperature will be sent to the microcontroller of the transmitter side and the temperature will be coded and it will be transferred through the light. From there the coded temperature is decoded and then sent to the receiver output and detected data will show in the receiver side.

CHAPTER 4

SOFTWARE DESCRIPTION

4.1 SOFTWARE REQUIREMENT

- MPLAB
- Embedded C
- VB

4.2 SOFTWARE

4.2.1 MPLAB Description

MPLAB IDE is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated “environment” to develop code for embedded microcontrollers. Experienced embedded systems designers may want to skip ahead to “Components of MPLAB IDE”. “MPLAB IDE On-line Help” and “MPLAB IDE Updates and Version Numbering” be reviewed. The rest of this briefly explains embedded systems development and how MPLAB IDE is used.

4.2.2 Install/Uninstall MPLAB IDE

To install MPLAB IDE on your system:

- If installing from a CD-ROM, place the disk into a CD drive. Follow the on-screen menu to install MPLAB IDE. If no on-screen menu appears, use Windows

4.2.3 Running MPLAB IDE

To start MPLAB IDE, double click on the icon installed on the desktop after installation or select Start>Programs>Microchip MPLAB IDE vx.x>MPLAB IDE vx.x. A screen will display the MPLAB IDE logo followed by the MPLAB IDE desktop.

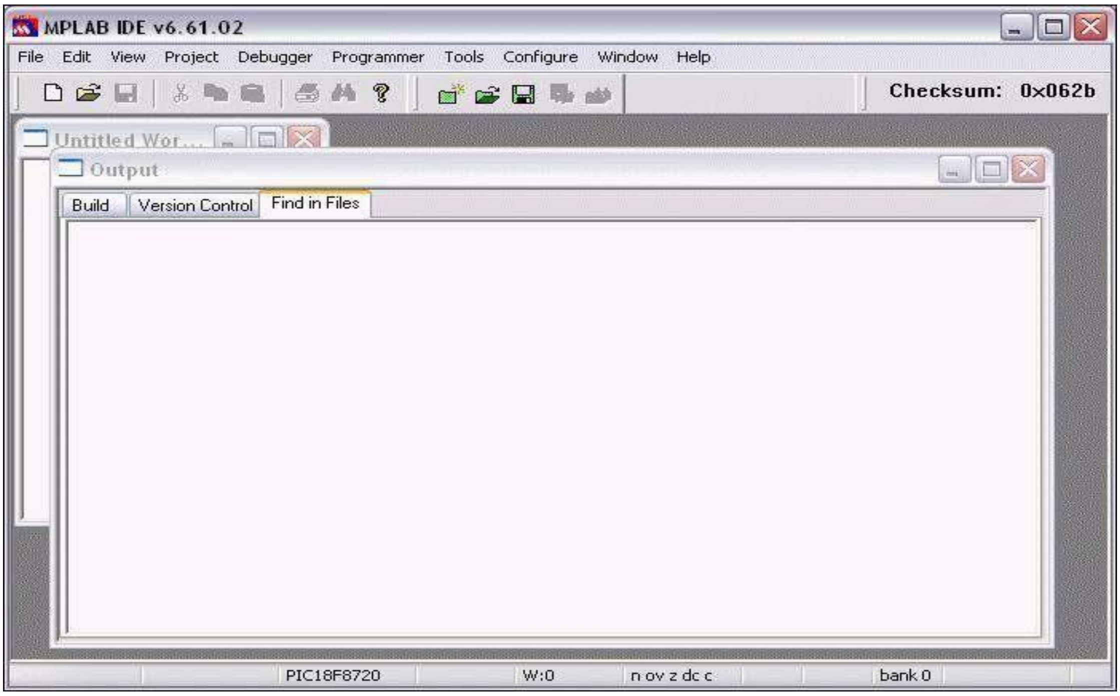

MPLAB IDE v6.61.02
File Edit View Project Debugger Programmer Tools Configure Window Help
Checksum: 0x062b
Untitled Wor...
Output
Build
Version Control
Find in Files
PIC18F8720
W:0
n ov z dc c
bank 0

Fig. 4.1. MPLAB IDE Desktop

4.2.4 Selecting the device

To show menu selections in this document, the menu item from the top row in MPLAB IDE will be shown after the menu name like this MenuName>MenuItem. To choose the Select Device entry in the Configure menu, it would be written as Configure>Select Device.

Choose Configure>Select Device.

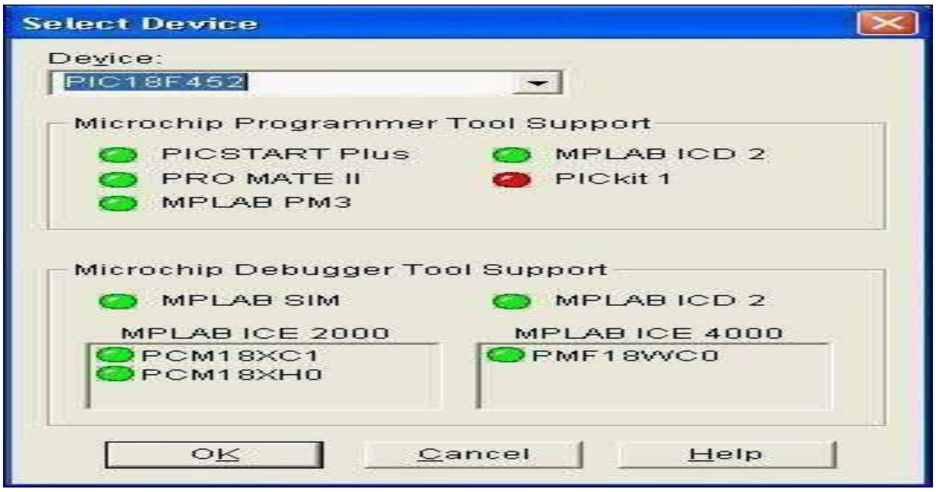


Fig. 4.2. Selecting the device

In the Device dialog, select the PIC18F452 from the list if it’s not already selected.

