REAL TIME DATA COMMUNICATION USING LIFI IN HOSPITAL MANAGEMENT

Karthikeyan Arun Kumar [1]
Department of Electronics and Communication Engineering
Panimalar Institute of Technology
Chennai, India
arunkarthi4761@gmail.com

Vedhasurya A [2]
Department of Electronics and Communication Engineering
Panimalar Institute of Technology
Chennai, India
vedhasurya50@gmail.com

Pon Abisheik [3]
Department of Electronics and Communication Engineering
Panimalar Institute of Technology
Chennai, India
abhidheeshek@gmail.com

Keerthimurugan N T [4]
Department of Electronics and Communication Engineering
Panimalar Institute of Technology
Chennai, India
keerthimuruganvel2003@gmail.com

Dr.S.Sathiya Priya, M.E.,Ph.D, [5]
Professor and Head
Department of Electronics and Communication Engineering
Panimalar Institute of Technology
Chennai, India

Abstract **- In hospitals, patient monitoring is often done by hand, with nursing personnel available around the clock. The availability of nursing personnel to monitor the well- being of neonates or critically ill patients is a time-consuming and difficult task. Many wireless technologies have been developed to monitor the patient's condition using various sensors to address this issue; nevertheless, these wireless approaches can interact with medical devices, posing a risk to patients and babies. Li-Fi is a bidirectional, high-speed, fully networked wireless optical communication protocol that uses visible light. The suggested model aids in patient monitoring in hospitals and may be accomplished by adopting the notion of Li-Fi instead of Wi-Fi technology to reduce the frequency. Li-Fi communication is a type of visible light communication that is bidirectional, fast, and completely networked. The suggested model aids in hospital patient monitoring and may be implemented by substituting Li-Fi for Wi-Fi technology to prevent frequency interference with biological tissues. The model uses many sensors, including motion, heartbeat, and temperature, to carry out its various tasks. These sensors provide their output to the microcontroller. The GSM module has been updated to notify doctors.**

Keywords: **LiFi, WiFi, GSM module, Optical Communication, Visible Light Communication**

I. INTRODUCTION

Light Fidelity, or Li-Fi for short, is a cutting-edge wireless communication system that transmits data wirelessly using the visible, infrared, and near-ultraviolet spectrums. Li-Fi uses light waves from LED lights to communicate data, as opposed to conventional Wi-Fi, which uses radio waves. Professor Harald Haas initially presented this method in a 2011 TED presentation, where he illustrated the idea of data transmission using flashing LED lights.

Li-Fi operates on a clever but comparatively simple idea. Data is encoded by rapidly modulating LED lights that are invisible to the human eye. The broadcast data is retrieved using light sensors or photo detectors in Receiving devices, which identify these variations and transform them back into electrical signals.

Li-Fi, a ground-breaking high-speed data network technology, was put out by German scientist Harold Haas. Li-Fi networks are also known as visible light communications (VLC) because they provide data transmission via the lighting of light-emitting diode (LED) bulbs. The need for faster, more secure, and more dependable wire-wireless communication is constant in the internet era, with wireless networks being the preferred option for all home applications, including those related to health care.

In hospitals, wireless networks are preferred since the cords connecting the devices may potentially contaminate patients' bodies. Reliance on wireless internet causes wireless fidelity (Wi-Fi) technology to be overworked, which in turn leads to an enormous demand for radio spectrum and capacity. Li-Fi, an alternative wireless internet technology with applications in nearly every industry, including automotive technology, helps relieve the strain on Wi-Fi.

The visible light spectrum is used by Li-Fi technology to enable high-speed data transmission. Li-Fi research is still ongoing, however, it has the potential to enhance wireless network performance by supplementing RF transmission. It transfers data at up to 224 GB per second using standard LED light bulbs from the home. Li- Fi speed is 100 times faster than the fastest Wi-Fi, which operates in the 60 GHz frequency range and can reach a maximum data throughput of 7 GB per second! Furthermore, a Li-Fi network's area data rate, also known as its rate per square meter, can surpass a Wi-Fi network's by a factor of 1,000.

