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Design a Data Transmission System using Li-Fi Technology

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Abstract **- The project begins with a review of Li-Fi technology, examining its principles, modulation techniques, and protocols for data transmission. It analyzes research studies and practical implementations to understand the current state and performance of Li-Fi in real-world scenarios. With the growing dependence on Wi-Fi, the need for a more reliable communication method led to the development of Li-Fi, which uses LEDs to transmit data through rapid blinking, imperceptible to the human eye.**
The system was implemented using off-the-shelf components, and testing revealed that Li-Fi offers advantages in security, availability, efficiency, and capacity, positioning it as a vital communication method in the near future. The project concludes with an analysis of the findings and recommendations for further improvements, contributing to the existing knowledge of Li-Fi and its potential integration into future wireless communication systems.

KeyWords: **Li-Fi Technology, Data Transmission, Light Emitting Diodes (LEDs), Security, Efficiency, Wireless Communication, Wi-Fi Alternative**

1.INTRODUCTION

Li-Fi (Light Fidelity) is a high-speed wireless communication technology that uses visible light for data transmission through varying LED intensities. It is secure, as data can only be received through visible light, making hacking difficult. Li-Fi is particularly useful in areas where Wi-Fi is limited and eliminates the health concerns of electromagnetic waves. Data speeds can reach gigabytes per second.
Developed by Harald Hass, Li-Fi offers faster data transfer than Wi-Fi and could expand internet access by replacing incandescent bulbs with LEDs. Unlike Wi-Fi, Li-Fi uses Visible Light Communication (VLC), providing higher bandwidth and reducing interference. Li-Fi addresses key wireless communication challenges, including capacity, cost, efficiency, and security.

2. LITERATURE SURVEY

Sr no	Paper/Journal Title	Published in	Major Domain Area/concepts
1	A review on LIFI : data transmission through illumination	International journal for technological research in engineering (2016)	Types of protocols for Data transfer
2	The technology of LIFI: A brief introduction	IOP conference series: materials science and engineering (2018)	Intro and working of li-Fi
3	Complete data transmission using LIFI Technology with visible light communication	International conference on futuristic technologies (INCOFT)(2022)	Mechanism of Li-Fi

Chart 1 :- Literature Survey

3. PROBLEM STATEMENT

The increasing demand for faster communication, greater frequency spectrum, and enhanced security has highlighted the limitations of traditional wireless technologies like Wi-Fi. As data usage continues to rise and network congestion becomes more common, the need for a more efficient and secure solution becomes critical. Li-Fi (Light Fidelity) technology addresses these challenges by using visible light for data transmission, offering high-speed communication, improved bandwidth, and secure data transfer. Unlike Wi-Fi, Li-Fi is immune to interference and offers a solution for overcrowded frequency spectrums, making it a promising alternative for the future of wireless communication.

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4. OBJECTIVE OF THE PROJECT

The objective of this Li-Fi project is to develop and implement a high-speed, secure, and energy-efficient wireless communication system based on visible light communication (VLC) technology. By leveraging LED light sources for data transmission, the project aims to explore the potential of Li-Fi as a viable alternative to traditional wireless communication methods such as Wi-Fi. The system will be designed to provide enhanced data transfer rates, reduced interference, and increased security, particularly in indoor environments. Additionally, the project will focus on overcoming challenges related to signal range, scalability, and the integration of Li-Fi with existing network infrastructures, ultimately contributing to the advancement of next-generation wireless communication technologies.

5. HARDWARE REQUIREMENT

Sr no.	Name of Component/ Module	Specification
1	ATmega328p Microcontroller	-Operating Voltage: 1.8V to 5.5V - Clock Speed: 16MHz - Flash Memory: 32KB - RAM: 2KB - EEPROM: 1KB - GPIO Pins: 23
2	Bridge Rectifier	-Input voltage:230 V -output voltage:12 V -Current: 1.5A -Power:12 W
3	7805 Voltage Regulator	-Input Voltage:12V -output Voltage:5V -Current: Less than 1A -power:4W -PSRR:50-60dB
4	Crystal Oscillator	-frequency:16MHz -Voltage:5V -Load Capacitance: 10 pF to 30 pF -Operating Temp Range: -30°C to +30°C
5	16*2 LCD	-Voltage:5V -Current: 2mA
6	Potentiometer (POT)	-10KΩ
7	LDR	-Voltage:5V -Dark Resistance: 1 MΩ to 10 MΩ (in darkness) -Light Resistance: 1 kΩ to 100 kΩ (under bright light) -Response Time: 10 ms to 100 ms -Power Dissipation: < 50 mW
8	Resistors	-330 Ω -10k Ω
9	Capacitors	-10uF -470uF -22pF
10	LED	-Red
11	Reset	-voltage:5V -Current:1 µA
12	Power Supply	-230V with DC power jack