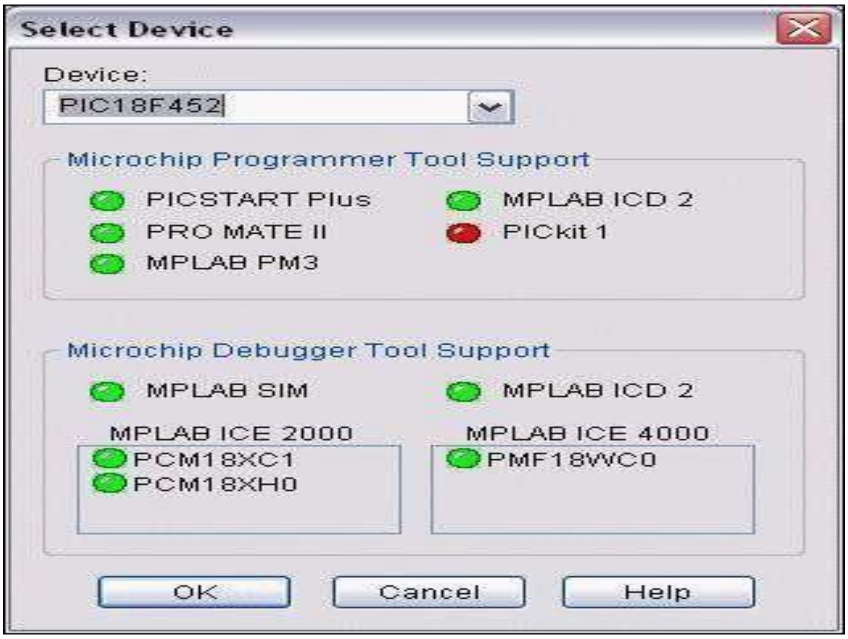


Fig. 4.3. Select device dialog

4.2.5 Creating the project

The next step is to create a project using the Project Wizard. A project is the way the files are organized to be compiled and assembled. We will use a single assembly file for this project and a linker script. Choose Project>Project Wizard. From the Welcome dialog, click on Next> to advance.

The next dialog (Step One) allows you to select the device, which we've already done. Make sure that it says PIC18F452. If it does not, select the PIC18F452 from the drop-down menu. Click Next >. A project is the way the files are organized to be compiled and assembled. To choose the Select Device entry in the Configure menu, it would be written as Configure>Select Device. Then "MPASM" and "MPLINK" should be visible in the Tool suite Contents box. Click on each one to see its location.

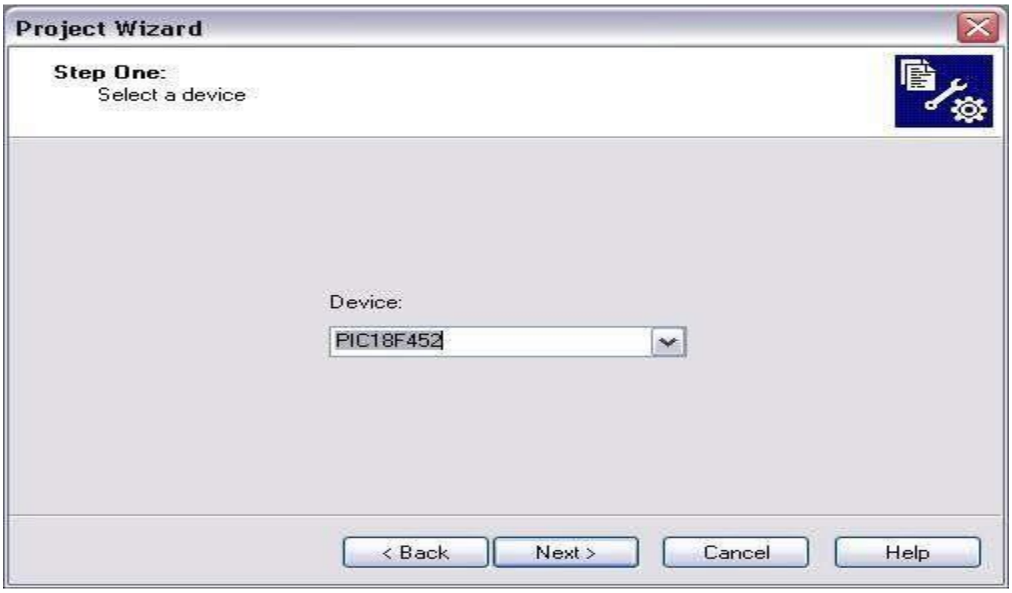


Fig. 4.4. Project Wizards - Select Device

4.2.6 Setting up language tools

Step two of the Project Wizard sets up the language tools that are used with this project. Select "Microchip MPASM Tool suite" in the Active Tool suite list box. Then "MPASM" and "MPLINK" should be visible in the Tool suite Contents box. Click on each one to see its location.

If these do not show up correctly, use the browse button to set them to the proper files in the MPLAB IDE subfolders. When you are finished, click Next>.

