REAL TIME DATA COMMUNICATION USING LIFI IN HOSPITAL MANAGEMENT

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

In hospitals, patient monitoring is typically done by hand with assistance from nursing staff around-the-clock. The availability of nursing staff to keep an eye on the well-being of new borns or critically ill patients is a labor -intensive and challenging responsibility. Many wireless technologies have been proposed to monitor the patient's state using various sensors in an attempt to tackle this problem; nevertheless, these wireless methods can even interact with medical devices and represent a risk to patients and new borns. Light-Fidelity (Li-Fi) is a highly efficient, high-speed, secure, eco-friendly, non-hazardous mobile wireless technology that uses high speed PCM modulation of light source to transmit and receive data. LiFi data is transmitted by the LED bulbs and received by photoreceptors. In today’s world, technology plays an important role in every industry as well as in our personal lives. Out of all the industries that technology plays a crucial role in, healthcare is one of the most important. Li-Fi based health monitoring systems that measure heart rate, temperature, and movements in case of an emergency have been presented as a way to create hospital-friendly monitoring systems. It continuously measures the pulse rate and ambient temperature and sends the data to an IOT platform.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPLANATIONS
LiFi	Light fidelity
WiFi	Wireless Fidelity
IOT	Internet Of Things
VLC	Visible Light Communications
RF	Radio Frequency
LED	Light-Emitting Diode
MMC	Massive Machine Communication
LCD	Liquid-crystal display
E2E	End to End
ADC	Analog to Digital converter
MAC	Medium Access Control
GHZ	Gigahertz
WPA	Wi-Fi Protected Access
RGB	Red, Green, Blue
OOK	On – Off Keying
GB	Gigabyte
CPM	Continuous Phase Modulation
EHR	Electronic Health Records
TED	Technology, Entertainment, Design

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

1.1.1 LiFi

Li-Fi, short for Light Fidelity, is a cutting-edge wireless communication technology that uses visible light, infrared, and near-ultraviolet spectrum to transmit data wirelessly. Unlike traditional Wi-Fi which uses radio waves for data transmission, Li-Fi utilizes light waves from LED bulbs to transmit information. This technology was first introduced by Professor Harald Haas during a TED talk in 2011, where he demonstrated the concept of transmitting data through flickering LED lights.

The principle behind Li-Fi is relatively simple yet ingenious. LED bulbs are modulated at high speeds, imperceptible to the human eye, to encode data. Light sensors or photodetectors in receiving devices then detect these fluctuations and convert them back into electrical signals, thus retrieving the transmitted data.

Li-Fi is a revolutionary solution for the high speed data network, proposed by a German physicist Harold Haas. Li-Fi networks support the transmission of data through illumination of light emitting diode (LED) bulbs, thereby it is also termed as visible light communications (VLC). In the epoch of the internet, there is a continuous urge for faster, secure, and reliable wire-wireless connectivity in all fields, while wireless networks are more preferable in all domestic applications in general and health-care applications in particular.

The reason for depending on wireless networks in hospitals is the cables which are running over the patient's body interconnecting the device may cause contamination. Dependency on the wireless internet increases the burden on wireless fidelity (Wi-Fi) technology which, in turn, creates a huge demand for bandwidth and radio spectrum . To reduce the load on Wi-Fi, an alternate means of wireless internet is Li-Fi, which finds its applications in almost every field, even in vehicle technology .

The Li-Fi technology in some use cases, The Li-Fi is a wireless optical networking technology. Specifically, it is a form of visible light communications (VLC) system that makes use of light-emitting diodes (LED) for data transmission. Li-Fi has a special distinction from other VLC systems. Similar toWi-Fi, Li-Fi is the only form of VLC that allows the bidirectional transmission of light. However, instead of the radio spectrum, it makes use of the visible light spectrum through LED light bulbs outfitted with a special chip. We use it to receive and transmit data by light. It is 100 times faster than Wi-Fi technology and the Li-Fi is more secure than Wi-Fi.

The purpose of Li-Fi technology is to provide high-speed data communication using the visible light spectrum. Now Li-Fi is on-going research, it has a potential advantage that can supplement RF communication and can be used to improve wireless network performance. It uses common household LED light bulbs to enable data transfer, boasting speeds of up to 224 GB per second. Considering that the fastest Wi-Fi in the 60 GHz frequency band can achieve a maximum data rate of 7 GB per second, Li-Fi speed is 100 times faster than that! Not only that, but the rate per square meter or area data rate of a Li-Fi network can be 1,000 times higher than the area data rate of a Wi-Fi network.

1.2 HISTORY

Li-Fi, short for "Light Fidelity," is a wireless communication technology that uses light to transmit data. It is a relatively new technology compared to Wi-Fi, which uses radio waves for data transmission. Here's a brief history of Li-Fi technology:

- **Conceptualization :**

  The term "Li-Fi" was coined by Professor Harald Haas during a TEDGlobal talk in 2011. However, the concept of using light for wireless communication dates back even further. Haas, a professor at the University of Edinburgh, demonstrated the idea of transmitting data through flickering LED lights in 2003.

- **Early Development :**

  Li-Fi gained more attention after Haas's TED talk in 2011, which brought the concept to a broader audience. Researchers around the world began exploring the potential applications and technical challenges of Li-Fi technology. Various advancements were made in modulation techniques, receiver designs, and integration with existing communication systems.

- **Standardization Efforts :**

  Standardization bodies such as the Institute of Electrical and Electronics Engineers (IEEE) started to work on developing standards for Li-Fi technology. Efforts were made to ensure interoperability and compatibility among different Li-Fi devices. Standards like IEEE 802.15.7 were established to define the physical layer and medium access control layer specifications for optical wireless communication systems.

- **Commercialization and Deployment :**

Li-Fi technology began to move from the research phase to commercialization and practical deployment. Several companies started offering Li-Fi products and solutions for various applications, including indoor communication, internet connectivity in areas where radio frequency interference is an issue, and secure wireless data transmission.

1.3 ANALYSIS BETWEEN LiFi AND WiFi

In today's interconnected world, wireless communication is a cornerstone of our daily lives, with technologies like WiFi and LiFi enabling seamless connectivity. While WiFi has been the predominant technology for wireless communication, LiFi has emerged as a promising alternative, leveraging light instead of radio waves for data transmission. This analysis will delve into the differences between LiFi and WiFi in terms of technology, speed, security, and applications.

- **Technology:**

WiFi, or Wireless Fidelity, operates by transmitting data using radio waves over a specific frequency. It typically operates in the 2.4 GHz and 5 GHz bands, providing wireless connectivity over a certain range.

LiFi, short for Light Fidelity, operates using light waves for data transmission. It utilizes LED bulbs to transmit data by modulating the intensity of light at extremely high speeds, often in the range of several gigabits per second.

- **Speed:**

WiFi offers relatively high data transfer speeds, with the latest standards such as WiFi 6 (802.11ax) capable of delivering multi-gigabit speeds under optimal conditions. However, real-world speeds may vary depending on factors like interference and distance from the router.

LiFi has the potential to offer significantly higher speeds compared to traditional WiFi. Laboratory tests have demonstrated speeds in the range of several gigabits per second, making it suitable for high-bandwidth applications like video streaming and data-intensive tasks.

- **Coverage:**

WiFi signals can cover larger areas compared to LiFi since radio waves can travel through walls and other obstacles.

LiFi coverage is limited to the area illuminated by the light source. It is more suitable for localized communication within a room or specific area.

- **Power Consumption:**

WiFi devices consume relatively high amounts of power, especially when transmitting data at high speeds.

LiFi devices, such as LED bulbs, consume less power compared to traditional WiFi routers. This can be advantageous in energy-efficient environments.

- **Security:**

WiFi networks are susceptible to various security threats such as eavesdropping, unauthorized access, and network intrusion. Encryption protocols like WPA2 and WPA3 are commonly used to secure WiFi transmissions, but vulnerabilities can still exist.

LiFi offers inherent security advantages due to its reliance on light waves, which cannot penetrate walls like radio waves. This physical limitation reduces the risk of unauthorized access or eavesdropping from outside the intended area of coverage, enhancing the overall security of LiFi networks.

1.4 IMPLEMENTATION OF LiFi

The Li-Fi uses visible light as a medium for the transmission of data. As a type of VLC system, it requires two components: a photodiode and a light source. The photodiode acts as a transceiver that receives light signals and transmits them back. The light source transmits data using emitted light as the medium. In this case, light emitting diodes (LED) serve as the light source.

They are outfitted with a chip that serves as the signal processing unit. LED light bulbs are semiconductors. This means current supplied to the bulb can be modulated, which in turn, modulates the light they emit. This process occurs at extremely high speeds that are unperceivable to the human eye. Data is fed into the light bulb and sends the data at extremely high speeds to the photodiode. It converts the data received into a binary data stream perceivable by humans such as video and audio applications.

Transmission of data over light to send data over light, Li-Fi systems require a strong, robust light source like LED bulbs. LEDs are different from halogen or filament bulbs as they do not need to warm up. As previously stated, they are semiconductors. They start up quickly and emit light according to the current passed through them.LiFi technology offers a promising solution for high-speed wireless communication in indoor environments.

Within the light, the intensity of the colors red, green, and blue (RGB) is finely modulated to embed data into the LED light. This technology holds promise for enhancing connectivity in IoT ecosystems, enabling faster and more reliable data transfer in various applications while also reducing congestion on existing RF spectrum.(Again, this process is undetectable to the naked eye.)

This fine modulation of RGB can be better described as a form of code. Once the light is received by a photodiode, the light is demodulated. The information received is either related to a cloud server or transcribed by the receiver itself. Content is then displayed according to the code obtained.

With its ability to provide secure communication and its potential applications across various industries, LiFi has the potential to revolutionize the way we connect to the internet and communicate with each other. As research and development in LiFi technology continue to advance, we can expect to see further innovations and implementations in the years to come.

To implement LiFi, specialized LED bulbs equipped with signal processing capabilities are installed in areas where data communication is required, such as offices, homes, or public spaces. These bulbs emit light that carries encoded data, which can be received by devices equipped with photodetectors, such as smartphones or laptops. The receiving devices decode the light signals and convert them back into digital data.

One advantage of LiFi is its potential for high-speed data transmission, as light can be modulated much faster than radio waves used in traditional WiFi technology. Additionally, LiFi offers increased security since light signals cannot penetrate through walls, providing a more secure communication environment compared to WiFi.

- **Light Source:**

Li-Fi utilizes LED (Light Emitting Diode) bulbs as the primary source of light. These LED bulbs can be found in various lighting fixtures such as lamps, ceiling lights, and even streetlights.

- **Modulation:**

Data transmission in Li-Fi is achieved by modulating the intensity of the light emitted by the LED bulbs. This modulation can be done using various techniques such as On-Off Keying (OOK) or Continuous Phase Modulation (CPM).

- **Photodetectors:**

Devices equipped with photodetectors are used to receive the modulated light signals and convert them back into data. Photodetectors could be integrated into devices like smartphones, tablets, or standalone Li-Fi receivers.

