ES 116 - Project: Laser-Based Communication System

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Abstract: Creating a laser-based communication system that uses laser to encrypt and send messages and then decrypts to obtain the information.

Keywords: Laser, Communication, Message, encrypt, decrypt, information.

I. Objective

To send messages using lasers and photodetectors to medium-range distances.

II. Equipment Used and Circuit

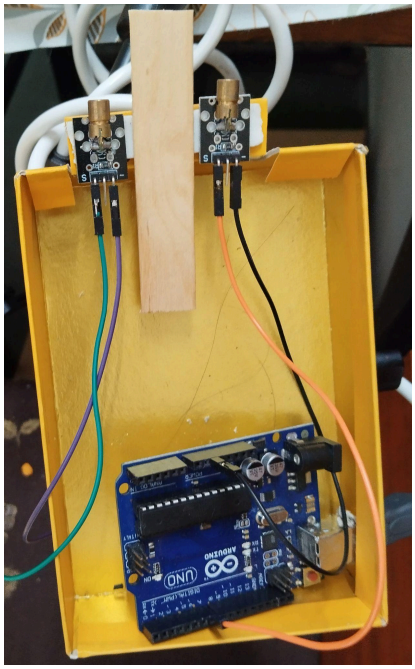

Fig 1 - Circuit of the Laser Sender Module

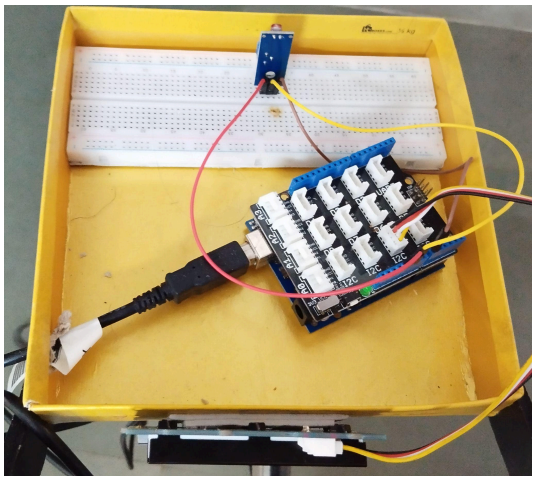

Fig 2 - Circuit of the Reciever module

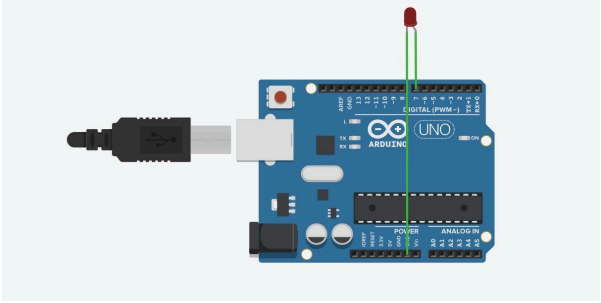

Fig 3 - Diagram of Laser Sender module

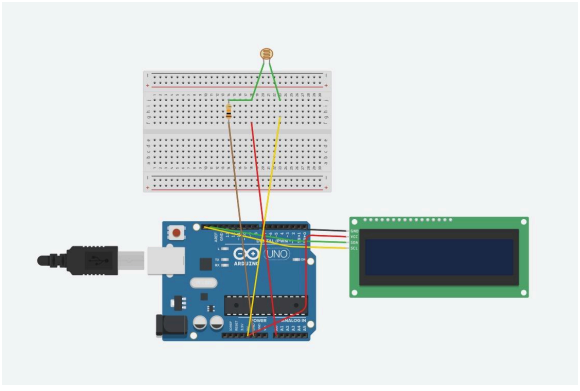

Fig 4 - Circuit Diagram of Reciever Module

Equipments:
Arduino Uno, Breadboard, Male-to-Male wire, Female-to-wale Wires, Grove Shield Base, Grover RGB LCD Display, Laser Module, LDR Sensor Module, tripod stands to mount the modules.

III. Working

This device is based on using a linear encoding system and laser on a photodetector to transmit and receive messages. Linear encoding, in this case, means that a number represents each letter of the alphabet; a is represented by 1, b by 2, and so on till z by 26. The photodetector detects how many times the laser falls on it within an interval of 500 milliseconds and counts that as a number using the code inputted in the Arduino. This number is then decoded into its respective letter and displayed on the LCD screen. A space between words is detected by an interval of 1000 milliseconds between laser beams.

We can also change the speed of the laser pulses by altering the duration in which they are switched on. This way, the message will be transmitted even faster. (In the video, speed has been kept low intentionally)

Attached below is the link to the Arduino code for the laser sender and receiver modules

https://docs.google.com/document/d/1yyOm2SA9S86yfey_pwbp5ExGmss5IPQlljtjzRB53Jk/edit?usp=sharing

IV. Results

As seen in the video, we were able to successfully send and receive messages, which was shown on the LCD screen. Shown below are the graphs of the photodetectors at different points in time.

