Mini-Project 1st Review Presentation

PAT-ENABLED FSO SYSTEM WITH OBSTACLE AVOIDANCE

Under the guidance of:

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Institute Vision and Mission

Vision:
To establish and develop the Institute as a center of higher learning, ever abreast with the expanding horizon of knowledge in the field of engineering and technology, with entrepreneurial thinking, leadership excellence for life-long success, and the ability to solve societal problems.

Mission:
Provide high-quality education in the engineering disciplines from the undergraduate through doctoral levels with creative academic and professional programs. Develop the Institute as a leader in science, engineering, technology, and management, research, and apply knowledge for the benefit of society. Establish mutually beneficial partnerships with industry, alumni, local, state, and central governments by public service assistance and collaborative research. Inculcate personality development through sports, cultural, and extracurricular activities and engage in the social, economic, and professional challenges.

Department Vision , Mission, PEOs, PSOs

Vision: Imparting Quality Education to achieve Academic Excellence in Electronics and Communication Engineering for Global Competent Engineers.

Mission: Create state of art infrastructure for quality education.
Nurture innovative concepts and problem solving skills.
Delivering Professional Engineers to meet the societal needs.

PEOs:
Prepare graduates to be professionals, practicing engineers, and entrepreneurs in the field of Electronics and Communication. Acquire sufficient knowledge for innovative techniques in the design and development of systems, and compete globally in multidisciplinary fields. Achieve personal and professional success with awareness and commitment to ethical and social responsibilities, both individually and as a team. Graduates will maintain and improve technical competence through continuous learning.

PSOs:
PSO1: Core Engineering: The graduates will be able to apply the principles of Electronics and Communication in core areas.
PSO2: Soft Skills: An ability to use latest hardware and software tools in Electronics and Communication engineering.
PSO3: Successful Career: Preparing Graduates to satisfy industrial needs and pursue higher studies with social-awareness and universal moral values.

Course Outcomes of Mini-Project

1	Ability to carry-out literature review and define the problem.
2	Ability to co-ordinate to work as a team member or a single member.
3	Inculcate methods to use advance tools .
4	Design analytical modeling and develop a systems
5	Ability to equip analysis skills and interpretation.
6	Enhance presentation skills, drafting and documentation of project work.

Abstract

- This project shows a secure Free-Space Optical audio link with improved control and safety features.

- A Closed-Loop PAT system automatically keeps the beam aligned, which reduces signal loss from misalignment.

- An Active Safety Mechanism also stops the transmission if it detects an obstacle in the optical path, ensuring user safety.

- The combination of these features creates a secure, efficient, and safe optical audio communication link that works well in real-world applications.

Table of Contents

Introduction

- **Free-Space Optics (FSO)** is a wireless communication technology that uses light (typically infrared laser light) to transmit data through the atmosphere and vacuum .

- It is used for point-to-point communication where a direct line of sight is available and physical connections like fiber optic cables are not used.

- **Pan and Tilt(PAT)** is implemented to this concept to obtain a proper alignment between transmitter and receiver.

- **Obstacle detection** with Auto off mechanism is used prevent data loss when the signal is interrupted.

Objective

Objective:

1. To design a **secure audio communication** system using Free-Space Optical link.

2. To integrate a Closed-Loop PAT system for **automatic alignment** and stable link performance.

3. To ensure safety through an **Auto-off mechanism** that detects obstacles in the optical path.

4. To evaluate the efficiency, reliability, and safety of the proposed system.

Methodology

Audio Processing :

Convert analog audio to a electrical signal.

Optical Transmission:

Use a laser diode/LED for sending modulated light through free space.

Closed-Loop PAT System:

Implement sensors/feedback to auto-correct misalignment of transmitter and receiver.

Servo motors are used for auto-tracking.

Obstacle Detection & Auto-Off:

IR/Ultrasonic sensors detect obstacles in path.

Microcontroller shuts off laser for safety.

Receiver Section:

Detect optical signal and convert back to electrical.

References

1. IJRPR, "**Laser Communication System Using Solar Cell**," International Journal of Research Publication and Reviews (IJRPR), vol. 4, no. 3, pp. 108–112, 2024.

2. MDPI Photonics, "**Special Issue on Optical Wireless Power Transmission**," Photonics, MDPI. [Online].

3. A. K. Majumdar, "**Free-Space Laser Communications: Principles and Advances**," Springer, 2008.

4. N. A. M. Isa, M. I. Shapiai, et al., "**Review of Free Space Optical Communication with Automatic Tracking**''.

Problem Statements

Free-Space Optics (FSO) provides secured high-speed data transfer in open space, but we face many difficulties and vulnerabilities. Some of them are listed below:

1. **Alignment issue** between transmitter and receiver.