II. LITERATURE REVIEW

The Literature survey delves into LiFi in data transmission and offers a thorough picture of the state of the field, emphasizing developments, obstacles, and new directions in this fast-paced area of study. With a focus on important research that has influenced our knowledge of LiFi in data communication, this investigation seeks to shed light on the development of LiFi technologies.

Research has also been done on the possible uses of LiFi, which include secure data transfer and communication in settings where radio frequency interference is an issue, as well as specific use cases such as indoor wireless communication in homes and workplaces. In addition, studies have looked into the difficulties in deploying LiFi, such as mobility problems brought on by line-of-sight constraints, as well as ways to get around these restrictions by using clever algorithms for smooth handover between access points and hybrid LiFi/WiFi systems. All things considered, the review of the literature emphasizes the increasing interest in LiFi technology and points to directions for further study and advancement to reach its full potential across a range of fields.

Patient monitoring in hospitals is usually done by hand, with round-the-clock help from nursing personnel. It is a demanding and labor-intensive task to have nursing personnel available to monitor the health of babies or patients who are seriously ill. The patient's condition might worsen to the point of death if there is a delay or lack of attention. To address this issue, several wireless technologies have been put out to monitor the patient's condition utilizing a variety of sensors; nevertheless, these wireless techniques may even interfere with medical equipment and put patients and infants at risk. Hospital- friendly monitoring has been proposed using Li-Fi-based health monitoring devices that detect heart rate, temperature, and movements in case of an emergency.

III. EXISTING SYSTEM

Wi-Fi and wired networks are the most common traditional data connection technologies used by the hospital management system that is now in place. Information sharing that is essential for patient care, administrative duties, and general hospital operations is made easier by these technologies. However, there are several built-in drawbacks and difficulties with the existing configuration.

Effective healthcare services are dependent on the administration and transfer of patient data in hospitals all over the world. There are still many hospitals that use outdated data management techniques, even though many healthcare institutions have switched to real-time data transmission systems to improve patient care and streamline operations. Patient data is frequently entered and transferred manually at these facilities, which might result in inefficiencies and delays in getting access to vital information.

In hospitals without real-time data transmission, the current system usually consists of an electronic health record (EHR) system that may not be able to transfer data in real-time together with paper-based records. Healthcare professionals' patient records are maintained by manual data input and sporadic updates, which can cause problems with decision-making, communication, and care coordination.

Furthermore, issues with privacy and security may arise with the current method. Even with encryption mechanisms installed, Wi-Fi networks might still be subject to data breaches and unwanted access. Hospitals handle extremely sensitive patient data, thus it's critical to protect the integrity and confidentiality of this information. Stronger data communication frameworks are required due to tighter privacy laws and growing cyber security concerns.

IV. PROPOSED WORK

The hospital management system that is being suggested integrates LiFi (Light Fidelity) technology with the current infrastructure, therefore presenting a novel approach. LiFi, which offers several benefits that can completely transform the effectiveness, dependability, and security of data connection inside healthcare facilities, transmits data using visible light waves.

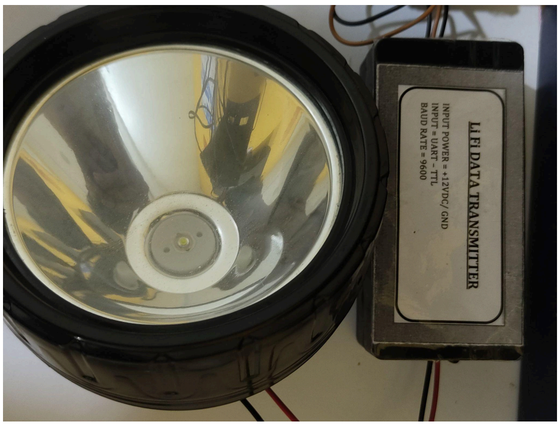
The utilization of LiFi-enabled devices and thoughtfully placed access points across the hospital form the foundation of the suggested system. Comprehensive coverage is ensured by this deployment, enabling smooth communication in vital locations including operating rooms, patient rooms, and diagnostic centers. LiFi's high- speed data transfer capabilities are particularly important in a hospital setting, where instantaneous communication is essential for making quick decisions and providing accurate, timely patient care.

