LiFi Based Morse Code Receiver

Introduction

With the rapid growth of wireless communication, there is increasing interest in alternative technologies that can reduce congestion in the radio frequency spectrum. Li-Fi (Light Fidelity) is an emerging communication technology that uses visible light for data transmission. This project demonstrates a simple and effective Li-Fi communication system by transmitting Morse code using light and decoding it at the receiver end.

The aim of this project is to design and implement a Li-Fi based Morse code receiver using an ESP32 microcontroller, where Morse code transmitted through a mobile flashlight is detected, decoded, and displayed as readable text on an LCD.

Objective

The objectives of this project are:

- To implement visible light communication using simple hardware components
- To detect light pulses using an LDR sensor
- To classify pulses into dots and dashes based on timing
- To decode Morse code into alphabets and words
- To display the decoded message on a 16×2 I2C LCD

System Overview

The system consists of a transmitter and a receiver:

- The transmitter is a mobile flashlight application that emits Morse code as light pulses.
- The receiver uses an LDR sensor connected to an ESP32 to detect these pulses.

The ESP32 measures the duration of light and dark intervals, decodes Morse code characters, and displays the output in real time on an LCD.

4. Hardware Components Used

- ESP32 Development Board
- LDR Sensor Module (with digital output D0)
- 16×2 I2C LCD Display
- Jumper Wires
- Breadboard
- Mobile Phone (Flashlight Morse Code App)

5. Software Tools Used

- Arduino IDE
- ESP32 Board Package
- C/C++ (Arduino Programming Language)

Block Diagram

Transmitter:

Mobile Flashlight (Morse Code App)

Receiver:

Light Pulses → LDR Sensor → ESP32 → Morse Decoder → I2C LCD

7. Working Principle

1. The mobile flashlight transmits Morse code using light ON and OFF pulses.
2. The LDR sensor detects changes in light intensity and outputs a digital signal.
3. The ESP32 measures the duration of each pulse:
    - Short pulse → Dot (.)
    - Long pulse → Dash (-)
4. A gap between pulses determines:
    - Letter separation
    - Word separation
5. The ESP32 decodes the Morse sequence into alphabets.
6. The decoded characters are displayed on the LCD.
7. When a line is full, text automatically moves to the next line.

Morse Code Decoding Logic

- Dot vs Dash:
  Determined using pulse duration thresholds.
- Letter Gap:
  Identified by a longer OFF duration between signals.
- Word Gap:
  Detected by an even longer pause, indicating a space.
- Error Handling:
  Invalid sequences are displayed as ?.

Features

- Real-time Morse decoding
- Word formation and spacing support
- Automatic LCD line shifting
- Low-cost and simple hardware
- No RF interference

Applications

- Educational demonstration of Li-Fi technology
- Basic optical communication systems
- Secure short-range communication
- Morse code learning tool
- Low-power communication environments

Advantages

- Uses visible light instead of RF
- Simple and inexpensive implementation
- Immune to electromagnetic interference
- Easy to understand and modify

Limitations

- Requires line-of-sight communication
- Ambient light can cause noise
- Limited data rate
- Performance depends on timing accuracy

Future Enhancements

- Use photodiode for higher sensitivity
- Implement error correction
- Add bidirectional communication
- Support numbers and special characters

- Improve decoding accuracy using analog input

Conclusion

This project successfully demonstrates a Li-Fi based Morse code receiver using an ESP32. Light pulses transmitted from a mobile flashlight were accurately detected, decoded, and displayed as readable text on an LCD. The project highlights the potential of visible light communication as an alternative wireless technology and serves as an effective educational tool for understanding Li-Fi and optical communication concepts.