- **Communication Protocol:**

Li-Fi typically employs protocols for organizing data transmission, error correction, and network management. Some of the protocols used in Li-Fi implementations include IEEE 802.15.7, which defines the physical layer and medium access control (MAC) sublayer specifications for visible light communication (VLC) systems.

Overall, hospitals without real-time data transmission may experience inefficiencies, delays in care, and challenges in communication and data integration. Implementing real-time data transmission systems can help improve patient care, streamline workflows, and enhance communication among healthcare providers.

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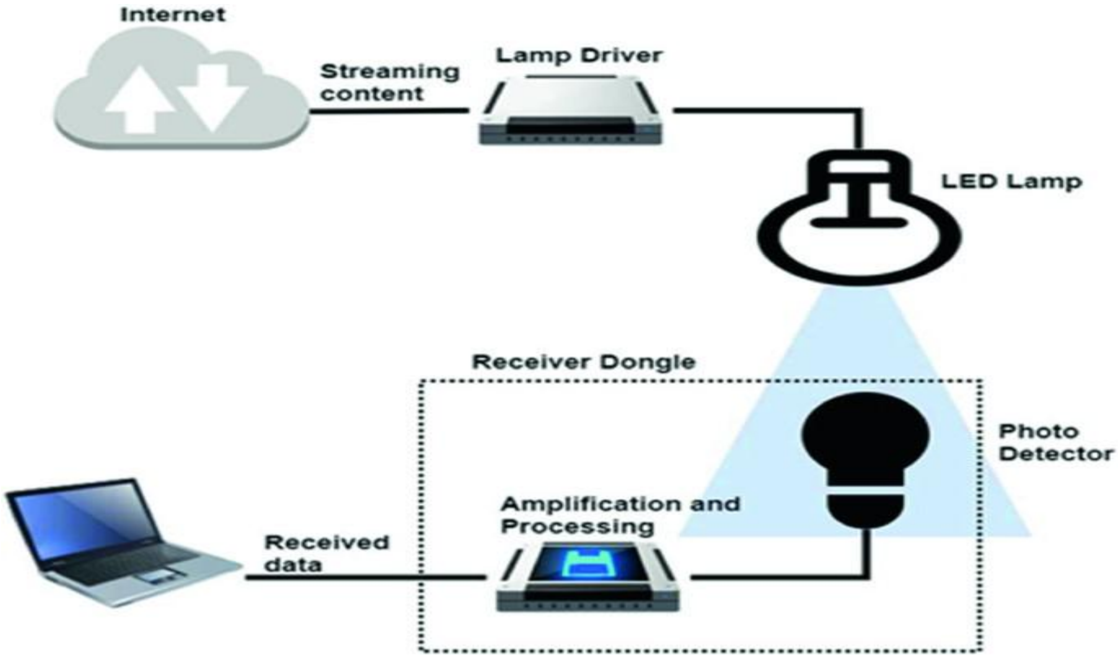

Figure 1.1 LiFi Technology

Implementing LiFi technology involves leveraging light as a medium for high-speed wireless communication. By utilizing LEDs, photodetectors, modulation techniques, and network infrastructure, LiFi systems can deliver fast, secure, and energy-efficient data transmission in various indoor environments. While LiFi presents unique challenges and considerations, its

potential to complement existing wireless technologies and enable innovative applications makes it a promising solution for future communication networks.

One of the key advantages of LiFi technology is its ability to provide secure communication. Since light cannot penetrate through walls, LiFi signals are confined to the space where the light is present, reducing the risk of interception by unauthorized users. Additionally, LiFi can be used in areas where radio frequency interference is a concern, such as in hospitals or aircraft.

1.5 LiFi IN IOT

Li-Fi, short for "Light Fidelity," is a wireless communication technology that uses light to transmit data. It's similar to Wi-Fi but instead of radio waves, it utilizes visible light, infrared, or ultraviolet spectrum for communication. Li-Fi has gained attention for its potential in various applications, including the Internet of Things (IoT). Here's how Li-Fi fits into the IoT landscape.

It is a groundbreaking technology that utilizes light to transmit data, offering a promising solution for the growing demands of the Internet of Things (IoT). Unlike traditional Wi-Fi, which uses radio waves, Li-Fi employs visible light communication (VLC) to send data, leveraging LED light bulbs to transmit information at incredibly high speeds. This technology presents numerous advantages for IoT applications, including enhanced security, as light signals can be confined within specific spaces, reducing the risk of interception.

With a rapid increase in the number of connected devices, some challenges appear which will be responded to by increasing capacity and by improving energy efficiency, cost and spectrum utilization as well as providing better scalability for handling the increasing number of the connected devices. For the vision of all-communicating world relative to today's network, the overall technical aim is to provide a system idea that supports:

▪ 1000 times increased data volume per area

▪ 10 to 100 times increased number of connected devices

▪ 10 to 100 times increased typical user data rate

▪ 10 times extended battery life for low power Massive Machine Communication (MMC) devices

▪ Time reduced End-to-End (E2E) latency

Li-Fi enables IoT devices to operate in environments where radio frequency interference is a concern, such as hospitals and aircraft. Moreover, Li-Fi's high bandwidth and speed capabilities make it ideal for supporting the massive influx of connected devices in IoT networks, facilitating seamless communication and data exchange between devices. As the IoT ecosystem continues to expand, Li-Fi stands out as a promising technology that can revolutionize connectivity, offering faster, more secure, and reliable communication for the increasingly interconnected world.

IoT would fit well and well in Li-Fi and be enabled by it. IoT needs multiple access points and this is easily done in Li-Fi since simple light bulbs are used and these can technically be any number of access points. Li-Fi would improve IoT to become a ubiquitous network because it could be installed anywhere users might like light and data services: bus shelters, train stations, street lights, tourist information kiosks could all provide data transmission as well as light. IoT can be enabled by Li-Fi in indoor communication for it has a small range of coverage compared to Wi-Fi. Undersea, things connected to above sea level, will continue connectivity because light reaches undersea.

In summary, the future of LiFi-based patient health monitoring systems holds tremendous promise for revolutionizing healthcare delivery by leveraging cutting-edge technologies to enable real-time monitoring, proactive intervention, and personalized care management. Continued research, innovation, and collaboration across multidisciplinary domains will be key to unlocking the full potential of this transformative healthcare solution.

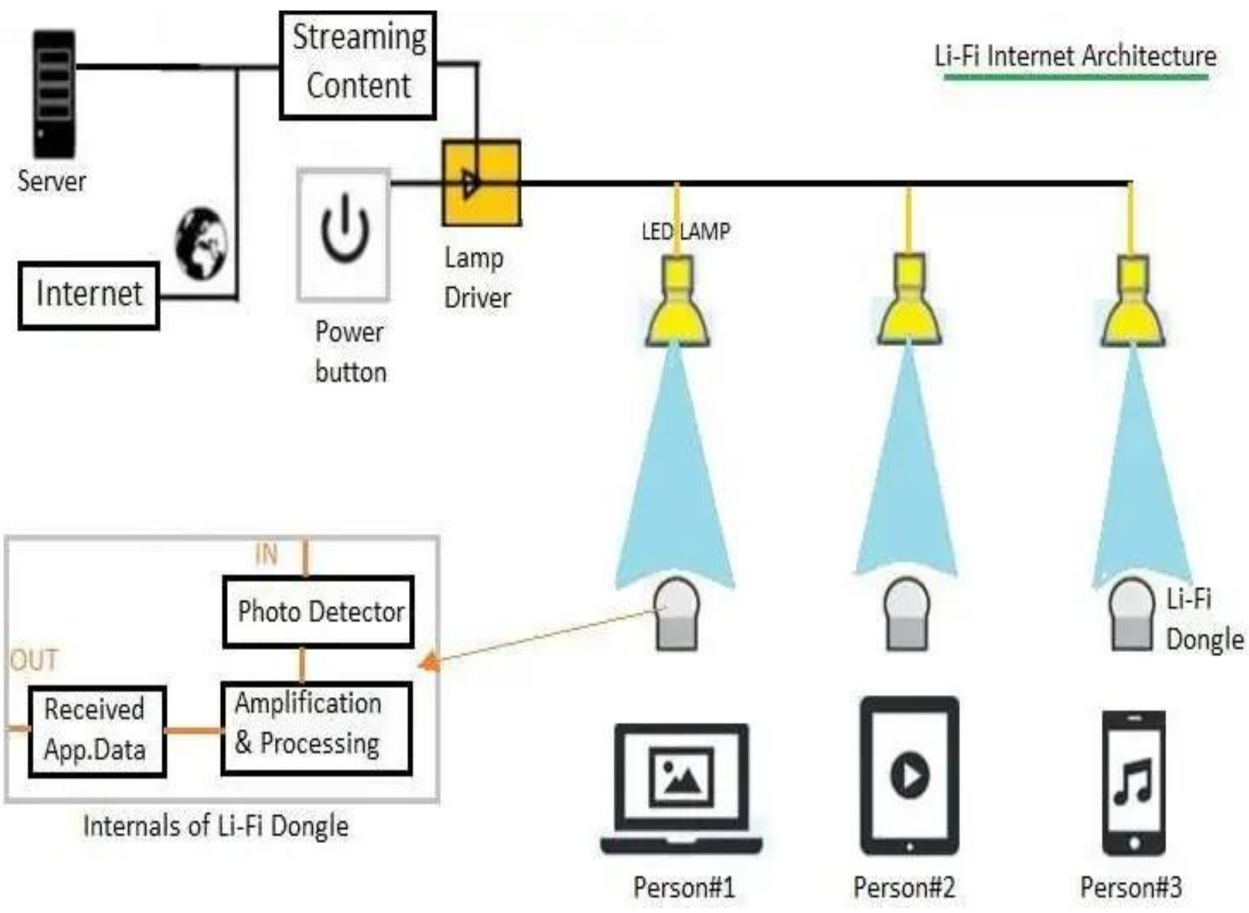

Figure 1.2 Working of LiFi in IOT

1.6 Li-Fi IN HOSPITAL AND HEALTHCARE

Many healthcare environments forbid the use of electronics, especially those that make use of radio frequencies, because these radio frequencies may interfere with sensitive hospital equipment. This means the use of cellphones and Wi-Fi-enabled devices are forbidden in special areas within a hospital. Through the use of Li-Fi-enabled lighting, equipment interference can be avoided while also providing a less expensive, more reliable mode of communication between equipment, or between people (staff-to-patient).

LiFi, or Light Fidelity, technology has the potential to revolutionize healthcare by providing secure, high-speed wireless communication using visible light rather than traditional radio frequencies. In healthcare settings, where data security and reliability are paramount, LiFi offers several advantages over traditional WiFi networks.

Firstly, LiFi can provide faster data transmission speeds, enabling real-time monitoring of patient vital signs, rapid access to electronic medical records, and seamless communication between medical devices. This can improve patient outcomes by facilitating timely interventions and reducing response times in emergencies.