The LiFi-based patient health monitoring system is a cutting-edge breakthrough in healthcare technology, utilizing the capabilities of Light Fidelity (LiFi) communication to quickly and securely send crucial patient data. This complex system incorporates various sensors, such as a heart rate sensor, respiration sensor, and temperature sensor, to continually monitor the patient's vital signs in real-time. As the sensors collect analog data, they are linked to analog-to-digital converters (ADCs), which convert the analog signals into digital format for processing. This digital data is then communicated via a LiFi transmitter, which uses visible light communication (VLC) technology to encode it into light signals. LiFi has various advantages over traditional wireless communication systems, including faster data transmission rates, more security, and resilience to electromagnetic interference (EMI).

The digital data is then sent via a LiFi (Light Fidelity) transmitter. LiFi technology uses light waves to transport data, providing benefits such as fast data transfer, immunity to electromagnetic interference, and better security. The LiFi transmitter effectively sends digital health data to a LiFi receiver located within the healthcare institution. Once the encoded data reaches the LiFi receiver, it is decoded and fed into a system that includes an LCD and a ESP32 (Microcontroller Unit) for graphical representation. The LCD gives real-time updates on the patient's vital signs, allowing healthcare practitioners to precisely and accurately monitor their status. Additionally, the ESP32 supports graphical representation, allowing for the visualization of trends and patterns in the patient's health metrics over time.

V. SYSTEM ARCHITECTURE

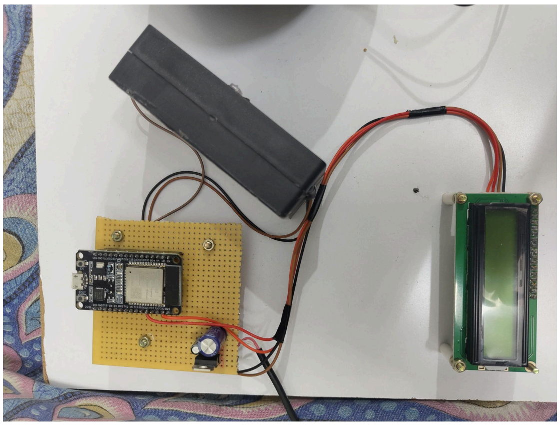
LiFi Transmitter



A LiFi transmitter uses light to wirelessly transport data, providing a faster, more secure alternative to existing radio frequency (RF) communication technologies such as WiFi. It uses light-emitting diodes (LEDs) to modulate data onto light waves, which are subsequently received by a receiver using a photodetector. This technique uses the visible and infrared sections of the electromagnetic spectrum to transport data, resulting in improved bandwidth and immunity to electromagnetic interference. LiFi transmitters may be embedded into a variety of devices, including lamps, streetlights, and electronic displays, allowing for smooth connectivity even in areas where RF signals are unreliable or crowded.

LiFi's capability for high-speed data transfer and its ability to coexist with current lighting infrastructure make it promising for applications in smart cities, indoor navigation, healthcare, and beyond.

