LiFi - Project

Introduction to Embedded Systems – CSE211
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Submitted to

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Introduction

The Li-Fi Project orchestrates a sophisticated network within a household, orchestrating seamless communication between sensors and microcontrollers for comprehensive home monitoring and alert systems. Functioning as the central nervous system, the Tiva C Launchpad microcontroller efficiently processes data received from a trio of pivotal sensors strategically positioned throughout the house. The Ultrasonic sensor, serving as a guardian against intruders, stands sentinel, while the Magnetic sensor vigilantly detects door openings, and the smoke sensor remains vigilant for signs of fire. This amalgamation of sensors forms the backbone of a robust security and safety infrastructure, constantly feeding crucial data to the Tiva C for swift processing and analysis.

The processed alerts, crucial for homeowner awareness and safety, traverse the Li-Fi protocol, a beacon of swift and secure data transmission, en route to the ATMEGA32 microcontroller. Within this microcontroller resides the user interface—a dynamic ensemble featuring an LED, buzzer, and LCD display. These components work harmoniously to relay alerts and notifications in real-time, ensuring that inhabitants are promptly informed of any detected intrusions, door openings, or fire hazards. Through this intricate network, the Li-Fi Project not only exemplifies the power of sensor technology but also showcases the seamless integration of microcontrollers and communication protocols for enhanced home safety and user awareness.

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System Layout

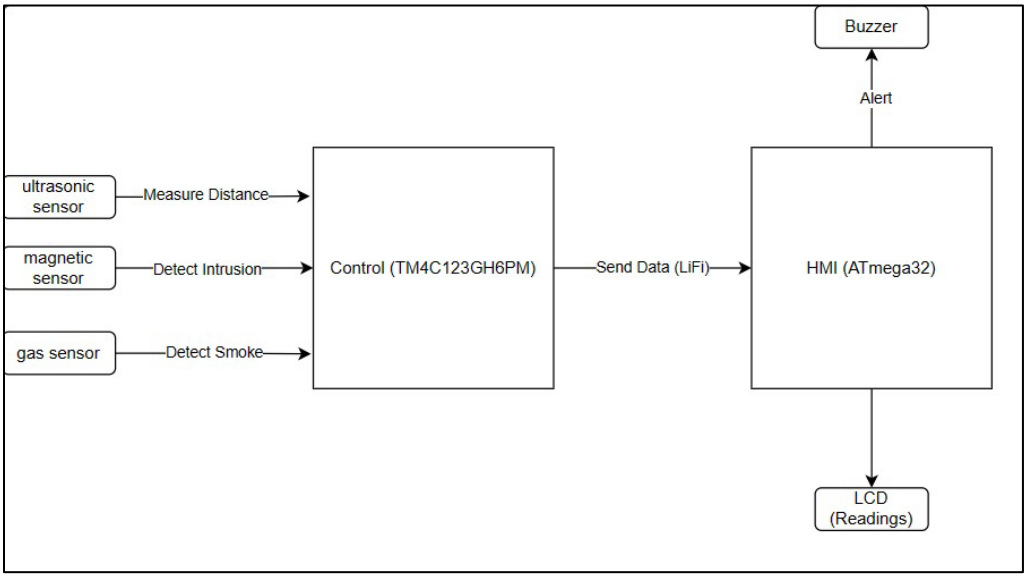


Figure 1System Layout figure

As shown, the system consists of two parts: The control microcontroller (Tiva C) which is responsible for managing sensor readings and reporting alerts which is sent to the other part of the system the second microcontroller. The Human Machine Interface (ATmega32) is responsible for displaying all the sensor readings and presents alerts which are sent from the Tiva C. The user functionalities include:

- Turn off/on the system.
- User is notified with LED and Buzzer
- Check current alert on LCD.
- Mute the buzzer.