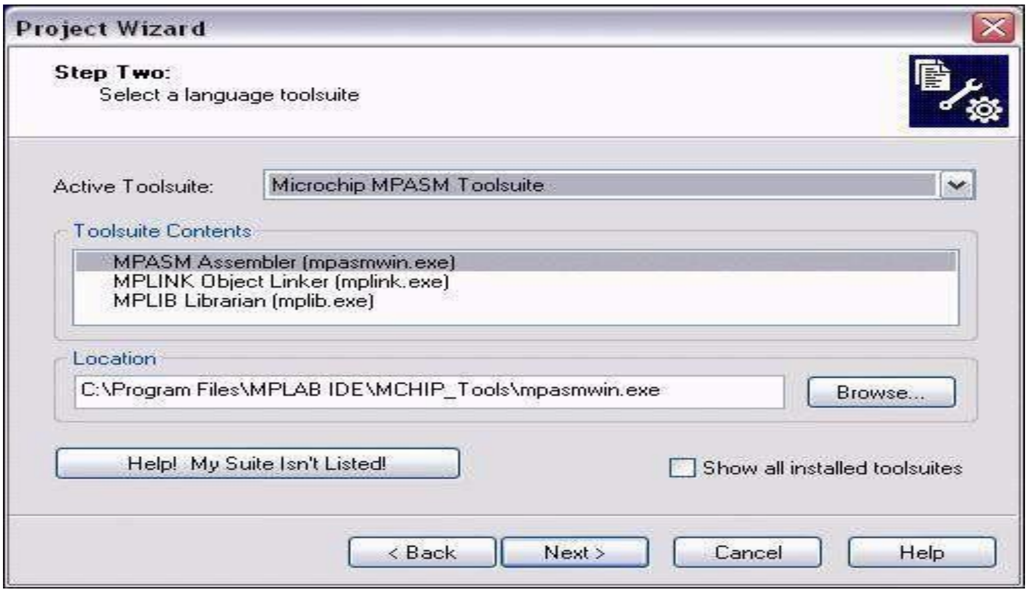


Fig. 4.5. Project wizard - select language tools

4.2.7 Naming the project

Step Three of the wizard allows you to name the project and put it into a folder. This sample project will be called My Project. Using the Browse button, place the project in a folder named Projects32. Click Next>.

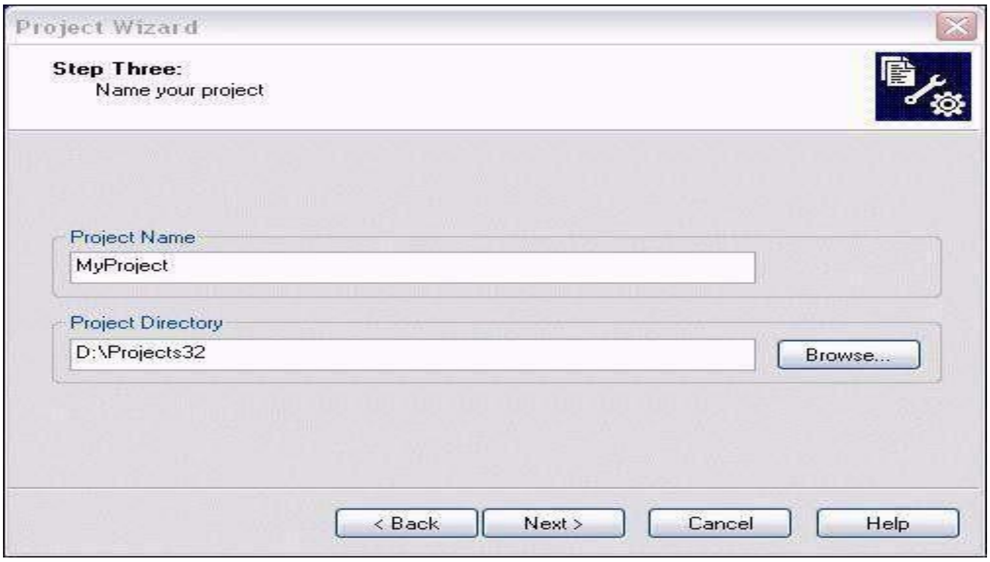


Fig. 4.6. Project wizard - Name project

4.2.8 Adding files to the project

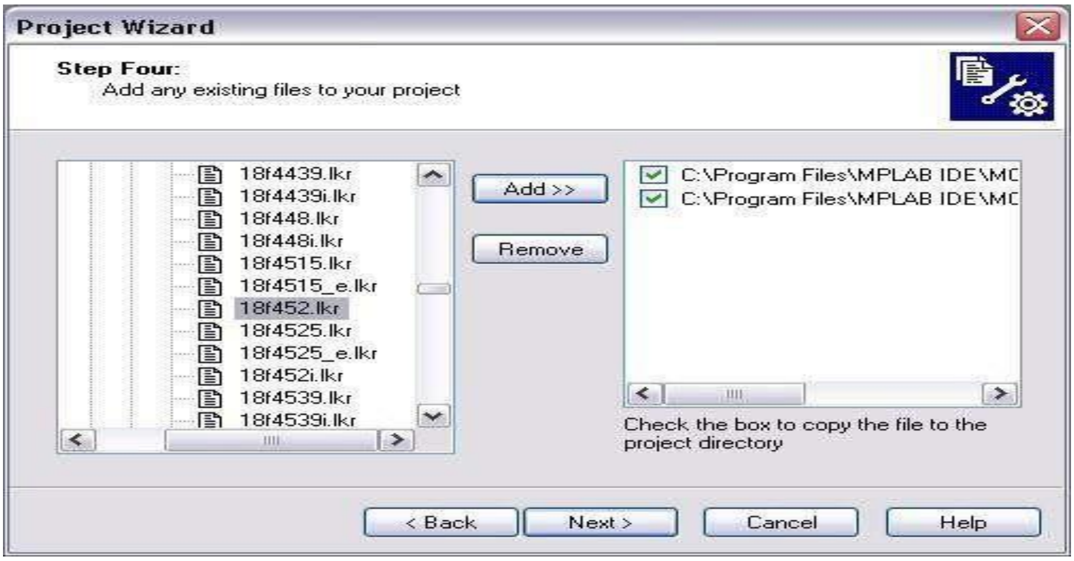


Fig. 4.7. Project wizard - Select linker script

Step Four of the Project Wizard allows file selection for the project.

A source file has not yet been selected, so we will use an MPLAB IDE template file.

The template files are simple files that can be used to start a project.

Make sure that your dialog looks like the picture above, with both check boxes checked, then press Next> to finish the Project Wizard. The final screen of the Project Wizard is a summary showing the selected device.

