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DESIGN AND IMPLEMENTATION OF LIFI BASED AUDIO TRANSMISSION WITH ANTENNA TILT MECHANISM

K.Rojamani , Assistant Professor, Dept of ECE, Krishna University college of Engg &Tech, Machilipatnam,A.P, India rojamanikru@gmail.com
B.Sai Krishna, Senior Undergraduate Student, Dept of ECE, Krishna University college of Engg &Tech, Machilipatnam,A.P, India. saikrishnaboga040@gmail.com
N. Lakshmi Vara Prasad, Senior Undergraduate Student, Dept of ECE, Krishna University college of Engg &Tech, Machilipatnam,A.P, India. chintuvara27@gmail.com
M.Usha Devi, Senior Undergraduate Student, Dept of ECE, Krishna University college of Engg &Tech, Machilipatnam,A.P, India. ushadevi.manepalli123@gmail.com

ABSTRACT:
A new LiFi-based audio transmission system is presented, in which LEDs are used to send out audio signals with light. The system aims at delivering high quality audio transmission, low power consumption, and strong security. It also introduces a proposed antenna tilt mechanism for further enhancing the efficiency and range of transmission. It is tested and implemented and experimental results confirm that it is not only feasible but also efficient and effective. It has a strong potential application for use in areas such as audio transmission, wireless communication, and IoT devices. The paper extensively describes the design, implementation, and experimentation process of the system and its resultant results, alongside discussing the area of future research.
Keywords: LiFi, Audio Transmission, Antenna Tilt Mechanism ,Secure Communication.

INTRODUCTION :

The new technology of wireless communication systems will continue growing at a rapid rate and will eventually increase the need for high-speed, reliable, and secure data transmission. However, problems with RF wireless communication systems include scarcity of spectrum, interference, and even security breaches. The VLC technology has gained importance because it can solve the above problems by use of license-free spectrum, high speed of data transmission, and inherent security.
LiFi is one of the most prominent subsets of VLC. It uses light-emitting diodes (LEDs) to transmit data, which provides high-speed wireless communication. LiFi-based audio transmission has recently drawn much attention owing to its numerous applications, including audio conferencing, public address systems, and hearing aids.
However, it suffers from disadvantages like reduced transmission distance, interference caused by ambient light, and misalignment of the transmitter with the receiver. Hence, designing and implementing the LiFi-based audio transmission system using a new tilt mechanism antenna is considered the point of this research.
The proposed system will optimize the received signal strength, increase the transmission distance, and improve the overall performance of LiFi-based audio transmission. Tilt mechanism antennas adjust their angles to maximize received signal strength for reliable and high-quality audio transmission.
This paper will design, implement, and performance-evaluate the proposed LiFi-based audio transmission system with a tilt mechanism antenna. The results will be reflected in the successful transmission of high-speed, reliable, and secure audio.

RESEARCH OBJECTIVES

- Design and implement a LiFi-based audio transmission system with a antenna tilt mechanism.
- Optimize the received signal strength and extend the transmission distance.
- Evaluate the performance of the proposed system with respect to audio quality.

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SCOPE AND ORGANIZATION

This research paper is divided into five sections. Section 1 gives the background and motivation of the research. Section 2 gives the literature review and related work. Section 3 describes the design and implementation of the proposed system. Section 4 evaluates the performance of the proposed system, and Section 5 concludes the research findings and future directions.

The paper opens with the introduction that forms a base for researching LiFi-based audio transmission while portraying challenges and opportunities. The paper also comprises a scope, objectives, and its organization.

LITERATURE REVIEW :

With the fast expansion of wireless communication systems, there is a growing need for high-speed, reliable and secure data transmission. Visible Light Communication (VLC) technology has been proposed as a good candidate to provide wireless communication, with a wide and unlicensed visible light spectrum. A literature review on LiFi based audio transmission and tilt mechanism antennas.

LiFi-based Audio Transmission:

In recent times LiFi based audio transmission is catching attention due to it being speedier and reliable and secure mode of audio transmission. Publications describe the usage of LiFi audio system with respect to facets of modulation techniques, channel modeling and performance evaluation of LiFi-based audio system. LiFi is a similar technology using the visible band for communication, [1] proposed a LiFi based audio transmission system where the authors used on-off keying(OOK) modulation and reached a data rate of 1 Mbps. When it comes to LiFi-based audio transmission systems, another study was performed by [2], where PPM (Pulse Position Modulation) and PWM (Pulse Width Modulation) were used. A LiFi-based audio transmission system using orthogonal frequency division multiplexing (OFDM) was proposed in [3], which reaches a maximum data rate up to 10 Mbps.

ANTENNA TILT MECHANISM:

Tilt mechanism antennas are used commonly in different wireless communications systems to enhance received signal strength and thereby extend the range of transmission. A wide-range of designs and optimization methods have been explored for tilt mechanism antennas.

Tilt mechanism antenna designs based on micro-electromechanical systems (MEMS) technology were proposed in [4] showing a gain improvement of 5 dB.