Chart -2: Hardware Specifications

6. BLOCK DIAGRAM

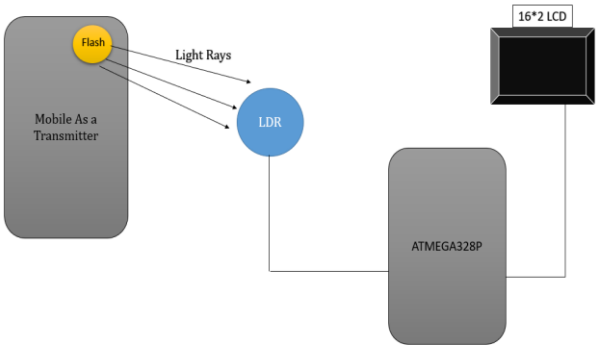

Diagram:-1

7. CIRCUIT DIAGRAM

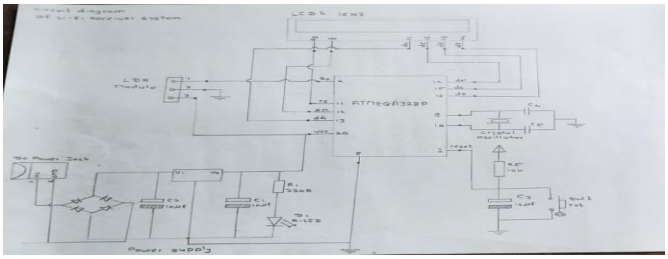

Diagram: -2

8. WORKING

When using a mobile phone as a transmitter, a user types a message and presses the send key. According to the software mechanism, the mobile adjusts the duration of the light, with the backflash light turning on for a short period based on the message length. This light is then emitted in the form of a modulated signal, which falls on the Light Dependent Resistor (LDR) placed in the receiver unit. The LDR detects the changes in light intensity, and the signal is passed to the AtMEGA328P microcontroller. The microcontroller, based on the program stored in its memory, decodes the message by interpreting the variations in light duration. Finally, the decoded message is displayed on the 16x2 LCD screen, providing real-time communication through the Li-Fi system. This method of communication is both energy-efficient and innovative, using visible light to transmit data.

9. ADVANTAGES

1. High-Speed Data Transmission: it has data rate in Gbps
2. Security: Li-Fi is more secure than Wi-Fi because light cannot penetrate walls, ensuring localized transmission and preventing data interception from outside the designated area.
3. No Health Risks: Unlike Wi-Fi's radio waves, Li-Fi uses non-ionizing visible light, making it safe for human health with no risk from electromagnetic radiation.
4. Global Availability of Light: Li-Fi is more versatile and accessible than traditional wireless technologies, as it uses universally available light and doesn't require specific frequency allocation.
5. Cost-Effective: Cost is very less as comparative other Technologies.

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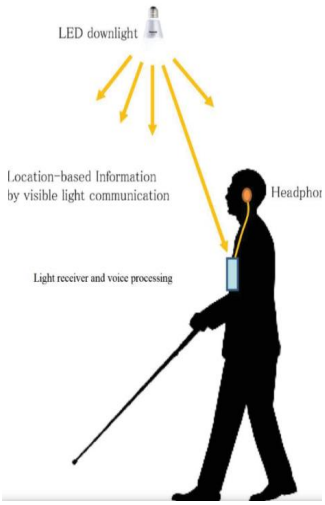
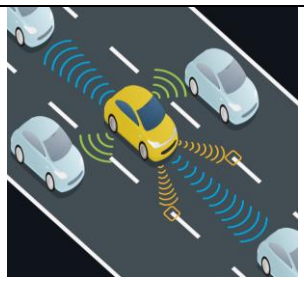
10.APPLICATIONS

Area	Description	Image
A. Indoor Navigation	Visible light communication for location-based services enables indoor positioning by using a cellular phone with a photodiode to detect signals from LED lights, overcoming GPS limitations indoors.	
B. Indoor Navigation for visually impaired people	Indoor navigation for the visually impaired uses LED lights emitting location data, which is received by a smartphone to calculate the optimal path and guide the user through spoken directions via headphones.	
C. Survey Measurement using Image Sensors as Receivers	A photogrammetric method combined with visible light communication provides millimeter-level position accuracy at 50 meters, offering continuous monitoring of LED positions, surpassing the capabilities of a total station.	
D. Vehicle to Vehicle Communication using Li-Fi	The system uses optical wireless communication, where a speed sensor converts vehicle speed data to DC, which is processed by a microcontroller, transmitted via an LED driver to an LED, received by a photodiode, converted into voltage by a trans-impedance amplifier, and displayed on an LCD.	

11.FUTURE SCOPE

A. Airways: Whenever we travel through airways we face the problem in communication media, because the whole airways communications are performed on the basis of radio waves. To overcomes this drawback on radio ways, li-fi can be introduced[1].

B. You Might Just Live Longer: For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of computers cans block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms[1].

C. Increase Communication Safety: Due to visual light communication, the node or any terminal attach to our network is visible to the host of network.

D. Multi User Communication: Li-Fi supports the broadcasting of network, it helps to share multiple thing at a single instance called broadcasting. [3][1]

12.CONCLUSION

The possibilities are numerous and can be explored further, this technology is in manufacturing process to produce every bulb to become a Wi-Fi hotspot to transmit wireless data and we will proceed towards the cleaner ,greener ,safer and brighter future without radio wave ,because radio waves create a harmful effect for living thing ,but Li-Fi is the optical wireless communication for data ,audio and video streaming in LEDs, this type of new invention can be encouraged to produce a safe and green technology. Li-Fi may not be able to replace conventional radios altogether, but it could turbo charge the development of wireless television and make it easier to throw a wireless signal across an entire house. At present, finding the ideal position for

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a wireless router is something of a divine art. If the signal could be passed via VLC from Point A to Point B inside a home, small local routers at both points could create local fields with less chance of overlapping and interfering with each other. Large scale areas that are saturated with radio signals or that doesn't permit them for security reasons could use Li-Fi as an alternate high-speed wireless network solution.

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