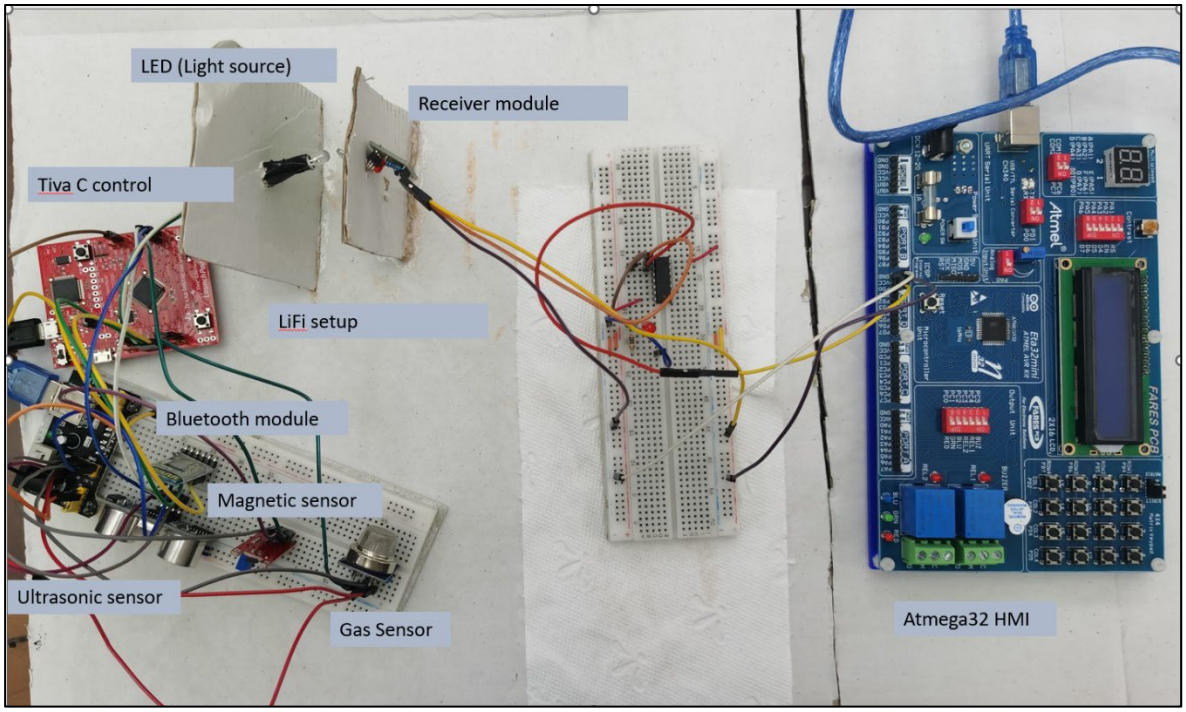


Figure 2System layout

Li-Fi Implementation

The innovative implementation of Li-Fi technology hinges on a clever utilization of the UART communication protocol, transforming conventional wired connections into a cutting-edge data transmission method. This evolution involves a fundamental swap: the traditional wired link is replaced with an LED serving as the emissary of data, while a laser receiver module stands ready at the receiving end, waiting to capture and decipher the transmitted information. This ingenious adaptation not only facilitates wireless data transfer but also harnesses the potential of light as a carrier, fundamentally altering the landscape of communication. By seamlessly integrating these components, the implementation guarantees not only high-speed data transfer but also extends the reach of communication across extended distances, effectively transcending the limitations of traditional wired connections.

At the heart of this implementation lies a transformative approach to long-distance communication, elevating the capabilities of Li-Fi beyond mere speed. By harnessing the inherent properties of light, the conversion from UART to Li-Fi marks a pivotal step towards a future where information travels swiftly and efficiently through beams of light. This breakthrough enables communication at unprecedented speeds while triumphantly overcoming the barriers of distance that often hinder traditional wireless technologies. Through this implementation, Li-Fi emerges as a beacon of innovation, promising not just rapid data transmission but also the potential for expansive and seamless connectivity in environments where conventional methods fall short.