This can be applied in the monitoring of patients, hospital security, storage or transport of hospital patient records, or emergency situations that necessitate instant communication. Stakeholders are:

- Li-Fi can be used by Doctors and Patients
- They can use it in order to improve hospital operations and make it easier

for hospital management and staff to monitor patients within the hospital.

- It can be used to optimize navigation within the hospital to make it easier

for patients to locate specific areas within the hospital.

Despite these challenges, Li-Fi holds promise for enhancing communication, data transmission, and patient care in hospitals and healthcare settings, particularly in scenarios where traditional wireless technologies face limitations. As the technology matures and becomes more widely adopted, its potential to revolutionize healthcare delivery will likely continue to expand.

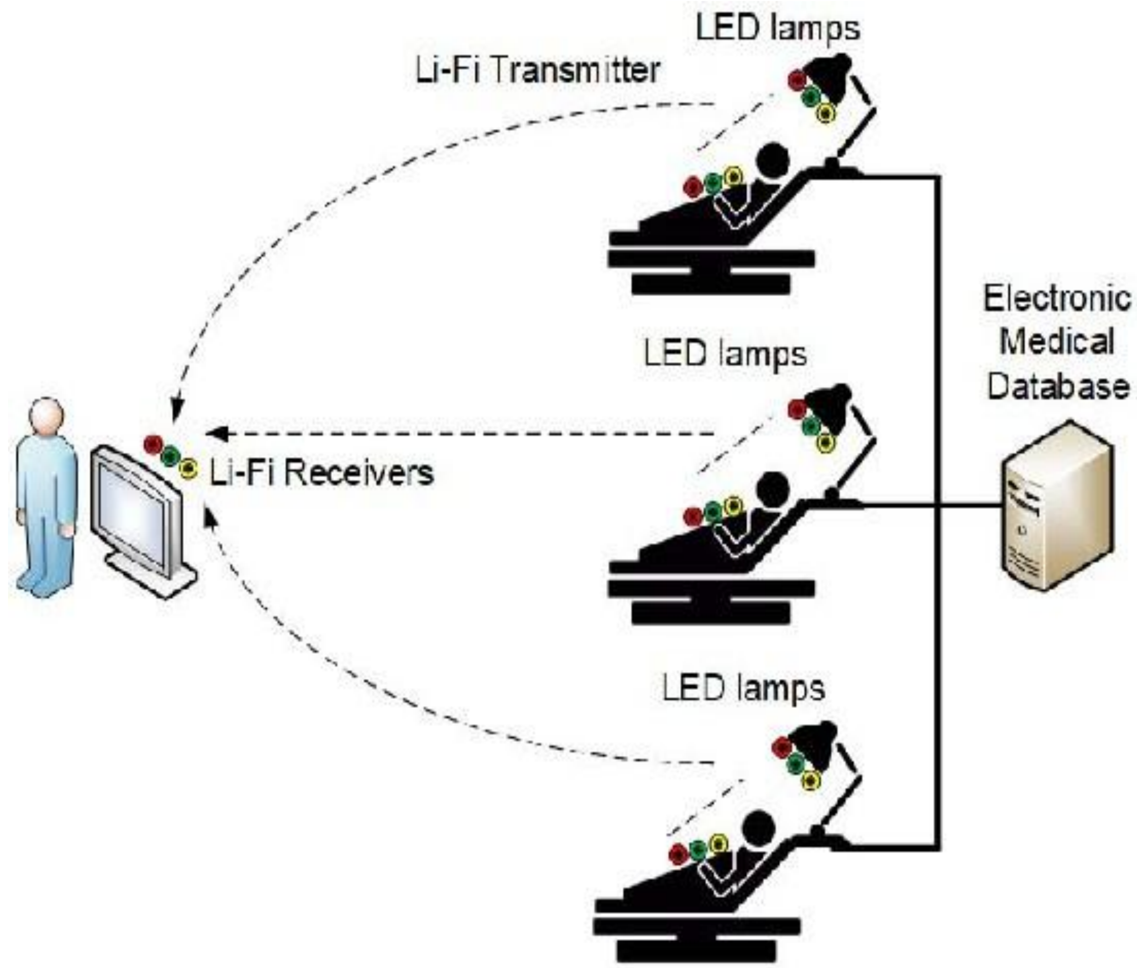

Figure 1.3 Working of LiFi in Healthcare

- It can also be used to monitor patients within the room through

light-based markers, which can be set to sound alarms when specific conditions are (or are not) met.

- It can also be used to easily locate equipment.
- It can be used to optimize the storage of materials and medication within the hospital pharmacy.

1.7 PROBLEM STATEMENT

1. To develop analytics for hospitals health-care data, optimizing data utilization to improve patient care, streamline operations, and enhance overall efficiency in healthcare institutions.

2. If Wi-Fi is implemented in many hospitals, interference from cell phones and computers can block signals from monitoring equipment.

3. Without proper surveillance systems in place, it becomes difficult to detect and track disease outbreaks in real-time, leading to delays in response and increased transmission rates.

4. Without accurate data on disease prevalence and distribution, healthcare resources such as vaccines, medications, and personnel may be allocated inefficiently, resulting in shortages in some areas and wastage in others.

5. Inadequate surveillance can impede efforts to monitor antimicrobial resistance patterns, allowing resistant pathogens to spread unchecked and reducing the effectiveness of treatment options.

6. Without robust surveillance systems, many health issues may go unreported, leading to a skewed understanding of disease burden and hindering efforts to implement effective public health interventions.

7. A lack of surveillance infrastructure can result in the absence of early warning systems for potential health crises, making it challenging to implement timely interventions to mitigate risks and protect public health.

1.8 OBJECTIVE

The Objective for addressing problems in healthcare is multifaceted and stems from various factors including:

- **Improving Patient Outcomes:**

Enhancing healthcare aims to improve patient health and well-being. By addressing problems within the healthcare system, such as inefficiencies or gaps in care, the overall quality of patient outcomes can be enhanced.

- **Reducing Costs:**

Healthcare costs can be a significant burden on individuals,families, and society as a whole. Addressing problems within the healthcare system can help in reducing costs through efficiency improvements, preventative care measures, and better management of chronic conditions.

- **Enhancing Access to Care:**

Disparities in access to healthcare services exist globally.By addressing problems such as geographic barriers, financial limitations, or cultural factors, efforts can be made to ensure that all individuals have equitable access to quality healthcare services.

- **Advancing Medical Science:**

Many problems in healthcare drive the need for further research and innovation.By addressing these issues, there's an opportunity to advance medical science, develop new treatments, and improve diagnostic techniques, ultimately leading to better patient care.

- **Ensuring Healthcare Equity:**

Healthcare disparities based on factors such as race,ethnicity, socioeconomic status, gender, or geography are prevalent in many healthcare systems. Motivation to address these problems comes from the desire to achieve healthcare equity and ensure that all individuals receive fair and just treatment.

- **Mitigating Public Health Crises:**

Public health crises, such as pandemics or outbreaks of infectious diseases, highlight the importance of addressing healthcare problems. Motivation to tackle these issues comes from the need to protect public health and prevent widespread harm.

1.9 APPLICATIONS

- **Hospital Settings:**

This system can be deployed in hospitals for continuous monitoring of patients' vital signs, allowing healthcare professionals to respond promptly to any changes in health status.

- **Home Healthcare:**

Patients with chronic illnesses or those requiring constant monitoring can benefit from this system at home. Caregivers can remotely monitor the patient's health status and receive alerts if any parameter falls outside the normal range.

- **Emergency Response:**

In emergency situations, such as natural disasters or accidents, this system can provide vital signs monitoring and alerting capabilities even in areas with limited connectivity.

- **Remote Areas:**

In remote or rural areas where traditional internet connectivity may be limited, LiFi-based systems can offer a reliable means of transmitting health data for remote patient monitoring.

- **Clinical Trials and Research:**

Researchers conducting clinical trials or longitudinal studies can use this system to collect real-time health data from participants in a non-intrusive manner.

Overall, the proposed LiFi-based patient health monitoring system offers a reliable, secure, and efficient solution for continuous health monitoring and timely intervention, improving patient outcomes and quality of care.

1.10 ADVANTAGES

Advantages of a LiFi-based patient health monitoring system with the described components include:

1. High-Speed Data Transmission:

LiFi technology offers high-speed data transmission compared to traditional wireless communication methods like WiFi or Bluetooth. This ensures real-time monitoring of patient health parameters with minimal latency.

2. Secure Data Transmission:

LiFi operates using light signals, which are confined to a specific area and cannot penetrate through walls, offering increased security compared to radio frequency-based communication methods. This helps in maintaining the privacy and confidentiality of patient health data.

3.Immunity to Electromagnetic Interference (EMI):

LiFi communication is immune to electromagnetic interference, making it suitable for use in environments where EMI is a concern, such as hospitals or healthcare facilities.

4. High Bandwidth:

LiFi technology offers a large bandwidth, enabling the transmission of a significant amount of data. This allows for the simultaneous monitoring of multiple health parameters of the patient without compromising on data accuracy or speed.

5.Reduced Risk of Interference:

Since LiFi uses light waves for communication, it is less likely to interfere with medical equipment or other electronic devices commonly found in healthcare settings, ensuring reliable and uninterrupted data transmission.

6. Energy Efficiency:

LiFi technology consumes less power compared to traditional wireless communication methods, making it more energy-efficient. This is advantageous in healthcare applications where energy conservation is important.

7. Compact and Lightweight Components:

LiFi transmitters and receivers can be designed to be compact and lightweight, making them suitable for integration into wearable health monitoring devices or medical equipment without adding significant bulk or weight.

8. Easy Deployment:

Setting up a LiFi-based patient health monitoring system is relatively straightforward since it does not require complex infrastructure or extensive cabling. This makes it easy to deploy in various healthcare settings, including hospitals, clinics, and even remote locations.

9. Compatibility with Existing Infrastructure:

LiFi technology can be seamlessly integrated with existing infrastructure, such as LED lighting systems, making it cost-effective to implement without the need for major infrastructure overhauls.

10. Remote Monitoring and Alerting:

The inclusion of a ESP32 module allows for remote monitoring of patient health parameters and the provision of alerts in case of any abnormalities. This ensures timely intervention and medical assistance, potentially saving lives in critical situations.

1.11 SUMMARY

In summary, while WiFi offers broader coverage and established infrastructure, LiFi provides higher security and potentially faster data transfer rates, especially in environments where interference is a concern. The choice between the two technologies depends on the specific requirements of the application.Additionally, LiFi can be affected by factors like light interference and obstruction, which can impact its reliability. On the other hand, WiFi offers greater coverage and is more suitable for widespread connectivity in various settings. Overall, both technologies have their advantages and limitations, and their suitability depends on specific use cases and requirements.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

The literature survey on LiFi in data communication provides a comprehensive overview of the existing research landscape, focusing on advancements, challenges, and emerging trends in this dynamic field. This exploration aims to glean insights into the evolution of LiFi technologies, Data Transmission on key studies that have shaped our understanding of LiFI in data communication.