LiFi Receiver

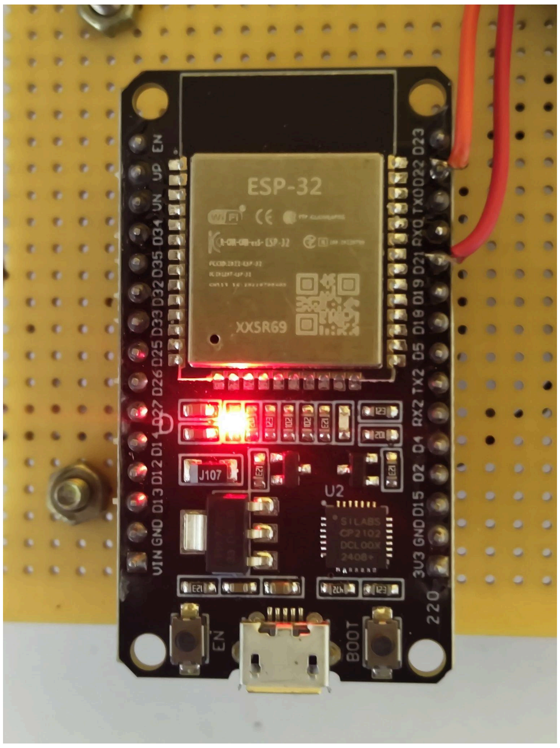


A LiFi receiver is needed to reap the benefits of Light Fidelity (LiFi) technology. It works by collecting modulated light signals sent by LiFi transmitters and transforming them into useful data. The photo detector on the receiver detects fluctuations in light intensity induced by data modulation onto light waves. Once discovered, the receiver decodes the signal and extracts the delivered data for further use. LiFi receivers are intended to work with a wide range of devices, from smart phones and laptops to IOT sensors and smart appliances. They enable the seamless integration of LiFi technology into existing infrastructure, providing high-speed data access in areas where traditional wireless communication techniques are limited.

LiFi receivers, with their small size and low power consumption, may be installed in a variety of contexts, including residences, offices, hospitals, and industrial buildings, enabling dependable, secure, and high-bandwidth wireless communication.

ESP32

The ESP32 is a flexible open-source development board. Wi-Fi, making it perfect for Internet of Things (IOT) applications. The ESP32 board has Lua-based software that simplifies programming and enables seamless connection with a variety of sensors, actuators, and other peripherals. It has GPIO pins for digital and analog input/output, as well as SPI, I2C, and UART interfaces for communicating with other devices. The ESP32's integrated Wi-Fi module connects it to wireless networks, allowing for remote monitoring, control, and data sharing via the Internet. The ESP32's tiny size, low price, and significant community support make it a popular choice among enthusiasts, students, and professionals for developing and deploying IOT solutions in home automation.



The ESP32's small size, low cost, and broad community support make it a popular choice among hobbyists, students, and professionals for developing and deploying IOT solutions in home automation, smart agriculture, environmental monitoring, and other applications.

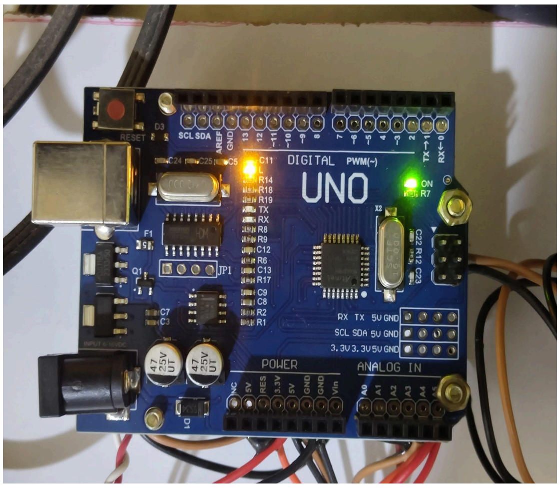
GSM Module

A GSM (Global System for Mobile Communications) module is a hardware component that connects a device to mobile networks. It has a GSM modem, which allows devices to send and receive text messages, make phone conversations, and use data services like internet connectivity. GSM modules are often modest in size and handle common AT instructions, making them simple to integrate with microcontrollers or embedded systems.

They include SIM card slots to authenticate with mobile networks and gain access to network services. Remote monitoring, asset tracking, security systems, and IOT devices that require cellular connectivity all make extensive use of GSM modules.

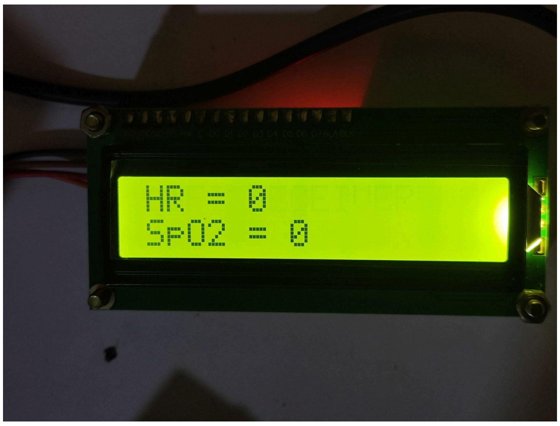
Arduino

Arduino is an open-source electronics platform with simple hardware and software. It comprises of a microcontroller board and an integrated development environment (IDE) to program it.The Arduino board functions as the brain of electrical projects, collecting inputs from various sensors and controlling outputs such as lights, motors, and displays.