System Architecture

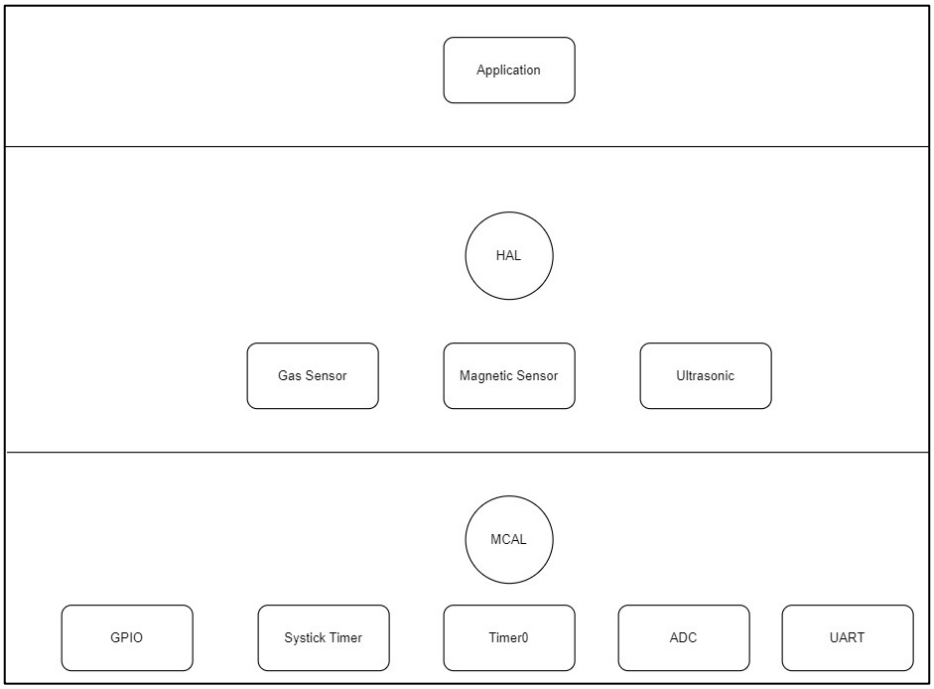


Figure 3Control Microcontroller (Tiva c)

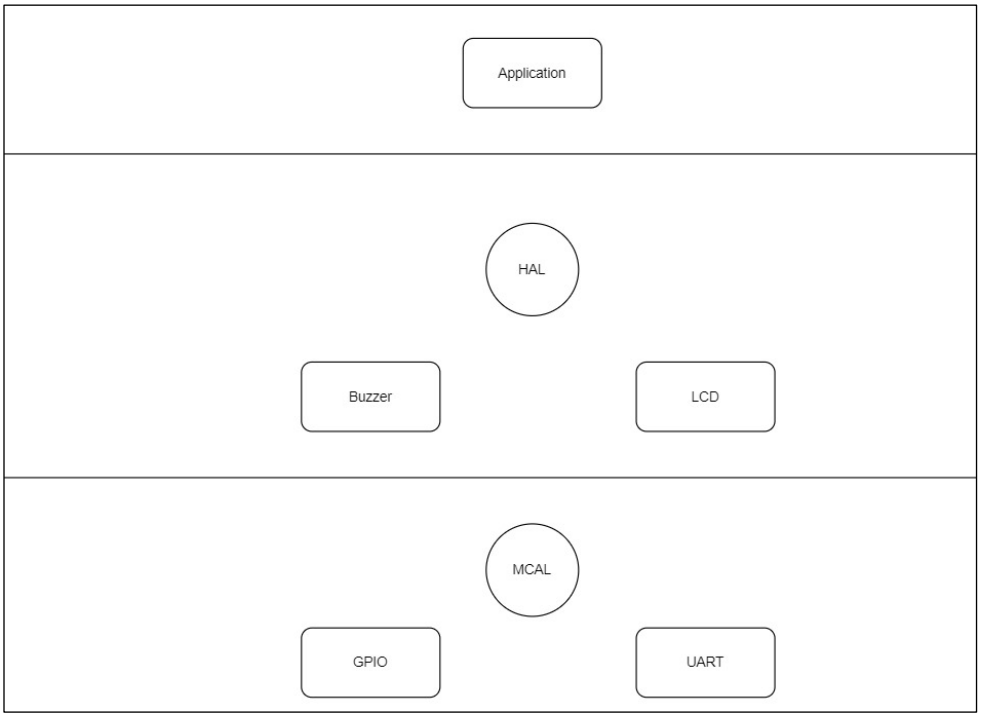


Figure 4HMI Microcontroller (ATmega32)