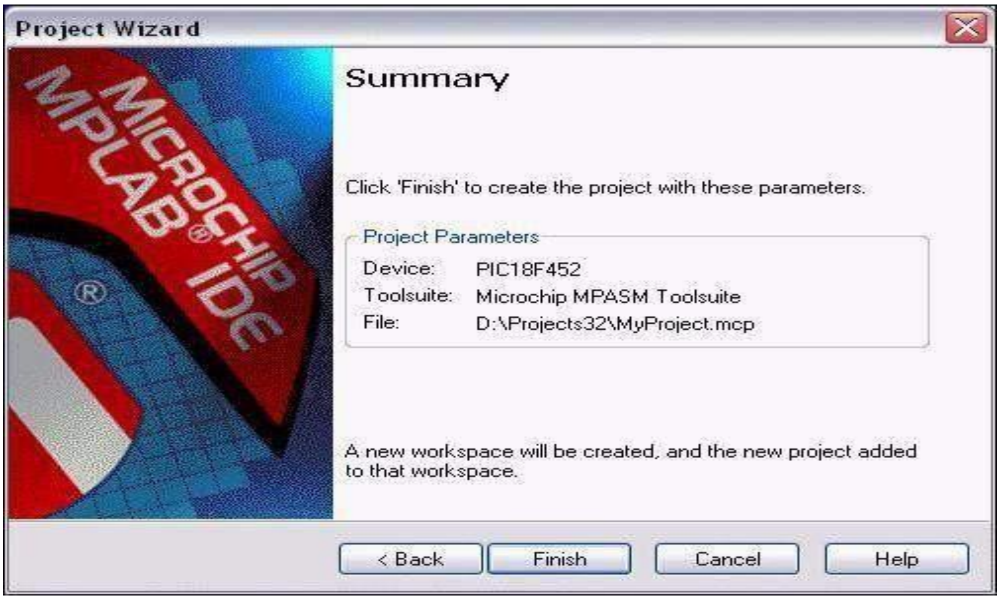


Fig. 4.8. Project wizard - Summary

After pressing the Finish button, review the Project Window on the MPLAB IDE desktop. It should look like Figure 2-10. If the Project Window is not open, select View>Project.