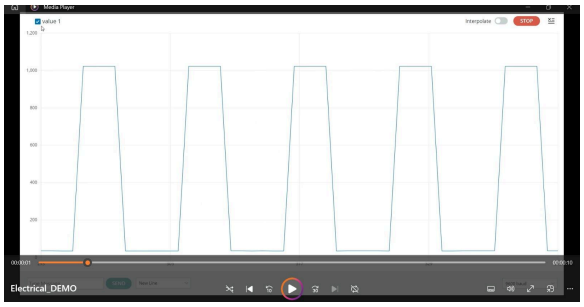

Fig 5

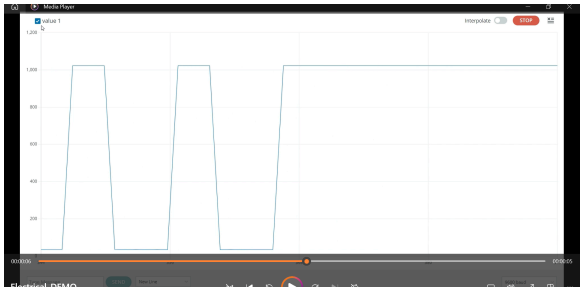

Fig 6

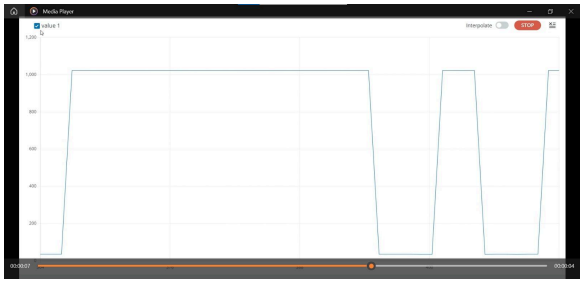

Fig 7

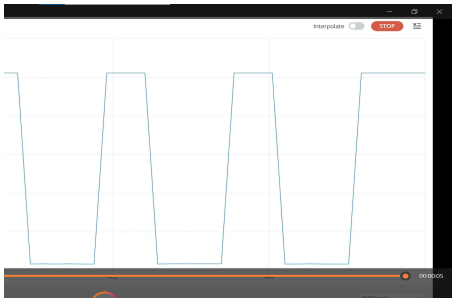

Fig 8

From the screenshot, it can be observed that light pulses carrying information are detected some number of times, which are then converted to alphabetical characters, and can be obtained on the screen, thereby establishing communication between both the modules.

The peaks on these graphs represent the laser pulse being detected by the photodetector since that is when current flows in the circuit.

The large interval in Fig 6 and Fig 7 represents a gap to show that the signal for the letter is done.

From Fig 5 and Fig 6, we can count 8 peaks in total. This corresponds to the letter “H”. Then, from Fig 7 and Fig 8, we can count 5 peaks. This corresponds to the letter “E”.

V. Applications

1. **Quick Deployment -** It can be used in situations in which quick deployment and a secure line are needed, for example - in the military during a battle where private and portable communication might be the difference between victory or defeat. We can place this device anywhere and can establish a secure line of communication to another point that cannot be breached or jammed.

2. **Industrial Applications -** It can be used in industries to monitor and control machines, equipment, and infrastructure. This system can automate status updates, alerts, and commands as it can send and receive text messages.

3. **Underwater Communication -** Laser communication systems can be adapted for underwater communication between submarines, unmanned underwater vehicles (UUVs), and surface vessels. They offer advantages such as higher data rates, lower latency, and greater security than acoustic communication systems.

4. **Agricultural Applications -** In agriculture, laser communication systems can be used to remotely monitor crop conditions, soil moisture levels, and weather patterns. Farmers can receive text message alerts and updates on their mobile devices, allowing them to make informed decisions about irrigation, fertilization, and crop management

V. Future Scope of Improvement

- For future aspects of our project- we would like to integrate technologies so that the laser sender and receiver modules align more efficiently and autonomously.

- We would incorporate a more sturdy and compact exoskeleton to withstand rugged terrain and be portable.
- We would also try to incorporate other methods of transmitting information, like Morse code encryption, binary code encryption, and frequency modulation.

VII. Challenges faced

First, we tried to do this project with multiple lasers and photodetectors. However, we faced some kind of cross-interference as well as synchronization errors which compelled us to go ahead with only one laser sender.

VIII. Acknowledgments

We thank Professor Arup Lal Chakraborty and our teaching assistant, Ms. Payel Ghosh, for their valuable insights and guidance throughout this project.

IX. Conclusions

We were able to successfully transmit and receive messages through our project, thereby establishing a wireless communication system. We learned a lot about the intricate mechanisms of lasers and photodetectors, as well as how to encrypt and decrypt messages using laser transmissions. This laid the groundwork for our understanding of laser systems and communication systems.

X. Contributions

Tejas Lohia (23110335) - Circuitry, Electronics (Laser and Photodetector arrangements) and Writing Code

Tejas Girish Joshi (23110334) - Documentation, Video editing, LCD screen integration

Tejavath Vinod (23110336) - Help in electronics and presentation