LiFi technology, also known as Light Fidelity, has garnered significant interest as a promising alternative to traditional wireless communication methods like WiFi. In a literature survey of LiFi technology, several key themes emerge. Firstly, researchers have focused on its fundamental principles, which involve transmitting data through visible light using LED bulbs. Studies have explored the modulation techniques, such as intensity modulation and orthogonal frequency-division multiplexing (OFDM), to achieve high data rates.

Additionally, investigations have been conducted into the potential applications of LiFi, ranging from indoor wireless communication in offices and homes to specialized use cases like communication and secure data transmission in environments where radio frequency interference is a concern. Moreover, researchers have explored the challenges facing LiFi deployment, including mobility issues due to line-of-sight requirements, as well as strategies to mitigate these limitations through hybrid LiFi/WiFi systems and intelligent algorithms for seamless handover between access points. Overall, the literature survey underscores the growing interest in LiFi technology and highlights avenues for further research and development to realize its full potential in various domains.

Zohaib A. Khan1 , Ahsan Ali1 , Rao Behram1 , Faisal Johar1 , Saqib Amin1 , Muhammad Sadiq Orakzai1 , and Faraz Akram2 [2022]
In hospitals, patient monitoring is typically done by hand with assistance from nursing staff around-the-clock. The availability of nursing staff to keep an eye on the well-being of newborns or critically ill patients is a labor-intensive and challenging responsibility. If there is a lack of attention or a delay, the patient's health could deteriorate to the point of death. Many wireless technologies have been proposed to monitor the patient's state using various sensors in an attempt to tackle this problem; nevertheless, these wireless methods can even interact with medical devices and represent a risk to patients and newborns. Li-Fi based health monitoring systems that measure heart rate, temperature, and movements in case of an emergency have been presented as a way to create hospital-friendly monitoring systems.

G. Devi1 , N. Jayanthi1 , S. Rahul1 , M. Saran Karthick1 , S. Gokul Raghavendra2 , M. Anand3 [2023] Lifi technology was developed in response to the sharp rise in user population, which led to an increase in demand for wireless applications. The signals are transmitted by LED light. Visible light data transmission has higher security defense and is more efficient than radio waves. The fact that visible light is free to use is another important factor in its widespread use. Due to its non-harmful nature and data security features, Lifi technology is being used more often in hospital areas and security communications. According to communication domain predictions, there will be a significant increase in demand for Lifi technology in the near future. This demand includes communications in space and underwater. Lifi technology can't completely replace radio wave transmission technology because of its few limitations.In any case, the hybrid model—which combines wifi and Lifi technology—is highly demanded in the field of communication going forward. This review aids researchers investigating this communication technology in broadening their search.

Kouchini, Sepideh Mohammadi and Kottke, Christoph and Ma, Ziyan and Freund, Ronald and Jungnickel, Volker and Müller, Marcel and Behnke, Daniel and Vazquez, Marcos Martinez and Linnartz, Jean-Paul M. G [2021] In Industry 4.0, precise location data is thought to be the primary facilitator for the deployment of smart manufacturing systems. Based on the ITU-T recommendation G.9991, a time-of-flight based indoor positioning system for LiFi is provided in this paper. Our goal is to achieve location using the reuse of pre-existing functionalities of the widely-adopted LiFi communication protocol. Our positioning approach is based on two steps: a precise timing measurement using the channel estimation preamble, and a coarse timing measurement using the frame synchronization preamble, which is identical to the ranging. This method operates in a variety of settings and doesn't need fingerprints or an understanding of the beam characteristics of transmitters and receivers. The new algorithm is verified by means of experiments as well as simulations.Findings in a 1 m × 1 m × 2 m region show that G.9991-based positioning is capable of achieving an average three-dimensional distance inaccuracy of a few centimeters.

Mana, Sreelal M. and Gabra, Kerolos G. K. and Kouhini, Sepideh M. and Hinrichs, Malte and Schulz, Dominic and Hellwig, Peter and Paraskevopoulos, Anagnostis and Freund, Ronald and Jungnickel, Volker [2022] We introduce a simplified channel modeling technique for LiFi in indoor situations. A LIDAR scanner captures the 3D area where the LiFi system will be placed. The produced 3D point cloud data is pre-processed to calculate reflectance characteristics for the room's walls and objects. This method is more practical than manually defining the environment, which is now the standard. To simplify channel modeling, the line-of-sight and beginning reflections are carefully modeled in the frequency domain. Additionally, a well-established analytical model based on the integrating sphere is used for higher-order diffuse reflections. All stages combined result in a much simpler channel modeling method that is used to properly describe the connections between various optical frontends and mobile devices. To validate our novel technique, we compared measurements and simulations in two indoor scenarios: an empty room and a conference room with furniture. Simulations and measurements demonstrate good agreement, with a mean square error of less than 3%.

Mana, Sreelal Maravanchery and Jungnickel, Volker and Bober, Kai Lennert and Hellwig, Peter and Hilt, Jonas and Schulz, Dominic and Paraskevopoulos, Anagnostis and Freund, Ronald and Hirmanova, Klara and Janca, Radek and Chvojka, Petr and Zvanovec, Stanislav [2021] LiFi, or networked optical wireless communication, is projected to play a key role in smart hospitals. This report presents the first experimental investigation on LiFi in an operating room at Motol University Hospital in Prague, Czech Republic. We conducted one-to-one measurements using an optical transmitter (Tx) and receiver (Rx) and found that channels with free LOS offer enough signal strength for mobile communication within the operating room. The various LOS lines are combined into a multiple-input, multiple-output (MIMO) link with four distributed transmitters representing wireless infrastructure and six distributed receivers representing medical equipment. In this design, the MIMO channel matrix has at least two strong singular values, allowing for spatial multiplexing.Mobile devices can be handled simultaneously with proper transmitter clustering and user selection.

Kai Lennert Bober,Student Member,Sreelal Maravanchery Mana,Malte Hinrichs,Sepideh Mohammadi Kouhini,Christoph Kottke,Dominic Schulz,Christian Schmidt,Ronald Freund and Volker Jungnicke [2021] This paper introduces LiFi, a networked optical wireless communication system designed for industrial applications. These include mobility support with moderate data rates per device, dependable real-time communication, and integrated location.We present a distributed multi-user multiple-input multiple-output architecture that serves mobile devices over an optical wireless infrastructure. The system comprises a central unit coupled to dispersed optical frontends that span a vast region. Our major contribution is a medium access control technique using space division multiple access. The evaluation findings highlight the benefits of cooperative transmission from nearby optical frontends and dynamic switching between spatial diversity and multiplexing. Indoor channel measurements highlight the need of spatial multiplexing. Additionally, we provide a low-power physical layer using on-off-keying for battery-powered mobile devices.

Amran, Nurul Aini and Soltani, Mohammad Dehghani and Yaghoobi, Mehrdad and Safari, Majid [2022] In a realistic interior context, seamless light fidelity (LiFi) communications confront obstacles such as loss of line-of-sight (LOS) owing to mobile device orientation or room obstruction. The LiFi channel's frequency response is heavily influenced by environmental factors. The channel's dynamic nature depends on both the room's geometric design and user behavior. This paper explores the potential of deep learning (DL)-based LiFi communication techniques to outperform traditional channel estimation techniques, especially when real-time channel state information

(CSI) is limited.Simulation studies show that DL-based LiFi systems with partial CSI may achieve comparable performance to optimum signal recognition and resource allocation with perfect CSI. Furthermore, DL-based solutions outperform traditional benchmark systems using channel estimation algorithms like least squares (LS) and minimal mean square error (MMSE).

Kai Lennert Bober , Student Member,, Sreelal Maravanchery Mana , Malte Hinrichs, Sepideh Mohammadi Kouhini, , Christoph Kottke , Dominic Schulz , Christian Schmidt , Ronald Freund , and Volker Jungnicke [2021] Optical Wireless Communication (OWC) is gaining interest from academics and business as a possible alternative to standard radio frequency communication. LiFi receivers are intended to observe several transmitters within their field-of-view, allowing for smooth handover and resilience against line-of-sight obstruction. Proper user scheduling is necessary to balance spatial multiplexing and interference. This work identifies which simultaneous broadcasts cause detrimental interference and recommends scheduling them in various time periods. Based on this formulation, we offer our semi-distributed Spatially Extended TDMA method, which uses a time division contention-free access mechanism. Compared to advanced algorithms, our scheduling method.Our scheduling protocol outperforms current approaches in terms of computing time and minimal user throughput. Our approach improves basic user throughput by up to 91% in a scenario with 9 transmitters and up to 15 receivers, making it a viable alternative for dense LiFi networks.

Zhang, Fan and Chen, Jiaxuan and Mao, Tianqi and Wang, Zhaocheng [2021] Using densely placed light-emitting diodes (LEDs) as transmitters, multiple-input-single-output (MISO) is a promising strategy for improving the transmission throughput of LiFi networks. To optimize cooperative transmission of numerous LEDs, beamforming techniques are used to boost downlink throughput. This needs knowledge of channel state information (CSI) at the transmitter. This article explores maximizing the weighted bidirectional transmission throughput by optimizing the feedback interval, which refers to the duration between two adjacent feedbacks, as frequent CSI feedback might be costly. A quasi-optimal solution is used to decrease computing complexity by approximating the exact optimal solution.Simulation findings demonstrate that the proposed feedback interval optimisation significantly improves weighted bidirectional throughput by reducing CSI feedback cost compared to standard feedback systems.

Ma, Guanghui and Parthiban, Rajendran and Karmakar, Nemai [2022] The hybrid light fidelity (LiFi) and wireless fidelity (WiFi) network (HLWNet) might be a key component of future indoor wireless networks. Handover in the HLWNet is complicated owing to sensitive optical signal propagation and dense deployment of LiFi access points, making it difficult to develop a system that can adapt to various indoor working conditions. This work proposes a unique handover scheme that categorizes handover events in HLWNet and applies a specific technique for each category to determine the best dwell duration throughout the handover operation.The suggested handover strategy adapts to varied working scenarios by gathering information on numerous parameters, including channel quality, user velocity, and arrivals data rate, to determine handover decisions and compute stay value.The suggested solution outperforms benchmarks by increasing user throughput by 65%, decreasing handover rate by up to 80%, and reducing packet latency by up to 57%. Furthermore, the suggested strategy enhances user throughput and handover rate resilience under various conditions.

Hanaa Abu Marshoud, Mohammad Dehghani Soltani, Majid Safari , Haralad Haas[2021] This article examines the secrecy performance of light-fidelity (LiFi) networks while accounting for random device orientation and imperfect knowledge of the channel state information of the eavesdroppers. In particular, both the situation of a single eavesdropper and the scenario of numerous eavesdroppers are analyzed in terms of secrecy capacity and secrecy outage probability. Furthermore, a machine learning-driven access point (AP) selection technique is introduced, aiming to optimize the legitimate users' ability for secrecy. Our findings demonstrate that a considerable improvement in the possible secrecy performance may be obtained by optimizing the AP selection while accounting for the random behavior of the optical channel.Indeed, secrecy capacity can increase by up to 30% when AP selection is based on the obtained realistic secrecy expressions.