The Arduino IDE provides a simple interface for creating, compiling, and uploading code to the Arduino board. Its simplicity and substantial community support make it suitable for both beginners and expert users.

LCD



LCD (Liquid Crystal Display) is a flat-panel display technology that is widely used in electronic devices including TVs, computer monitors, and digital clocks. It works by modifying light that passes through liquid crystal molecules controlled by electric currents. LCDs are made up of several layers, including a backlight, polarizing filters, a liquid crystal layer, and glass substrates with electrodes. When voltage is given to the electrodes, the liquid crystals align and regulate the passage of light, resulting in pictures or text on the screen.

LCDs provide benefits such as reduced power consumption, a narrow profile, and high picture quality. They come in a variety of sizes and resolutions, making them suitable for a wide range of applications, from small portable devices to large-screen displays.

VI. ARCHITECTURE DESIGN AND METHODOLOGY

The design technique for the LiFi-based patient health monitoring system starts with the integration of three important sensors: a heart rate sensor, a breathing sensor, and a temperature sensor. These sensors continually monitor the patient's vital signs and generate analog data indicating their health state. To connect these analog signals to the digital system, an analog-to-digital converter (ADC) is used to transform the signals into digital format for further processing.

The data is digitized and then delivered to a LiFi receiver via a LiFi transmitter. LiFi technology enables high-speed and secure data transmission via visible light communication. The receiver then sends the received data to a microcontroller, such as ESP32, for real-time processing and analysis.

The processed data is then presented on an LCD screen for instant review by healthcare specialists. In addition, the ESP32 is used to create graphical representations of the patient's health data, allowing for a thorough examination of trends over time.

Furthermore, the device includes a GSM module to ensure early assistance in the event of deteriorating health circumstances. This module is set up to send warnings when the patient's health metrics fall below predetermined criteria. These warnings can be sent to healthcare practitioners or caregivers, allowing immediate action to be taken.

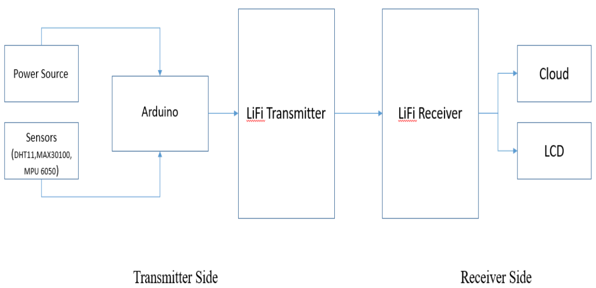


Figure 1 Block Diagram

To summarize, the design technique includes sensor integration, analog-to-digital conversion, LiFi- based data transfer, microcontroller-based data processing and display, graphical representation, and alarm production via GSM technology. This comprehensive method guarantees that the patient's health state is monitored efficiently and reliably in real-time, allowing for timely medical treatments as needed.

VII. RESULTS

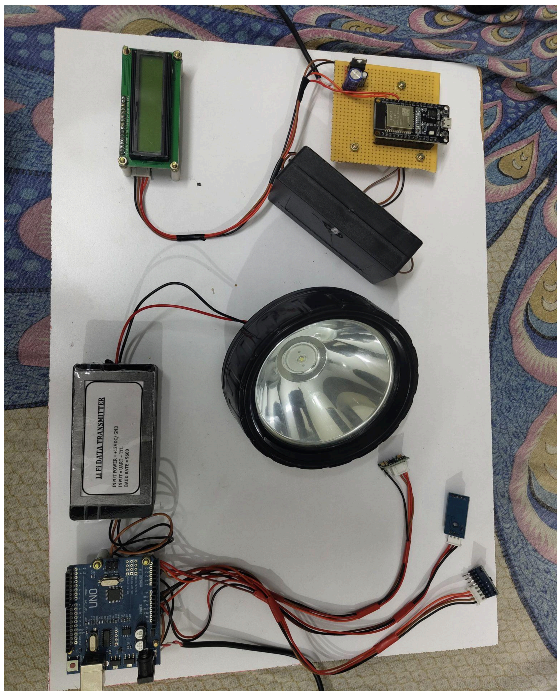
The sensors continually monitor the patient's vital indicators, such as heart rate, breathing rate, and temperature.