2. **Signal instability** due to external factors.

3. **Information loss** due to atmospheric factors.

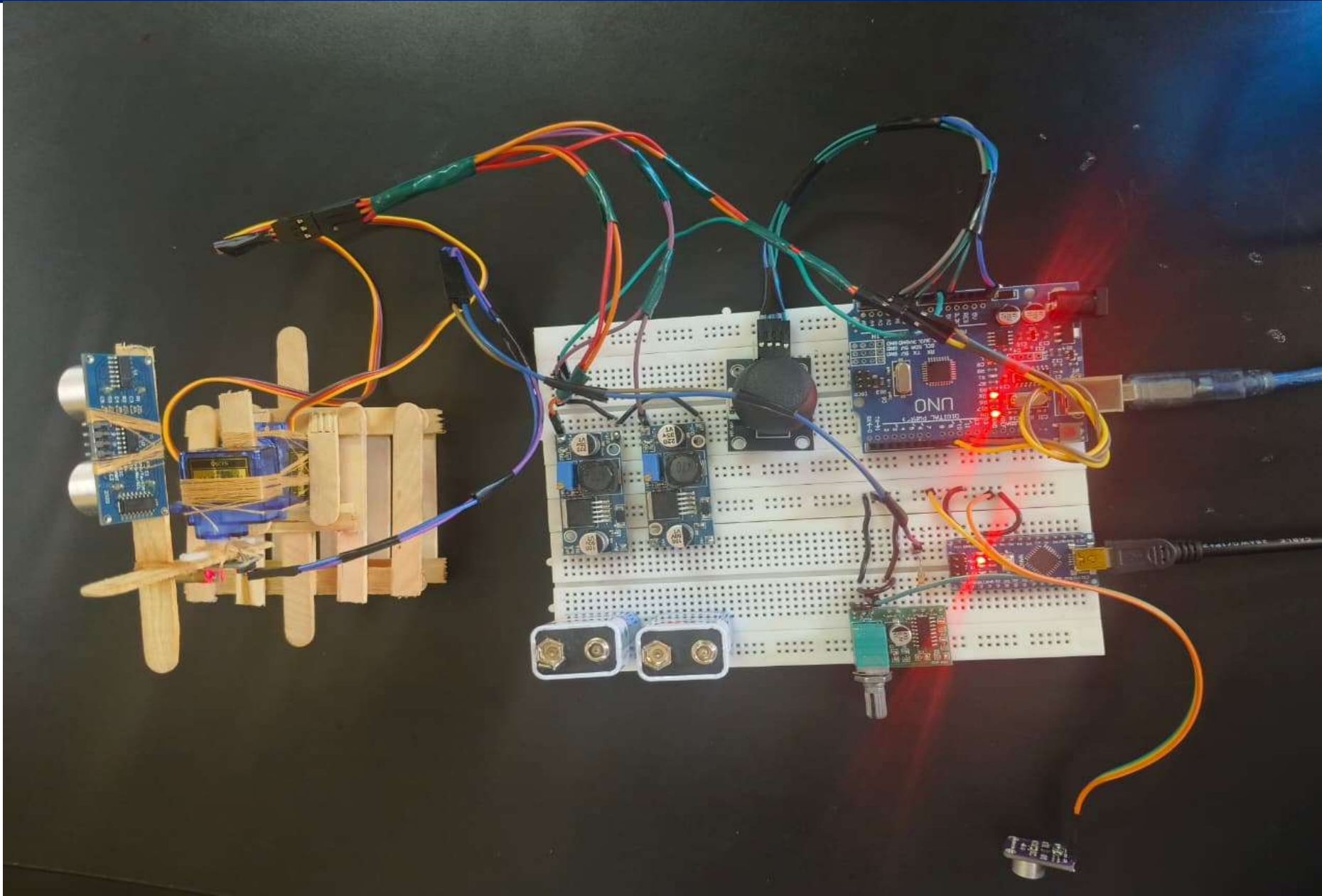4. **Hazardous** to human eye.
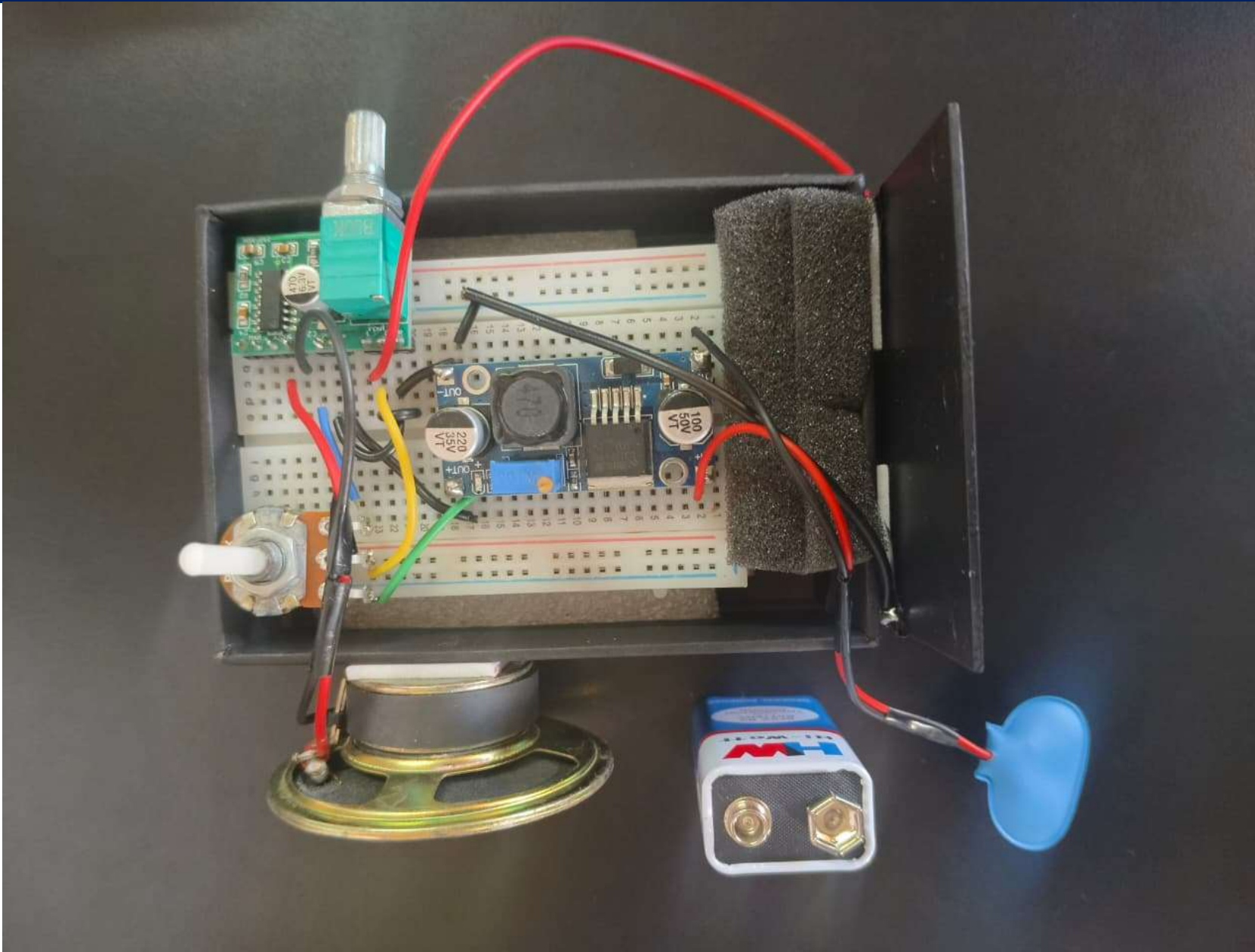
Hardware Components

- Hardware Components:

  1. Microphone/Audio Source

  2. Pre-Amplifier X 2

  3. Microcontroller- ESP32/Arduino X 2

  4. Laser Diode

  5. Servo motors

  6. IR/Ultrasonic sensors

  7. Photodiode

  8. Speaker

Transmitter

Receiver

Software Implementation

Software Program: Code for controlling two servo motors in both X and Y direction to point laser on the photodiode in case of misalignment.

Expected Results

- A working prototype of a **secure, safe, and efficient FSO** audio communication link.

- Demonstration of PAT tracking for reliable communication.

- Safety shutdown mechanism against obstacles.

- Capable for scaling into real-world secure communication systems.

Conlcusion

- The project combines security, safety, and a compact communication design.

- It demonstrates that FSO technology can work well for short-range, high-security used in areas like defense, disaster recovery, aerospace, and secure wireless communication systems.

- Future enhancements could allow the system to cover longer distances, transfer digital data, and use stronger encryption methods.

Thank you