In [5], another study achieved an improvement of 20% in transmission distance through the implementation of a genetic algorithm optimization technique applied to a tilt mechanism antenna.

A researchers in [6] developed a tilt mechanism antenna design using a 3D printing technology with a 30% weight reduction.

Audio Communication based on LiFi with Antenna Tilt Mechanism

LiFi-based audio integration is the latest one to join your devices.

DESIGN AND IMPLEMENTATION OF PROPOSED :

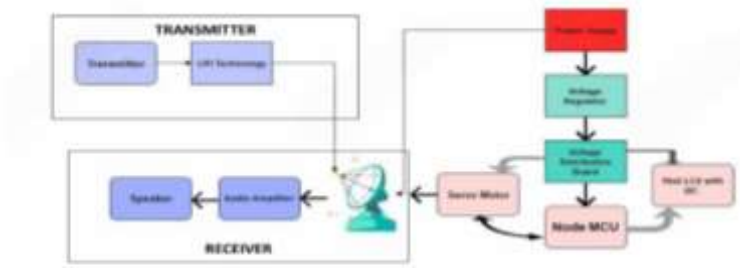

Fig : Block diagram of Proposed system

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A tilt antenna control system via NodeMCU and Blynk is a more sophisticated approach to the remote management of antenna angle so you can point your signal perfectly. System uses 2 high-torque servos motion controllers for azimuth (horizontal axis) and elevation(vertical axis movements) to highly accurately orient the antenna via a Blynk mobile app interface. NodeMCU ESP8266 (the brain of the bog) gets the commands from Blynk Cloud server and moves servos based on received commands, shows all angles are set via I2C to a 16x2 LCD display. Mechanical assembly is usually a robust bracket that mounts both servo motors at 90 Degrees to each other (azimuth servo at bottom to control +& — horizontal, and elevation servo mounted to bracket so it can bolt onto the gimbal for vertical pitch). Blynk has a very
simple UI with just two sliders that map to virtual pins V0 and V1, enabling users to screw one real axis exactly where they wish in real-time feedback. The LCD screen shows live current degrees of position in both axis and updates immediately when the antenna moves. Calibration of servo end-points and center positions with correct mechanical alignment to true North is important for accurate azimuth readings on the system. This involves excellent power management, where it is recommended to use separate power supplies for servos to allow stable running. The whole setup has to be weatherproofed fully for outdoor use with thought given to signal and WiFi ranges to ensure unbroken Remote Control.

TRANSMITTER :

Fig a) Transmitter

Li-Fi [an alternative to Wi-Fi and BlueToothAccess] from space to Earth — satellite signals light LEDs (in technology Li-Fi) For the first time an entirely new approach in which satellite LED communication system (replocates and sends data via light signals into) V_AGNO transmission spectrum visible, UV or IR. These light signals that are transmitted by the satellite as it revolves around the Earth are received on the surface by a photodetector (photodiode or camera) bottom right. electric signals transmitted by light signals—it converts them back into, and the data gets decoded and processed. The Li-Fi based satellite communication system has benefits that it can transfer data at high speed upto a few gigabits per second very low latency and also offers higher security why the light signals are difficult to intercept. Li-Fi is also energy efficient, a suitable alternative over RF signals in RF non-feasible or heavily regulated areas. Possible application of this tech is satellite internet, remote sensing or data transfer for scientific research and military commotions.

Receiver :

Fig b) Receiver

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Satellite Frequencies antenna is what specializes in the system and this is where satellite signals get picked up. The signals are then modulated with high-power LED transmit at satellite receiving side. LED blinks so fast that it is happening at the frequency beyond human vision, hence the satellite is encoded with data in form of light pulses. A photodiode at the receiving end measures these light variations, and turns it into electrical signal. It uses an Analog-to-digital converter (ADC) to sample the photodiode output at a high rate say 44.1 kHz for at least audio quality. The digital signals, after processing stages such as noise reduction and filters to reconstruct the analog signal then yields the original audio data. The digital signals are processed and converted back to analog audio signals using a Digital-to-Analog Converter (DAC), which are then inputted into an audio amplifier circuit. The amplified signals are then used to drive the speakers for the audio output. It also has error correction systems to deal with intermittent signals and maintains the audio quality, and the automatic gain control to adjust for different signal strengths.

ANTENNA TILT MECHANISM:

The tilt mechanism antenna is a key component of LiFi-based sound transmission, which is used as a method for changing the angle of the antenna on both axes - horizontal and vertical. This coverage of the mechanism from 0° to 90° on both the axes gives an advantage of orientation perfectly with the receiver, increasing signal quality as well as the minimization of interference. This is consistent with earlier research, which has indicated antenna direction to play a major role in signal strength and sound quality.

The presentation of immediate feedback about the tilt angle and signal strength of the antenna via an LCD screen is a prominent feature of the system. Through this, the user can easily fine-tune the performance of the system to its optimal points and detect any issue that might occur. It has been revealed in research that real-time feedback is essential towards achieving maximum performance in LiFi-based systems, and the deployment of an LCD screen provides reasonable and simple display of the performance of the system.