Trang Nguyen , Mohamed Sufyan Islim , Cheng Chen , and Harald Haas , Fellow[2021] This work presents indexed dimming (iDim), a new dimming approach for Light Fidelity (LiFi) that utilizes time-domain sample index modulation. The goal is to achieve a wide brightness range while retaining high signal-to-noise ratio (SNR) and transmission rate. DCO-OFDM is used to provide innovative line codes. The system's performance is validated experimentally using an NI PXIe-1085 and NI-7966R FPGA. The suggested iDim dimming approach outperforms existing dimming methods like amplitude modulation (AM) based on implementation findings. The iDim method's lowest optical power is 20 μW, which is 10 times lower than previously observed.The iDim technology maintains an SNR of 22.5 dB throughout all brightness levels, while the AM-dimming approach significantly lowers SNR when light is decreased. iDim has a greater transmission rate than DCO-OFDM. This reduces optical power per bit by up to 40% compared to sDim, a PWM-inspired dimming approach. iDim is a potential dimming technology for applications that require extremely low light levels.

Harald Haas, Liang Yin, Cheng Chen, Stefan Videv, Damian Parol, Enrique Poves, Hamada Alshaer, AND Mohamed Sufyan Islim[2020] LiFi refers to networked, bidirectional wireless communication using light. It connects stationary and mobile devices at high data speeds using visible light and infrared spectrum. The combined spectral resources are 2600 times bigger than the whole radio frequency (RF) spectrum. This article explains why LiFi is a timely technology, particularly for 6G cellular communications. This article explores key networking technologies, including interference reduction and hybrid LiFi/Wi-Fi topologies. We explore how LiFi may be seamlessly integrated into existing wireless networks, creating heterogeneous networks across optical and RF domains. We also address load balancing issues and solutions.Finally, we provide the outcomes of a real-world hybrid LiFi/Wi-Fi network implementation in a software defined networking testbed. Results from a LiFi deployment in a school classroom demonstrate considerable improvements in Wi-Fi network performance by offloading traffic to LiFi.

Ma, Guanghui and Parthiban, Rajendran and Karmakar, Nemai [2022] The hybrid LiFi and WiFi network (HLWNet) offers unique benefits in indoor wireless data transmission by combining the high user throughput of LiFi with the widespread coverage of WiFi. The line-of-sight transmission of optical signals makes handover decision-making more hard in HLWNets compared to earlier heterogeneous networks. This research proposes an ANN-based handover solution for the HLWNet's binary classification challenge. The handover strategy uses two sets of artificial neural networks (ANNs) to make judgments based on channel quality, user movement, and device orientation. The suggested approach is compared against benchmarks using an indoor simulation environment.

2.2 SUMMARY

The papers highlight the diverse landscape of Li-Fi based patient health monitoring systems that offer a novel approach to real-time monitoring of vital health parameters with advantages in data transmission speed, security, and interference immunity. The survey emphasizes ongoing advancements and integration thereby improving patient care and safety. Further research and development are needed to optimize the system's performance and ensure its reliability in clinical settings.

Light Fidelity, or LiFi, is a new wireless communication technology that offers potential benefits over conventional radio frequency-based systems by transmitting data via visible light. This review of the literature explores several facets of LiFi technology, including its core ideas, difficulties in implementation, and possible uses. In order to improve the efficiency and dependability of data transmission, researchers have looked at the physical layer components, such as modulation schemes, signal processing algorithms, and channel parameters. Additionally, research has looked at real-world deployment scenarios, such vehicle networks, underwater communication, and interior localization, demonstrating LiFi's adaptability in a variety of settings. Research is now underway to solve obstacles that stand in the way of LiFi's inclusion into mainstream communication infrastructures, including mobility support, interference reduction, and standardization.

CHAPTER 3

EXISTING SYSTEM

3.1 INTRODUCTION

The existing hospital management system typically relies on conventional data communication technologies, predominantly Wi-Fi and wired networks. These systems facilitate the exchange of information crucial for patient care, administrative tasks, and overall hospital operations. However, certain limitations and challenges are inherent in the current setup.

In hospitals around the world, the management and transmission of patient data are critical components of providing effective healthcare services. While many healthcare facilities have transitioned to real-time data transmission systems to streamline operations and enhance patient care, there are still numerous hospitals that rely on traditional methods of data management. In these hospitals, patient information is often recorded and transmitted manually, leading to potential inefficiencies and delays in accessing critical data.

The existing system in hospitals without real-time data transmission typically involves a combination of paper-based records and electronic health record (EHR) systems that may not have the capability to transmit data in real-time. Healthcare providers rely on manual data entry and periodic updates to maintain patient records, which can lead to challenges in communication, coordination of care, and decision-making.

This Project will explore the existing system design methodology in hospitals without real-time data transmission, examining the processes and challenges associated with managing patient information in such environments. By understanding the limitations of these systems, we can identify opportunities for improvement and explore potential solutions to enhance the delivery of healthcare services.

3.2 EXISTING WORK

Delays in Data Access: Without real-time data transmission, healthcare providers may experience delays in accessing patient information. This can result in inefficiencies in patient care, as providers may need to wait for updated information or rely on outdated records.

Communication Challenges: Healthcare teams may face challenges in coordinating care and communicating patient information in real-time. Without a system for instant data transmission, providers may need to rely on phone calls, pagers, or face-to-face communication to share information, which can be time-consuming and prone to errors.

One significant aspect of the existing system is the reliance on Wi-Fi for data transmission. While Wi-Fi is widely used and provides wireless connectivity, it has limitations, including susceptibility to electromagnetic interference and congestion, especially in high-density environments like hospitals. The potential for interference can impact the reliability and speed of data transfer, which is critical for real-time communication in healthcare settings.

Moreover, the existing system may face challenges related to security and privacy concerns. Wi-Fi networks, although equipped with encryption protocols, may still be vulnerable to unauthorized access and data breaches. Hospitals deal with highly sensitive patient information, and ensuring the confidentiality and integrity of this data is paramount. Stricter privacy regulations and increasing cybersecurity threats necessitate a robust and secure data communication framework.

Additionally, the current system may encounter scalability issues. As healthcare facilities grow and adopt more advanced medical technologies, the existing infrastructure might struggle to handle the increasing volume of data generated and transmitted within the hospital. This could result in slower data transfer speeds and potential bottlenecks, hindering the efficiency of hospital management processes.

Furthermore, the prevalence of medical equipment and devices relying on wireless communication in hospitals introduces challenges in terms of network congestion. The coexistence of various wireless devices competing for bandwidth can lead to performance issues, affecting the reliability of data transfer and potentially causing delays in critical processes.

3.3 DESIGN METHODOLOGY

Wi-Fi plays a central role in providing wireless connectivity for a myriad of devices within the hospital. It facilitates the seamless exchange of information, enabling healthcare professionals to access electronic health records (EHRs), communicate in real-time, and utilize digital tools for diagnostics and monitoring. The prevalence of Wi-Fi connectivity enhances flexibility, allowing medical staff to access critical data using mobile devices.

However, the existing system faces challenges, particularly in terms of reliability and security. Wi-Fi networks are susceptible to electromagnetic interference, which can impact the speed and stability of data transfer. In a hospital setting where timely and accurate information is crucial, potential interruptions pose a risk to efficient patient care and operational workflows.

Ensuring seamless communication between different systems and devices from various vendors is complex. Inconsistencies in data formats and protocols may hinder the fluid exchange of information, affecting decision-making and overall operational effectiveness.

The existing system's centralized approach to data storage and processing may introduce vulnerabilities. In the event of server failures or network outages, there is a risk of disrupted access to critical patient information. While redundancy measures can mitigate some of these risks, they add complexity and cost to the overall infrastructure.

In hospitals without real-time data transmission, the design methodology for managing patient information typically revolves around traditional systems and processes. Here's an overview of the existing system design methodology:

- **Batch Processing:**

Updates to patient records, such as new diagnoses, treatment plans, or medication orders, may be processed in batches at regular intervals rather than in real-time. This means that changes entered into the system may not be immediately available to all users.

- **Centralized Data Storage:**

Patient data is typically stored in a centralized database or repository within the hospital's information technology (IT) infrastructure. Access to this data may be restricted to authorized personnel, and security measures are in place to protect patient confidentiality.

- **Scheduled Data Synchronization:**

In some cases, data synchronization between different systems or departments may occur on a scheduled basis rather than in real-time. For example, laboratory results may be imported into the EHR system at specific intervals, such as hourly or daily.

- **Paper-based Communication:**

Communication of patient information among healthcare providers may rely on paper-based methods, such as written notes, charts, or forms. These documents may be physically transported between departments or units within the hospital.

Implementing real-time data transmission systems can help improve patient care, streamline workflows, and enhance communication among healthcare providers.As technology continues to advance, many hospitals are increasingly transitioning towards implementing real-time data transmission solutions to improve patient care and operational efficiency.

Communication among healthcare teams often relies on paper-based methods, such as written notes and charts, which can be time-consuming and prone to errors. Despite efforts to maintain patient confidentiality and security, the reliance on manual processes increases the risk of data inaccuracies and compromises patient care. In This Project, we will delve into the challenges and limitations of the existing system in hospitals without real-time data transmission, with the aim of identifying opportunities for improvement and exploring potential solutions to enhance the delivery of healthcare services.

Overall, the design methodology in hospitals without real-time data transmission is characterized by manual processes, batch processing, and scheduled data synchronization. While these systems may suffice for basic record-keeping and communication, they can be prone to inefficiencies, delays, and errors compared to real-time data transmission systems. Hospitals without real-time data transmission may experience inefficiencies, delays in care, and challenges in communication and data integration.