Fig. 4.9. Project window

4.2.9 Input and Output

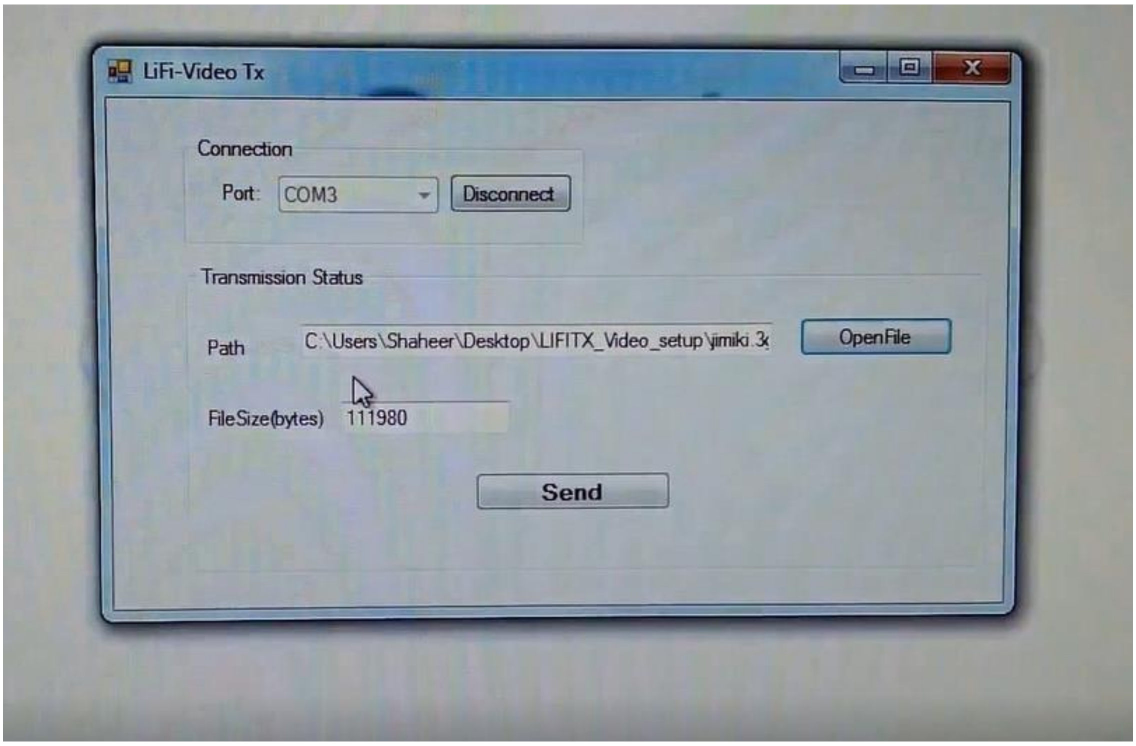


Fig. 4.10. Input screen

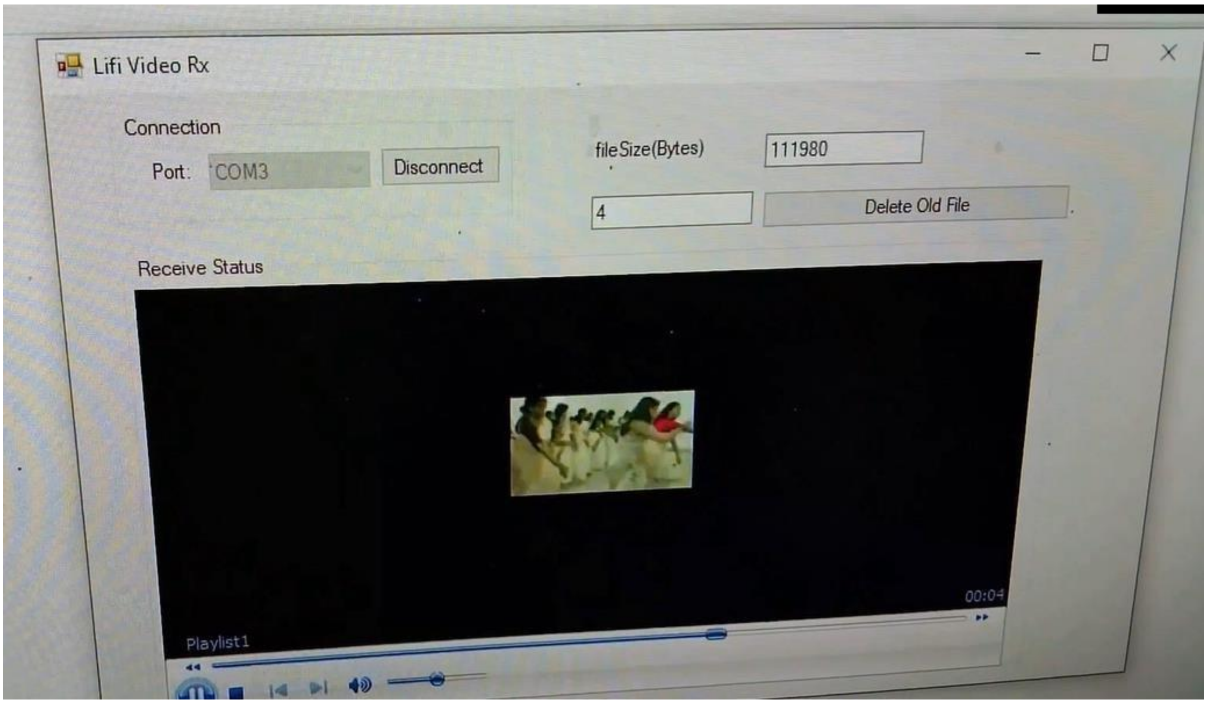


Fig. 4.11. Output screen

CHAPTER 5
HARDWARE IMPLEMENTATION

5.1 HARDWARE

In an embedded system, assigning functions to hardware and software is a vital consideration. Hardware implementation has the advantages that the task execution is faster than in software implementation. On the flip side, the hardware chip occupies space, cost money, and consumes power. Good software design in embedded systems stems from a good understanding of the hardware behind it.

5.1.1 Processor

Each design is unique in embedded system. But to make the system intelligent we use processors and the kinds of processors used in are quite varied. A plethora of processors are available to cater to different applications. 8- bit, 16-

bit, and 32- bit processors are available with different processing powers and memory addressing capabilities. A list of some of the common processor families are: Intel 8051/80188/x86 family, Motorola 68k family, Zilog Z8 family and the PowerPC family. Application functionality processing speed and memory capability dictate processor selection.

5.1.2 Memory

An Embedded System also needs Memory for two Purposes:

1. To store its program and
2. To store its data

Unlike normal desktops, in which programs and data are stored at same place, embedded systems store data and programs in different memories. This is simply because the embedded system doesn't have a hard drive and the program must be stored in memory, even when the power is turned off.

5.1.3 Peripherals

Any additional requirement in an embedded system is dependent on the equipment it is controlling. Very often these systems have a Standard Serial Port, Network Interfaces, Input/output (I/O) interface or hardware to interact with sensors and activators on the Equipment. A list of some of the common processor families are: Intel 8051/80188/x86 family, Motorola 68k family, Zilog Z8 family and the PowerPC family. Application functionality processing speed and memory capability dictate processor selection.[9]. This is simply because the embedded system doesn't have a hard drive and the program must be stored in memory, even when the power is turned off. These systems have a Standard Serial Port, Network Interfaces, Input/output (I/O) interface or hardware to interact with sensors and activators on the Equipment.

5.1.4 Hardware Requirements

- MICROCONTROLLER
- VLC MODULE
- BATTERY
- LCD
- POWER SUPPLY

- LAPTOP

5.2 MICROCONTROLLER

PIC 16F877 is one of the most advanced Microcontroller and a family of Harvard architecture microcontrollers from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on. The PIC 16F877 features all the components which modern microcontrollers normally have. The figure of a PIC16F877 chip is shown below.

Fig. 5.1. PIC CONTROLLER

Microcontroller is a single chip microcomputer made through VLSI fabrication. A microcontroller also called an embedded controller because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.

5.3 Voice Module

APR9600 is a low-cost high performance sound record/replay IC incorporating flash analogue storage technique. Recorded sound is retained even after power supply is removed from the module. The replayed sound exhibits high quality with a low noise level. Sampling rate for a 60 second recording period is 4.2 kHz that gives a sound record/replay bandwidth of 20Hz to 2.1 kHz. However, by changing an oscillation resistor, a sampling rate as high as 8.0 kHz can be achieved. This shortens the total length of sound recording to 32 seconds. Total sound recording time can be varied from 32 seconds to 60 seconds by changing the value of a single resistor. The IC can operate in one of two modes: serial mode and parallel mode. In serial access mode, sound can be recorded in 256 sections. In parallel access mode, sound can be recorded in 2, 4 or 8 sections. The IC can be controlled simply using push button keys. It is also possible to control the IC using external digital circuitry such as micro-controllers and computers.

The APR9600 has a 28 pin DIP package. Supply voltage is between 4.5V to 6.5V. During recording and replaying, current consumption is 25 mA. In idle mode, the current drops to 1 µA. The APR9600 experimental board is an assembled PCB board consisting of an APR9600 IC, an electrets microphone, support components and necessary switches to allow users to explore all functions of the APR9600 chip. The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2 kHz. The board measures 80mm by 55mm.

Fig. 5.2. APR9600sound record/replay

5.4 Liquid Crystal Displays (LCD)

An LCD is a small low-cost display. It is easy to interface with a microcontroller because of an embedded controller (the black blob on the back of the board). This controller is standard across many displays (HD44780) which means many micro-controllers (including the Arduino) have libraries that make displaying messages as easy as a single line of code.