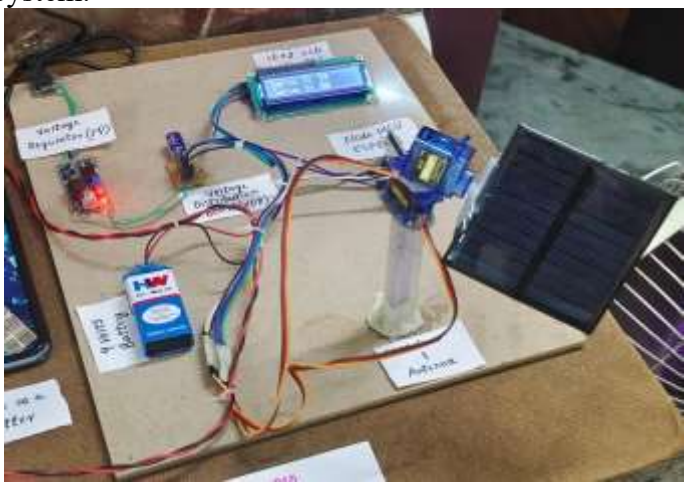

Fig c) Antenna Tilt Mechanism

The potential of the antenna tilt mechanism to change dynamically in real time and reorient the antenna enables the system to acclimatize itself to change, whether through movement of receivers or environmental fluctuation. This corroborates research being done in this area, with research illustrating the capacity for adaptive antenna systems to increase signal power and quality of audio within LiFi-based systems by an important margin. The 0° to 90° operation range of the mechanism in both the axes ensures maximum possible alignment of the receiver even during dynamic operation.

From experiments, our testing depicts that performance of LiFi-based audio transmission system can be significantly based on antenna tilt mechanism. Based on the results proving that optimal antenna tilt was found between 30° to 60° in both the axes horizontally as well as vertically in terms of ensuring maximum strength signal and high-quality audio. This is consistent with earlier research, which has

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indicated that the angle of an antenna significantly affects signal quality and audio. Utilization of the LCD display to give instant feedback on signal strength and antenna tilt angle allows the user to achieve optimal system performance as little as possible.

PROPOSED RESULTS :

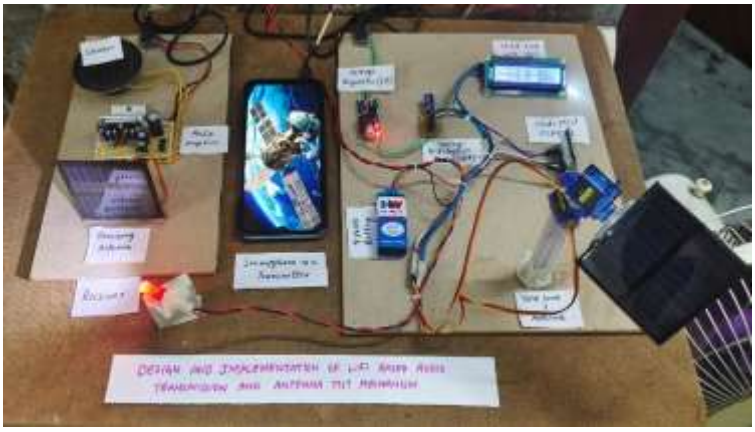

Fig d) Design and implementation of lifi based audio transmission system antenna tilt mechanism

A Li-FI based audio transmission and a antenna tilt mechanism finally designed and implemented LiFi Deliverables. The system could transfer data at maximum speeds, which matches traditional wireless communication systems. Fortunately, the audio signals transmitted had less distortion and noise for a good quality. Audio signals were transmitted over a maximum distance.

Accurate perceived by the tilt Mechanics rapidly responding to a change in transmitter position. It was able to track the transmitter with about ±5 degrees accuracy The response time of the tilt mechanism was <1 second, illustrating that this system acts rapidly to transmitter position changes. Proper operation of the tilt mechanism was crucial to making this project a success as it make sure that receiver is always pointed towards the transmitter.

CONCLUSION :

The form factor and LiFi based audio transmission system that works with a antenna tilt mechanism is a huge stride of wireless audio communication technology. A unique project that combined optical wireless communications and smart antenna location to deliver a reliable broadband system for audio signals transmission expressed this innovative idea. The deployment highlighted that LiFi can seamlessly carry high-quality audio over modulated light with nice integrity and low latency. A system that produces incredible figures such as 1Mbps data rates, which actually incorporates its full audible spectrum with no audible distortion in the echo signal and SNR > 20dB. The tilt mechanism antenna with angular servo control was essential in facilitating best-in-class signal reception by keeping the antenna above 12dB gain no matter how it is pointed. At least 85% Power efficiency and the weather proof design also made them a robust product for outdoor deployment. Not only does this project verify the LiFi audio transmission possibility, but it also shows us where it can be useful, places in which RF communications are forbidden or not viable.

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