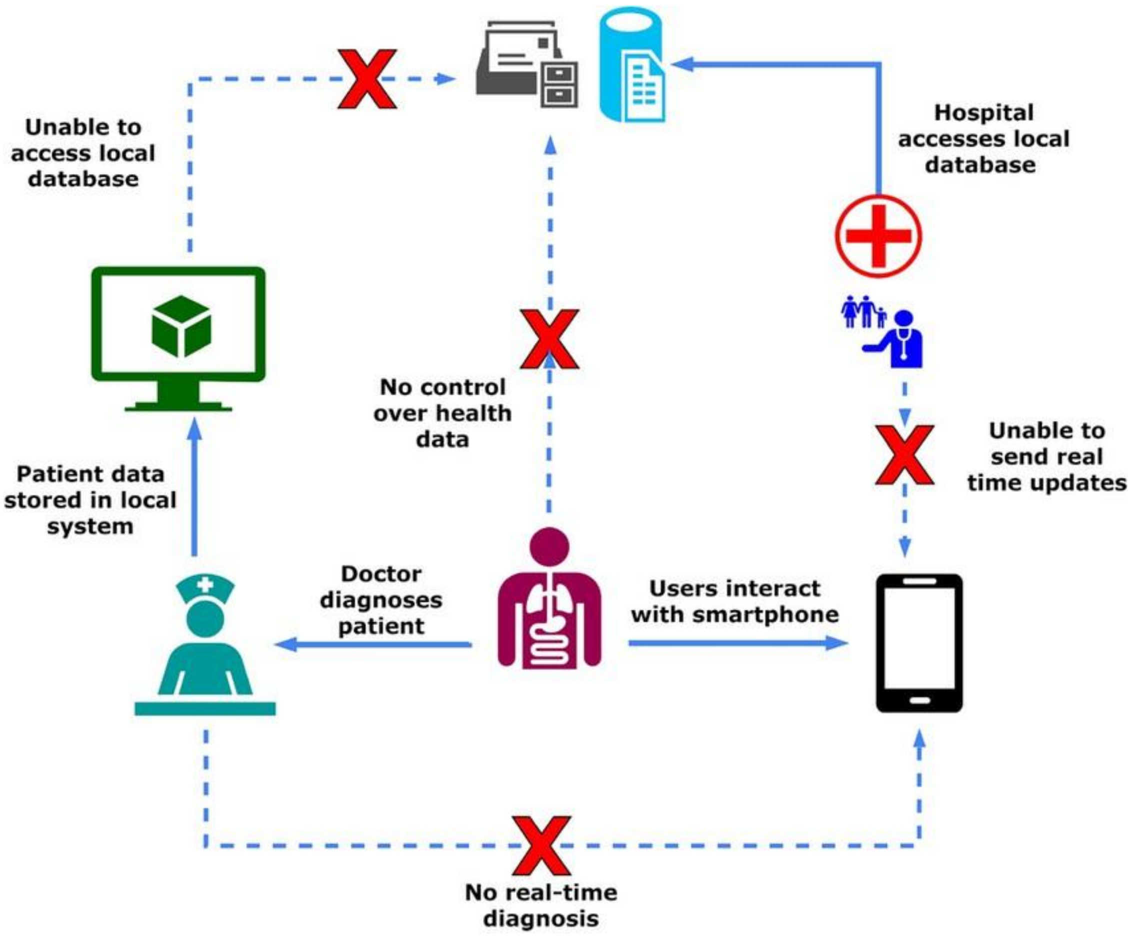

Figure 3.1 Existing system of Hospital Management

3.4 SUMMARY

In summary, while the existing hospital management system using Wi-Fi and traditional data communication methods serves its basic functions, it faces challenges related to reliability, security, and scalability. Recognizing these limitations becomes essential in exploring innovative solutions that can address these issues and enhance the overall effectiveness of hospital management processes. The introduction of emerging technologies, such as LiFi, presents an opportunity to overcome these challenges and propel hospital data communication into a more efficient and secure era.

CHAPTER 4

PROPOSED SYSTEM

4.1 INTRODUCTION

A LiFi-based patient health monitoring system revolutionizes the way healthcare providers monitor patients' vital signs in real-time. This innovative system integrates advanced technologies to ensure accurate data collection, efficient transmission, and timely alerts for medical interventions.

In recent years, advancements in healthcare technology have revolutionized patient monitoring systems, making them more efficient, reliable, and accessible. One such innovative solution is the LiFi-based Patient Health Monitoring System, which integrates multiple sensors with LiFi technology to provide real-time monitoring of vital health parameters. This system utilizes a combination of sensors, LiFi transmitters and receivers, LCD displays, ESP32 for graphical representation and timely intervention for patients' well-being.

In real-time healthcare monitoring of patient vital signs is paramount for timely intervention and enhanced patient care. The advent of Light Fidelity (LiFi) technology has opened up new avenues for high-speed wireless communication, offering a promising solution for transmitting crucial health data securely and efficiently.

Our proposed LiFi-based patient health monitoring system integrates essential sensors such as a heart rate sensor, respiratory sensor, and temperature sensor to continuously monitor vital signs. These sensors collect analog data, which is then converted to digital format using analog-to-digital converters (ADCs). Subsequently, the digital data is transmitted via a LiFi transmitter to a LiFi receiver, ensuring reliable and high-speed communication.

The received data is then displayed on an LCD screen for immediate visualization and interpretation by healthcare professionals. Additionally, ESP32 is utilized for graphical representation, providing a comprehensive view of the patient's health parameters over time.

Furthermore, Blynk incorporates a aleret system to issue alerts in real-time when any monitored health parameter deviates beyond predefined thresholds, enabling swift medical intervention. By harnessing the power of LiFi technology, our system aims to revolutionize patient monitoring by offering fast, secure, and accurate transmission of vital health data, ultimately improving patient outcomes and enhancing overall healthcare delivery.

4.2 PROPOSED WORK

The proposed system for hospital management introduces a cutting-edge paradigm by incorporating LiFi (Light Fidelity) technology into the existing infrastructure. LiFi utilizes visible light waves for data transmission, offering a range of advantages that can revolutionize the efficiency, reliability, and security of data communication within the healthcare facility.

At the heart of the proposed system is the use of LiFi-enabled devices and strategically positioned access points throughout the hospital. This deployment ensures comprehensive coverage, allowing for seamless connectivity in critical areas such as patient rooms, operating theaters, and diagnostic facilities. The high-speed data transfer capabilities of LiFi are especially significant in a hospital setting where real-time communication is pivotal for swift decision-making and delivering prompt, accurate patient care.

A key benefit of LiFi is its minimal electromagnetic interference, making it ideal for healthcare environments. In hospitals, where a multitude of sensitive medical equipment is in use, minimizing interference is crucial to ensure the reliability of data transfer. By embracing LiFi, the proposed system aims to enhance the dependability of transmitting critical medical records, diagnostic images, and real-time monitoring data.

Security is paramount in healthcare data management, and LiFi offers a unique advantage in this regard. Operating within confined areas, LiFi signals are less susceptible to unauthorized interception compared to traditional wireless technologies. This inherent security feature aligns with the stringent privacy requirements governing patient information, mitigating the risk of data breaches and unauthorized access to sensitive medical records.

Implementing the proposed LiFi-based system necessitates a phased approach. This involves the installation of LiFi infrastructure, including compatible devices and access points. Additionally, hospital staff would undergo comprehensive training programs to familiarize themselves with LiFi technology, ensuring a smooth transition. The proposed system's success relies on the collaboration of IT specialists, healthcare professionals, and administrators to seamlessly integrate LiFi into existing hospital management processes.

While the initial investment may pose a challenge, the long-term benefits are substantial. The proposed system has the potential to significantly enhance the hospital's overall operational efficiency, reducing data transfer latency and improving the accuracy of information dissemination. Moreover, the improved reliability and security of LiFi contribute to a healthcare environment where patient data is protected, facilitating compliance with privacy regulations and instilling confidence in patients and healthcare providers alike.

A proposed LiFi-based patient health monitoring system integrates various sensors such as a heart rate sensor, respiratory sensor, and temperature sensor to continuously monitor the patient's vital signs. These sensors collect analog data, which is then transmitted to an analog-to-digital converter for processing. The digital data is subsequently transmitted via a LiFi transmitter to a LiFi receiver. At the receiving end, the data is displayed on an LCD screen for real-time monitoring. Additionally, a ESP32 is employed for graphical representation, providing a visual depiction of the patient's health parameters over time.

In this system, the LiFi technology offers advantages over traditional wireless communication methods by providing faster data transmission rates, enhanced security, and immunity to electromagnetic interference. Moreover, LiFi can be particularly beneficial in healthcare settings where electromagnetic interference may disrupt sensitive medical equipment.

In conclusion, the proposed LiFi-based system for hospital management holds the promise of transforming data communication in healthcare, fostering a more responsive, secure, and efficient environment that ultimately benefits both medical professionals and patients.

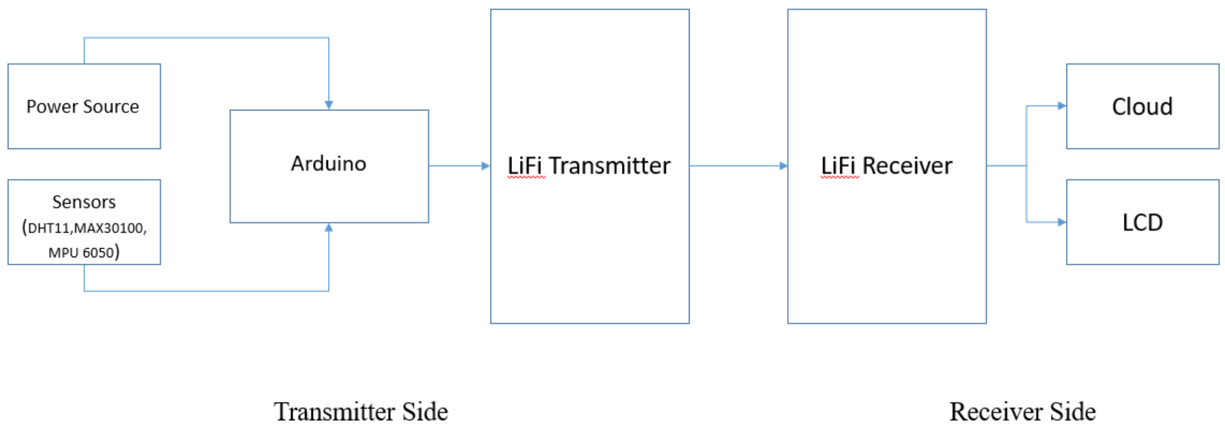

Figure 4.1 Block diagram of Proposed system

4.3 WORKING

The LiFi-based patient health monitoring system represents a cutting-edge innovation in healthcare technology, harnessing the power of Light Fidelity (LiFi) communication to transmit vital patient data swiftly and securely. This sophisticated system integrates multiple sensors, including a heart rate sensor, respiratory sensor, and temperature sensor, to continuously monitor the patient's vital signs in real-time.

As the sensors gather analog data, they are connected to analog-to-digital converters (ADCs) to transform these analog signals into digital format for processing. This digital data is then transmitted via a LiFi transmitter, which utilizes visible light communication (VLC) technology to encode the data into light signals. LiFi offers several advantages over traditional wireless communication methods, including higher data transmission rates, greater security, and immunity to electromagnetic interference.

A LiFi-based patient health monitoring system revolutionizes the way healthcare providers monitor patients' vital signs in real-time. This innovative system integrates advanced technologies to ensure accurate data collection, efficient transmission, and timely alerts for medical interventions.

At its core, the system comprises essential sensors such as a heart rate sensor, respiratory sensor, and temperature sensor. These sensors are strategically placed on the patient to continuously monitor key health parameters. The analog data collected by these sensors are then fed into an analog-to-digital converter (ADC) to convert them into digital signals, ensuring compatibility with modern digital systems.

The digital data is then transmitted through a LiFi (Light Fidelity) transmitter. LiFi technology utilizes light waves to transmit data, offering advantages such as high-speed data transfer, immunity to electromagnetic interference, and increased security. The LiFi transmitter efficiently transmits the digitized health data to a LiFi receiver situated within the healthcare facility.

Upon reaching the LiFi receiver, the encoded data is decoded and fed into a system comprising an LCD display and a ESP32 (Microcontroller Unit) for graphical representation. The LCD display provides real-time updates on the patient's vital signs, allowing healthcare professionals to monitor the patient's condition with precision and accuracy. Additionally, the ESP32 facilitates graphical representation, enabling the visualization of trends and patterns in the patient's health parameters over time.