Fig. 5.3. LCD

Pin Number Symbol Function

Pin 1 Vss Ground for Logic

Pin 2 Vdd Power Supply for Logic

Pin 3 Vo Power Supply for LCD

Pin 4 RS Register Selection (H: Data, L: Instruction)

Pin 5 R/W Read/Write Selection (H: Read, L: Write)

Pin 6 E Enable Signal

Pin 7 -14 DB0 – DB7 Data Bus Lines

Pin 15 A BKL +16 K BKL

5.5 Temperature sensor (LM35)

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10°

with improved accuracy). The LM35 series is available packaged in hermetic TO46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

5.5.1 LM35 Sensor Sources

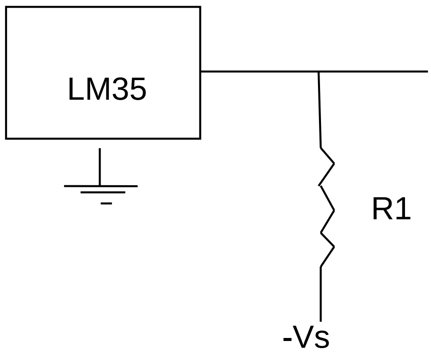
There are several manufacturers of this popular part and each has LM35 sensor specs, datasheets and other free LM35 downloads. This amplifier is available from the following manufacturers.

- National Semiconductor
- On Semiconductor
- Analog Devices
- Medical applications

5.5.2 LM 35 Circuit Diagram

+Vs

V_{OUT}



DSOO5516-4

Choose $R_1 = -V_s/50$ uA (5.1)

$V_{OUT} = +1{,}500$ mV AT $+150°C$ (5.2)

$= +250$ mV at $+25°C$ (5.3)

$= -550$ mV at $-55°C$ (5.4)

Fig. 5.4. LM 35 Circuit diagram

5.5.3 Applications

- Suitable for remote applications
- Low cost due to wafer-level trimming

- Operates from 4 to 30 volts
- Storage and warehouses
- Food processing
- Room comfort control