The digital data is wirelessly exchanged between the LiFi transmitter and the LiFi receiver using LiFi technology.

The received data is shown on the LCD screen for real-time monitoring.

The GSM module analyzes data and sends alarms when any health parameter exceeds specified criteria.

Alerts are issued by SMS or phone calls to healthcare practitioners or family members, allowing for fast action in the event of a health emergency.



VIII. CONCLUSION AND FUTURE WORK

Finally, the invention of a LiFi-based patient health monitoring system marks a huge step forward in healthcare technology. This system provides real-time monitoring of vital signs by combining heart rate, respiration, and temperature sensors, allowing for quick intervention in the event of any irregularities. The use of analog-to-digital converters guarantees precise and reliable data conversion, allowing for the uninterrupted transmission of information.

In the field of healthcare technology, integrating LiFi (Light Fidelity) with patient health monitoring systems offers a great opportunity to improve real-time monitoring, data transfer, and alarm mechanisms. The proposed future work for a LiFi-based patient health monitoring system includes several major areas of growth and enhancement.

IX. REFERENCES

[1] F. Zhang, J. Chen, T. Mao, and Z. Wang, "Feedback Interval Optimization for MISO LiFi Systems," in IEEE Access, vol. 9, pp. 136811-136818,2021,doi:10.1109/ACCESS.2021.3117341.

[2] G. Ma, R. Parthiban and N. Karmakar, "An Adaptive Handover Scheme for Hybrid LiFi and WiFi Networks," in IEEE Access, vol. 10, pp. 18955-18965,2022, doi:10.1109/ACCESS.2022.3151858.

[3] H. Abu Marshoud, M. D. Soltani, M. Safari and H. Haas, "Realistic Secrecy Performance Analysis for LiFi Systems," in IEEE Access, vol. 9, pp. 120675-120688, 2021, doi:10.1109/ACCESS.2021.3108727.

[4] J. Beysens, J. -P. M. G. Linnartz, D. Van Wageningen and S. Pollin, "TDMA Scheduling in Spatially Extended LiFi Networks," in IEEE Open Journal of the Communications Society, vol. 1, pp. 1524-1538, 2020, doi: 10.1109/OJCOMS.2020.3023745.

[5] K. L. Bober et al., "Distributed Multiuser MIMO for LiFi in Industrial Wireless Applications," in Journal of Lightwave Technology, vol. 39, no. 11, pp. 3420-3433, June 1, 2021, doi:10.1109/JLT.2021.3069186.

[6] M. Elamassie, L. Bariah, M. Uysal, S. Muhaidat and P. C. Sofotasios, "Capacity Analysis of NOMA-Enabled Underwater VLC Networks," in IEEE Access, vol. 9, pp. 153305-153315, 2021, doi: 10.1109/ACCESS.2021.3122399.

[7] M. F. Ali, D. N. K. Jayakody and Y. Li, "Recent Trends in Underwater Visible Light Communication (UVLC) Systems," in IEEE Access, vol. 10, pp. 22169-22225, 2022, doi: 10.1109/ACCESS.2022.3150093.

[8] N. A. Amran, M. D. Soltani, M. Yaghoobi and M. Safari, "Learning Indoor Environment for Effective LiFi Communications: Signal Detection and Resource Allocation," in IEEE Access, vol. 10, pp. 17400-17416, 2022, doi: 10.1109/ACCESS.2022.3150919

[9] S. M. Kouhini et al., "LiFi Positioning for Industry 4.0," in IEEE Journal of Selected Topics in Quantum Electronics, vol. 27, no. 6, pp. 1-15, Nov.-Dec. 2021, Art no. 7701215, doi: 10.1109/JSTQE.2021.3095364.