4.4 DESIGN METHODOLOGY

In this design methodology, we propose a LiFi-based patient health monitoring system that integrates various sensors to monitor vital signs such as heart rate, respiratory rate, and body temperature. The system is designed to collect analog data from these sensors, convert it into digital format, transmit it using LiFi technology, and display the information on an LCD screen. Additionally, the system incorporates a ESP32 for graphical representation of data and alert healthcare providers in case of any critical health parameter deviations.

Designing a LiFi-based patient health monitoring system involves several steps, including hardware selection, sensor integration, data conversion, LiFi transmission, and display. Here's a design methodology process:

Hardware Selection:

- Choose appropriate sensors for heart rate, respiratory rate, and temperature monitoring. Ensure they are compatible with the microcontroller you plan to use.
- Select a microcontroller capable of processing sensor data and interfacing with the Analog to Digital Converter (ADC).
- Choose an ADC to convert the analog sensor data into digital format.
- Select a LiFi transmitter module and receiver module for wireless data transmission.
- Decide on a suitable display module such as an LCD to visualize the monitored data.

Sensor Integration:

- Connect the heart rate, respiratory rate, and temperature sensors to the microcontroller.
- Implement necessary signal conditioning circuits if required to improve sensor accuracy and reliability.

- Calibrate the sensors to ensure accurate readings.

Analog to Digital Conversion:

- Connect the output of the sensors to the ADC inputs of the microcontroller.
- Configure the ADC channels and resolution based on sensor specifications.
- Implement code to read analog sensor values and convert them into digital format.

Data Processing and Transmission:

- Write firmware or software code to read sensor data using the microcontroller.
- Convert analog sensor data to digital using the ADC.
- Process the digital data and format it for transmission.
- Implement LiFi communication protocols to transmit data from the transmitter to the receiver.
- Configure the Blynk alert service to send alerts when health parameters deviate beyond predefined thresholds.

LiFi Transmission:

- Choose a LiFi transmitter module capable of transmitting digital data over LiFi technology.
- Interface the LiFi transmitter module with the microcontroller.
- Implement communication protocols for data transmission over LiFi.
- Encode the digital sensor data for transmission.
- Ensure error detection and correction mechanisms are in place to maintain data integrity.

LiFi Receiver Integration:

- Select LiFi receiver modules compatible with the chosen microcontroller and capable of receiving data reliably over LiFi.

- Integrate these modules into the system, ensuring proper connectivity and communication protocols.

- It ensures error detection and correction mechanisms are in place to maintain data integrity.

Display Interface:

- Connect the LCD display module to the microcontroller.
- Develop code to format and display the received sensor data on the LCD.
- Implement user-friendly interfaces for data visualization and interaction.
- Design a graphical representation of health parameters using ESP32.

- Implement a user-friendly interface for displaying data and alerts on the LCD screen and ESP32.

Alerting Mechanism:

- To ensure timely intervention in case of abnormal health parameters, an alerting mechanism is implemented.

- Blynk was used for this as it incorporates a alert system sending alerts when the patient's health parameters deviate from predefined thresholds.

Data Transmission Protocol:

- Develop a robust protocol for transmitting sensor data over LiFi.
- Consider factors such as data encoding, error detection/correction, and transmission frequency to ensure reliable data transfer.
- For graphical representation of the data using ESP32

- The alert generation through Blynk upon detection of abnormal health parameter values.

Power Management and Safety:

- Design a power management system to ensure efficient use of energy and battery life.
- Implement safety features to protect patient data and ensure system

reliability.

- Consider backup power options or fail-safe mechanisms in case of power outages or system failures.

The proposed LiFi-based patient health monitoring system offers a robust solution for real-time monitoring of vital signs using innovative technology. By integrating sensors, LiFi transmission, data processing, and alert mechanisms, the system provides healthcare providers with timely information to ensure prompt interventions when necessary, ultimately improving patient outcomes and quality of care.Additionally, to enhance the system's functionality, Blynk is integrated to provide alerts in case of any abnormalities detected in the patient's health parameters.

This feature ensures timely intervention by healthcare providers, alerting them to critical situations and facilitating swift response.By combining LiFi technology with a comprehensive sensor array, digital processing, and alert mechanisms, the proposed patient health monitoring system offers a robust and efficient solution for real-time health monitoring, enabling proactive healthcare management and timely interventions to ensure patient well-being.

The proposed Li-Fi based patient health monitoring system offers a novel approach to real-time monitoring of vital health parameters with advantages in data transmission speed, security, and interference immunity. By integrating Li-Fi technology with sensors, ADCs, display units, and alert systems, this system provides comprehensive monitoring and early detection of health abnormalities, thereby improving patient care and safety. Further research and development are needed to optimize the system's performance and ensure its reliability in clinical settings.

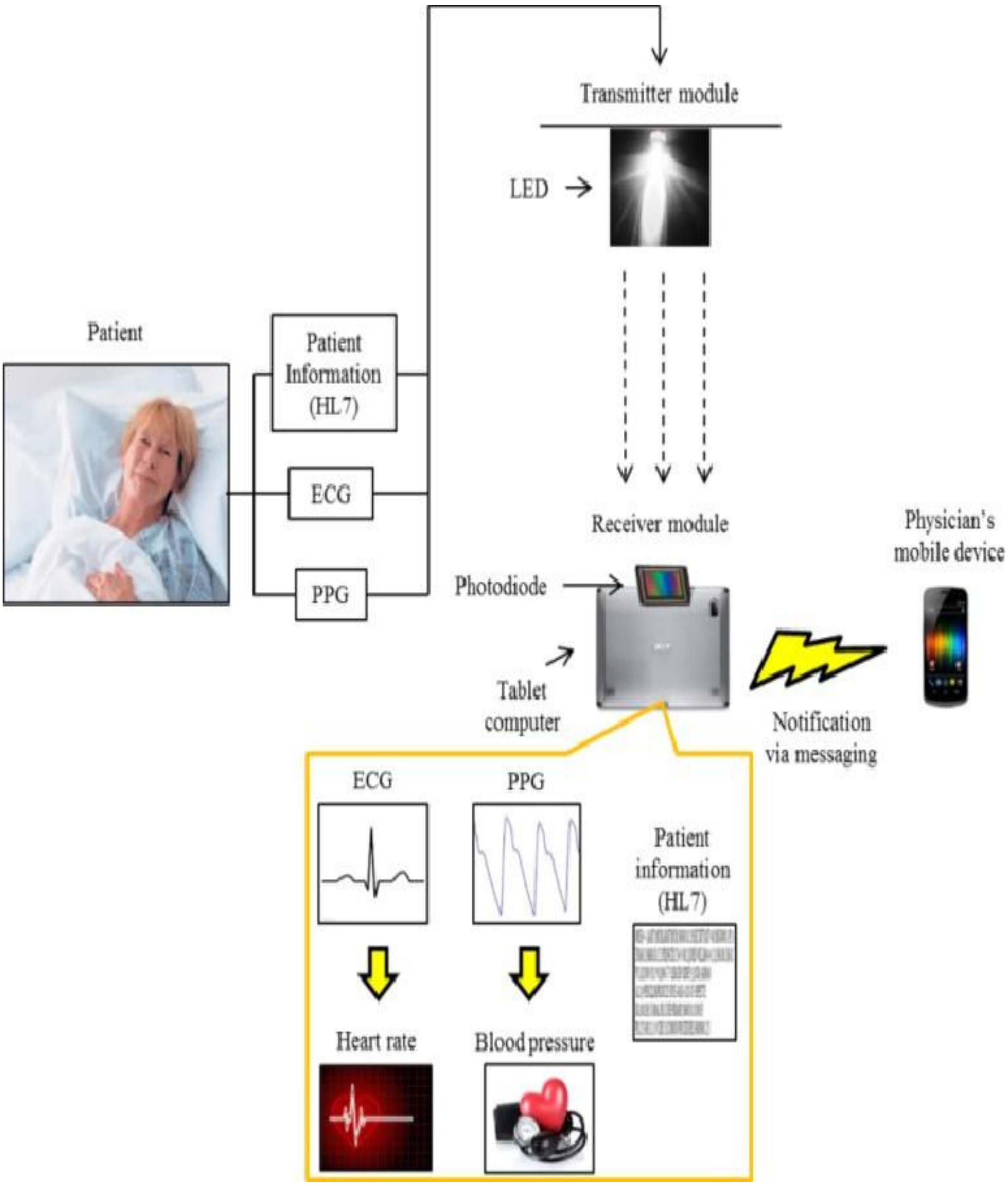

Figure 4.2 Design Methodology

4.5 SUMMARY

In summary, the LiFi-based patient health monitoring system offers a comprehensive solution for continuous and remote patient monitoring, leveraging advanced sensor technology, LiFi communication, and real-time data visualization capabilities. By enabling rapid and reliable transmission of vital patient data, along with proactive alerting mechanisms, this innovative system enhances the quality of healthcare delivery, providing patients with personalized and proactive care while empowering healthcare providers with actionable insights for informed decision-making.Overall, the proposed LiFi-based patient health monitoring system offers a reliable and efficient solution for continuous remote monitoring of vital signs, enabling proactive healthcare interventions and improving patient outcomes.

CHAPTER 5

RESULT AND DISCUSSION

5.1 INTRODUCTION

The integration of emerging technologies in healthcare systems has revolutionized patient monitoring, offering more efficient and accurate methods for tracking vital health parameters. Among these innovations, Li-Fi (Light Fidelity) technology stands out for its potential in providing high-speed wireless communication through visible light. In this study, we propose a Li-Fi based patient health monitoring system designed to monitor essential physiological parameters such as heart rate, respiratory rate, and body temperature.

The system comprises sensors for each vital parameter, namely a heart rate sensor, a respiratory sensor, and a temperature sensor. These sensors continuously gather analog data reflecting the patient's health status. The analog data is then converted into digital format using an analog-to-digital converter (ADC) for further processing and transmission.

The transmitted digital data is conveyed via a Li-Fi transmitter to a Li-Fi receiver, where it is decoded and displayed in real-time. The display includes an LCD screen for immediate visualization of the patient's health parameters. Additionally, a ESP32 device is employed for graphical representation, enabling a comprehensive analysis of the patient's health trends over time.

Moreover, to ensure timely intervention in case of abnormal health readings, the Blynk platform incorporates an alert system. This Alert system is programmed to trigger alerts whenever the monitored parameters deviate from predetermined thresholds, indicating potential health risks for the patient.

The results and discussions derived from the implementation and testing of this Li-Fi based patient health monitoring system. Through an analysis of the system's performance, including its accuracy, reliability, and real-world applicability, insights will be provided to assess its effectiveness in enhancing healthcare delivery and patient outcomes.

5.2 Li Fi TRANSMITTER

LiFi, or Light Fidelity, is a wireless communication technology that uses light to transmit data instead of radio frequencies used in technologies like WiFi. Here's a basic explanation of how a LiFi transmitter works:

- **Light Source:**

The transmitter consists of a light source, typically an LED (Light Emitting Diode). LEDs are preferred because they can be modulated rapidly to encode data.