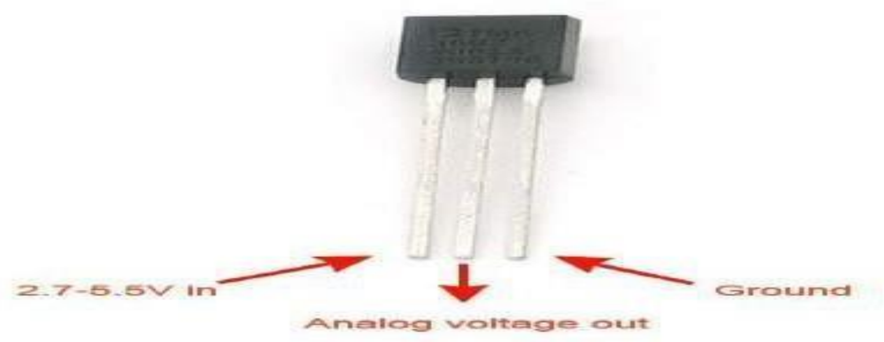


Fig. 5.5. LM 35 pin out

5.6 Transmitter and Receiver

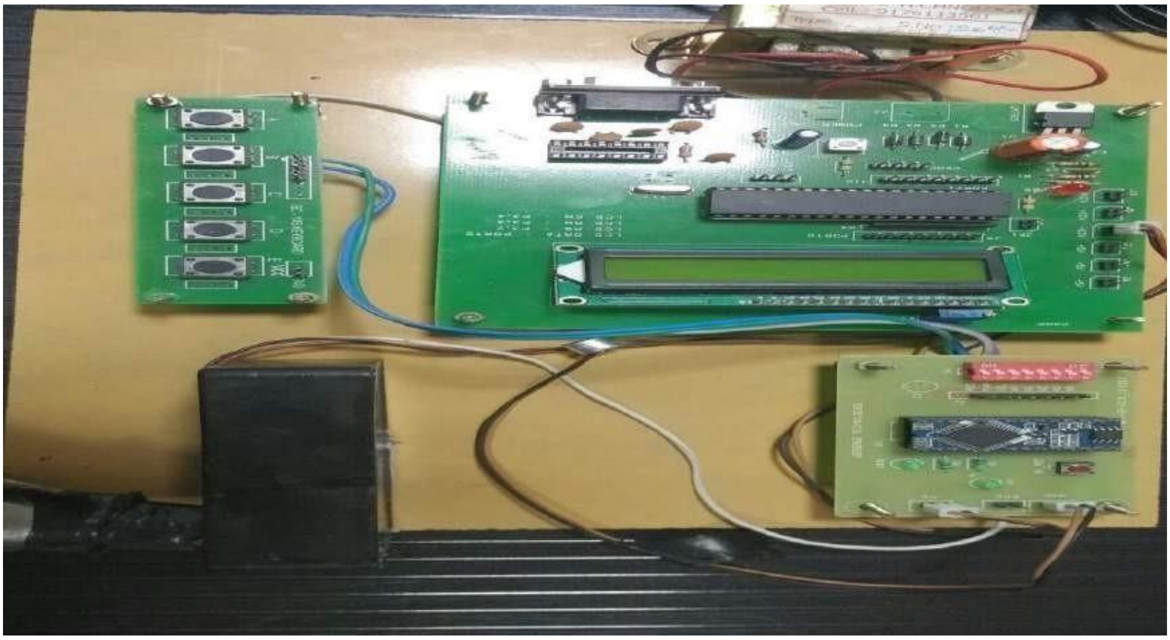


Fig. 5.6. Transmitter Side

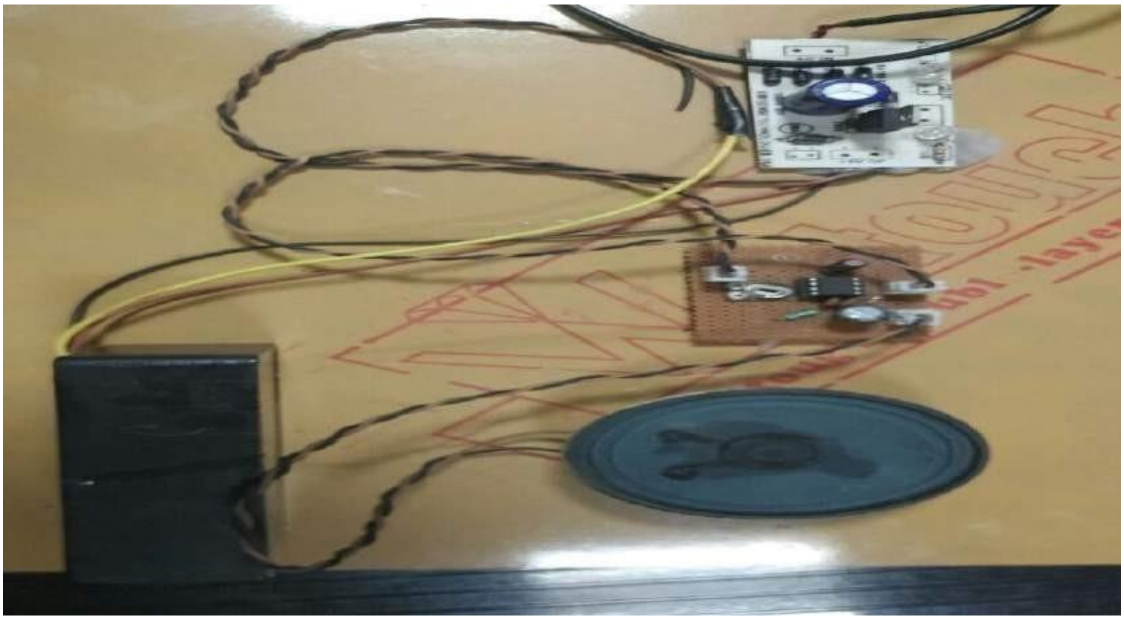


Fig. 5.7. Receiver Side

Fig. 5.8. Transmitter connection with pc

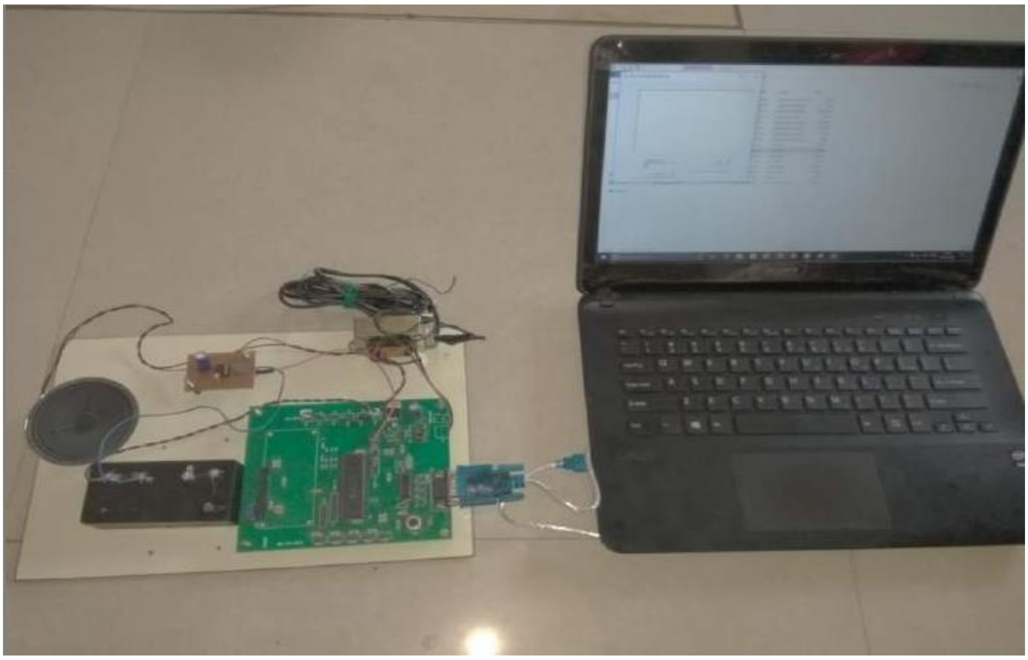


Fig. 5.9. Receiver connection with pc

5.7 FULL SETUP OF HARDWARE

Fig. 5.10. Full setup of Hardware

This is the full setup of the visible light communication. Here we are going to transfer video and image data through visible light. At first the text will be typed to the source like computer/laptop/palmtop/mobile in order to keep the thing to be transmitted ready. Then the transmitting side will work in accordance with the image that is needed to be transferred. The image will be sent to the microcontroller of the transmitter side. There the image will be coded in a form to proceed for the further processing. Once the code is ready, it will be transferred to the converter where the image that is in coded form is converted to the light form. Then the data is transferred to the receiver side when it is being placed within the range of the light. From there the coded image is decoded and then sent to the receiver output. And then the output is obtained on the source present on the receiver side.

At first the video will be recorded by the help of a voice recorder in order to keep the thing to be transmitted ready. Then the transmitting side will work in accordance with the recorded voice that is needed to be transferred. The video will be sent to the microcontroller of the transmitter side. There the video will be coded in a form to proceed for the further processing. Once the code is ready, it will be transferred to the converter where the video that is in coded form is converted to the light form. Then the data is transferred to the receiver side when it is being placed within the range of the light. From there the coded video is decoded and then sent to the receiver output. And then the output is obtained on the Laptop present on the receiver side.

Similarly, we can transfer temperature data. Data will be transferred in the form of binary codes. At first the temperature that is detected will be recorded by the help of a temperature detector in order to keep the thing to be transmitted ready. Then the transmitting side will work in accordance with the recorded temperature that is needed to be transferred. The temperature will be sent to the microcontroller of the transmitter side. There the temperature will be coded in a form to proceed for the further processing. Once the code is ready, it will be transferred to the converter where the temperature that is in coded form is converted to the light form. Then the data is transferred to the receiver side when it is being placed within the range of the light. From there the coded temperature is decoded and then sent to the receiver output. And then the output is obtained on the display present on the receiver side.