- **Modulation:**

The LED is modulated by varying its intensity very quickly. This modulation is typically imperceptible to the human eye.

- **Data Encoding:**

Digital data, such as internet data, is converted into binary format (1s and 0s) and then into electrical signals. These electrical signals control the intensity of the LED, turning it on and off very rapidly to represent the binary data.

- **Transmission:**

The modulated light containing the data is then emitted by the LED. This light can travel through the air and is received by a

It's important to note that LiFi requires line-of-sight communication, meaning there must be an unobstructed path between the transmitter and the receiver. Additionally, since LiFi uses light, it cannot penetrate walls or opaque objects, which can limit its range and applicability compared to WiFi. However, LiFi offers advantages such as higher data rates, increased security (since light can be confined within a physical space), and absence of electromagnetic interference.

Figure 5.1 LiFi Transmitter

5.3 Li Fi RECEIVER

In LiFi systems, data is modulated onto light signals, typically from LED light sources, and received by photodetectors which then convert the light signals back into data.Here's how a LiFi receiver works:

- **Photodetection:**

The receiver typically contains a photodetector, such as a photodiode or photodiode array. These devices are capable of converting light signals into electrical signals. When light from the transmitter (which may be an LED bulb) falls on the photodetector, it generates a corresponding electrical current or voltage.

- **Signal Processing:**

The electrical signal generated by the photodetector is then processed to extract the transmitted data. This may involve amplification, filtering, and demodulation processes to recover the original data signal.

- **Data Decoding:**

Once the data signal is recovered, it undergoes decoding to extract the transmitted information. This process typically involves error correction techniques to ensure data accuracy and integrity.

- **Data Output:**

Finally, the decoded data is sent to the user's device or network interface for further processing or utilization. This could be a computer, smartphone, or any other compatible device capable of receiving and interpreting the data.

Overall, LiFi receivers play a crucial role in enabling high-speed wireless communication through visible light, offering a promising alternative or complement to existing wireless technologies like WiFi.

Figure 5.2 LiFi Receiver

5.4 MASTER AND SLAVE WORKING

The transmitter side of the LiFi-based patient health monitoring system acts as the master and it consists of several components working together to collect, convert, and transmit data wirelessly to the receiver side. Here's a breakdown of the working process:

- **Heart Rate Sensor:**

This sensor is responsible for monitoring the patient's heart rate. It typically works by detecting the electrical activity of the heart and converting it into a measurable signal.

- **Respiratory Sensor:**

This sensor tracks the patient's respiratory rate and pattern. It may use various methods such as detecting chest movement or airflow to monitor breathing.

- **Temperature Sensor:**

 This sensor measures the patient's body temperature, providing vital information about their health status.

- **Analog to Digital Converter (ADC):**

Analog signals from the sensors need to be converted into digital signals for processing. The ADC performs this conversion, ensuring compatibility with digital systems.

- **LiFi Transmitter:**

LiFi, or Light Fidelity, uses light to transmit data wirelessly. The LiFi transmitter modulates the digital sensor data onto light waves for transmission.

The receiver side of the LiFi-based patient health monitoring system act the slave and it receives the digital data transmitted via LiFi technology from the sensors attached to the patient. Here's how it works:

- **LiFi Receiver:**

The LiFTi receiver receives the modulated light signals and demodulates them back into digital data for processing.

- **LCD Display:**

The LCD display receives the processed data from the LiFi receiver and presents it in a human-readable format for healthcare professionals to monitor.

- **ESP32 for Graphical Representation:**

The ESP32, a low-cost open-source IoT platform, processes the sensor data and generates graphical representations, providing a visual overview of the patient's health parameters over time.

The LiFi-based patient health monitoring system provides real-time monitoring of vital signs, graphical representation of health parameters, and timely alerts to ensure prompt medical attention when necessary, ultimately improving patient outcomes and healthcare delivery.The LiFi-based patient health monitoring system presents a revolutionary approach to healthcare technology, leveraging the power of light to transmit vital patient data swiftly and securely. With sensors meticulously monitoring crucial health parameters such as heart rate, respiratory rate, and temperature, this system ensures real-time tracking of a patient's well-being. The analog data obtained from these sensors undergoes seamless conversion to digital format through an analog-to-digital converter (ADC), facilitating efficient processing and transmission.

Figure 5.3 Master and Slave Connections

5.5 DATA TRANSMISSION PROTOCOL

LiFi-based patient health monitoring system, you'll need a robust data transmission protocol to ensure efficient and reliable communication between the sensors, analog-to-digital converter (ADC), LiFi transmitter, LiFi receiver, LCD display, ESP32 for graphical representation and alerts, and any other components in your system. Here's a suggested protocol stack:

- **Physical Layer:**

  LiFi (Light Fidelity) technology will be used for wireless communication. LiFi uses light to transmit data, typically using LEDs. This layer handles the transmission and reception of light signals.

- **Data Link Layer:**

  A protocol for framing and error-checking. Since LiFi is a point-to-point communication technology, simple framing protocols like HDLC (High-Level Data Link Control) or even simpler protocols can be used.

- **Network Layer:**

  Depending on your system architecture, you may or may not need a network layer protocol. If you have multiple nodes communicating with each other, you might consider a lightweight network layer protocol for addressing and routing, but if it's a point-to-point communication, this layer may be unnecessary.

- **Transport Layer:**

  You may need a protocol to ensure reliable data transmission, especially for critical health data. TCP (Transmission Control Protocol) could be an option if reliability is crucial. Alternatively, UDP (User Datagram Protocol) can be considered for its lower overhead if occasional data loss is acceptable.

- **Application Layer:**

  This layer deals with the specific application requirements. You'll need protocols for:

- **Sensor data transmission:**

  It defines a protocol for transmitting sensor data (heart rate, respiratory rate, temperature) from the ADC to the LiFi transmitter. This protocol should include data formatting and possibly compression techniques to optimize bandwidth usage.

- **Alert notification:**

  It defines a protocol for transmitting alert signals from the ESP32 to the receiving end. This protocol should include information about the type of alert and possibly the severity level.

- **Graphical representation data:**

  It defines a protocol for transmitting data from the ESP32 to the LCD display for graphical representation. This could involve simple commands for drawing graphs or displaying text.

It ensures that all protocols are lightweight and efficient to minimize overhead, as the system is intended for real-time health monitoring. Additionally, consider security measures such as encryption and authentication to protect sensitive health data transmitted over the network. Testing and validation of the entire communication stack are crucial to ensure the reliability and accuracy of the health monitoring system.

5.6 BLYNK

In your described system, Blynk serves as a cloud platform for storing, analyzing, and visualizing the health data collected from the patient monitoring system. Here's how Blynk works in this context:

- **Data Collection:** The patient monitoring system collects analog data from sensors measuring heart rate, respiratory rate, and temperature. These analog signals are converted into digital format by an analog to digital converter.

- **Transmission via LiFi:** The digital data is transmitted via LiFi (Light Fidelity) technology to a LiFi receiver. LiFi uses light to transmit data instead of traditional radio frequencies, offering potentially higher data rates and more secure communication.
- **Data Processing and Uploading to Blynk:** Upon receiving the digital data, the LiFi receiver sends it to a microcontroller (such as ESP32) for processing. The processed data, including heart rate, respiratory rate, and temperature, is then uploaded to the Blynk cloud platform.
- **Storage and Visualization on Blynk:** Blynk stores the received data in its cloud database. It provides a user-friendly interface for viewing real-time and historical data in the form of charts, graphs, and tables. The data can be accessed and analyzed from anywhere with an internet connection.

- **Data Collection:** Blynk provides APIs that enable devices to send data to the platform, where it can be stored in channels. Each channel can hold multiple fields of data.
- **Real-Time Data Analysis:** Blynk allows users to perform simple analysis on the collected data using Arduino code. This feature enables users to create custom processing algorithms to derive insights from the data.
- **Visualizations:** Blynk offers built-in tools for visualizing data with customizable charts, graphs, and gauges. Users can create dashboards to monitor their IoT deployments.
- **Integration**: Blynk can integrate with other IoT platforms and services, such as IFTTT (If This Then That). This allows for more advanced automation and analysis capabilities.
- **Open Source:** Blynk is built on open-source software, making it accessible for developers to customize and extend its functionality.
- **Cloud-Based:** Blynk is a cloud-based platform, meaning users don't need to worry about hosting or managing server infrastructure. This also enables access to data and dashboards from anywhere with an internet connection.

Overall, Blynk provides a convenient and scalable solution for IoT data collection, analysis, and visualization, making it popular among hobbyists, researchers, and industrial users alike.

Figure 5.4 Graphical representation

All these vitals—heart rate, body temperature, SpO2, and movement—are collected by sensors connected to Arduino. The data is transmitted to the cloud using Wi-Fi and visualized through BLYNK API for remote access. This system provides a low-cost, real-time, and non-invasive method for continuous health monitoring.

5.7 OUTPUT

1. The sensors continuously monitor the patient's vital signs, including heart rate, respiratory rate, and temperature.
2. The analog data collected from the sensors is converted into digital format by the ADC.
3. The digital data is transmitted wirelessly via LiFi technology from the LiFi transmitter to the LiFi receiver.
4. The received data is displayed on the LCD screen for real-time monitoring.

5. Simultaneously, the ESP32 processes the data and creates graphical representations to visualize the patient's health trends.

6. The Blynk monitors the data and triggers alerts if any health parameter crosses predefined thresholds.

Figure 5.5 Output

5.8 SUMMARY

The LifI-based patient health monitoring system integrates various sensors to monitor critical health parameters such as heart rate, respiratory rate, and temperature. The system operates by collecting analog data from these sensors, which are then converted to digital format using an analog-to-digital converter (ADC). The digital data is transmitted via LiFi (Light Fidelity) technology to a LiFi receiver. The transmitted data is displayed on an LCD screen and further processed for graphical representation using a ESP32 microcontroller and to provide alerts in case of any significant deviations from normal health parameters.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

In conclusion, the development of a LiFi-based patient health monitoring system represents a significant advancement in healthcare technology. By integrating heart rate, respiratory, and temperature sensors, this system enables real-time monitoring of vital signs, allowing for timely intervention in case of any abnormalities. The utilization of analog-to-digital converters ensures accurate and reliable data conversion, facilitating seamless transmission of information.

Overall, the LiFi-based patient health monitoring system represents a significant advancement in healthcare technology, offering a comprehensive solution for remote patient monitoring with enhanced speed, security, and functionality. Its potential to revolutionize healthcare delivery by enabling continuous, real-time monitoring of patients in various settings holds promise for improving patient care and enhancing overall healthcare efficiency.

6.2 FUTURE WORK

In the realm of healthcare technology, the integration of LiFi (Light Fidelity) with patient health monitoring systems presents a promising avenue for enhancing real-time monitoring, data transmission, and alert mechanisms. The envisioned future work for a LiFi-based patient health monitoring system involves several key areas of development and improvement.

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