5.8 RESULT

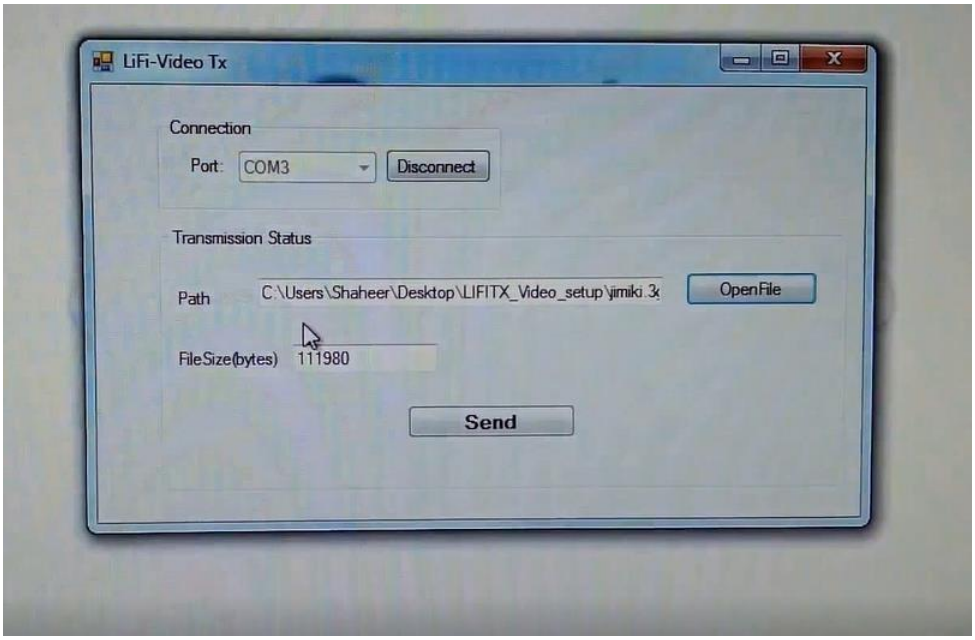


Fig. 5.11. Input screen

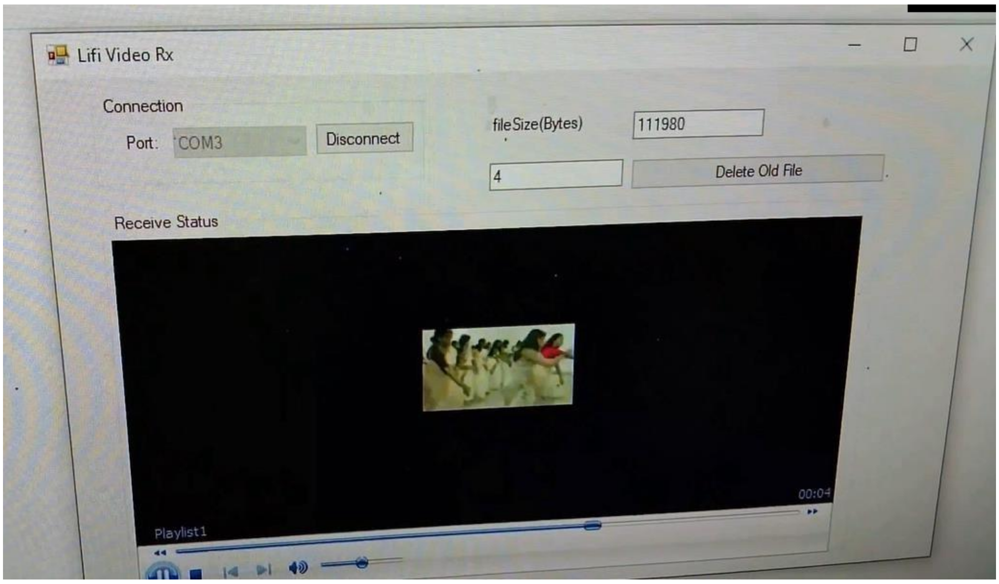


Fig. 5.12. Output screen

CHAPTER 6
SUMMARY AND CONCLUSION

6.1 SUMMARY

Once we are ready with the hardware inserted with the software inside it, the things that are needed to find is the image and Video. There is a transmitter side and the receiver side. We give the input through the transmitter side by providing the text through the system. Then we provide the sound through the voice recorder. And then we detect the temperature with the help of temperature detector. There is light source for transmitting the data to the receiver side. On the other side, there is a light detector for detecting the light. Once the light gets detected, the data get transmitted to the receiver side. The output can be seen on the receiver system, image on the Laptop and video on the system too.

6.2 CONCLUSION

We have been able to transfer the image, video recorded voice on the receiver side through the help of light source which is present on the transmitter side. A proper audible sound is heard on the Laptop speaker and the video and image is displayed accordingly. This technology has a bright scope in future. Visible Light Communication is a rapidly growing segment of the field of communication. There are many advantages to using VLC. The **Li-Fi** technology is now developed into an omnipresent system technology with ground-breaking networking capabilities for universal application to deliver a variety of device platforms for high-speed internet communications. VLC will be able to solve many of the problems people have been facing for many years. In spite of the research problems, it is our belief that the VLC system will become one of the most promising technologies for the future generation in optical wireless communication.

6.3 FUTURE SCOPE

This technology has a bright scope in future. This technology established a solution to the problem of integrating Visible Light Communication technology with present infrastructure, without having to make major changes to that set-up. Visible Light Communication is a rapidly growing segment of the field of communication. There are many advantages to using VLC. There are also many challenges. VLC will cleverly solve many of the problems people have been facing for many years, primarily environmental and power usage problems. VLC is still in its starting stages, but progresses have been made rapidly, and shortly this technology will be able to be used in our daily lives. In spite of the research problems, it is our certainty that the VLC system will develop as one of the most promising technologies for the forthcoming generation in optical wireless communication. As the data transfer using LASER light is possible without any kind of modulation, this idea can be used in the development of Li-Fi technology by proper design changes in circuits. This method of data transmission can be applied in optic fiber and radiation prohibited areas such as chemical plants. This method can be used for wireless communication such as communication between space shuttles etc. This analytic study can be used for the future development of visible light communication systems. This can be applied at the chemical plants where the RF waves and OFC cannot be used.

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