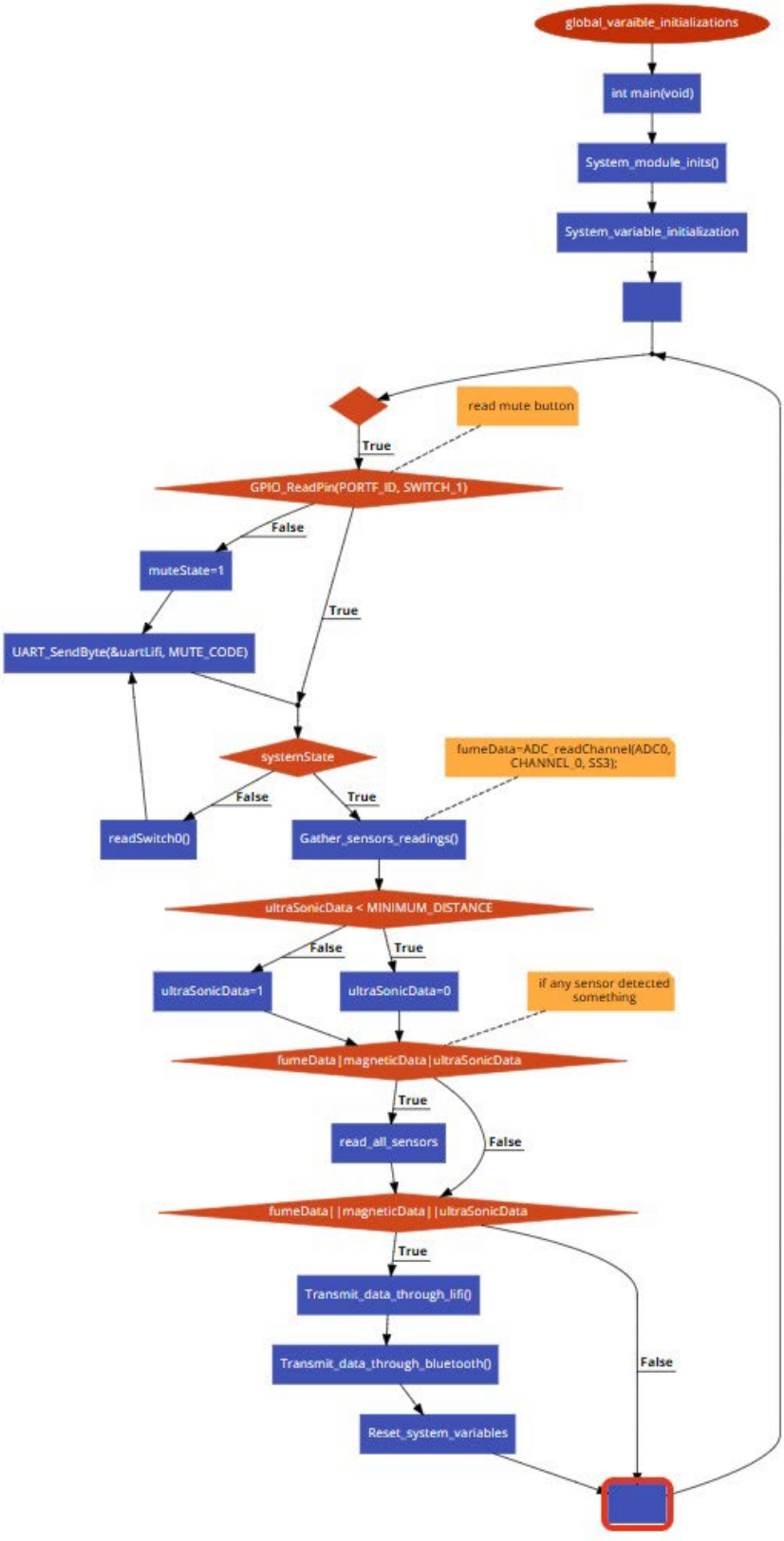


Figure 5System Overflow

List of Components

Transmitter (Control)

This is the list of components connected to the Tiva C Launchpad board to configure sensors and send data through LIFI.

	Ultrasonic Sensor (HC-SR04)	detecting intruders by measuring how far are they
	Fume Sensor (MQ2)	Detect fire from the smoke.
	Hall effect sensor (Magnetic Sensor)	Detect door opened/closed with the change of magnetic field
	LED Diode (Light source)	send data by light to the receiver
	HC-05 (Bluetooth Module)	send data to the mobile application by Bluetooth

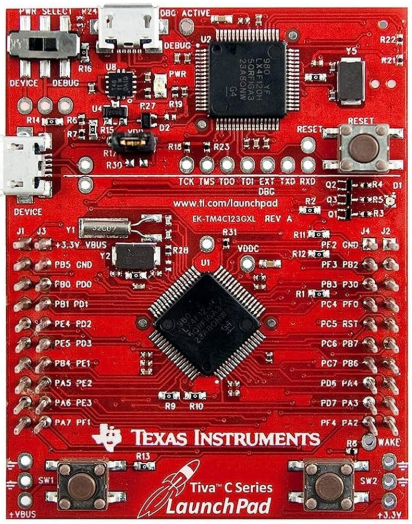
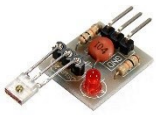


Figure 6TM4C123GH6PM (Sender)

Receiver (HMI)

This is the list of components connected to the ATmega32 Microcontroller to receive the data transmitted through LI-FI

	Receive data sent by light
	Display the readings of the sensors

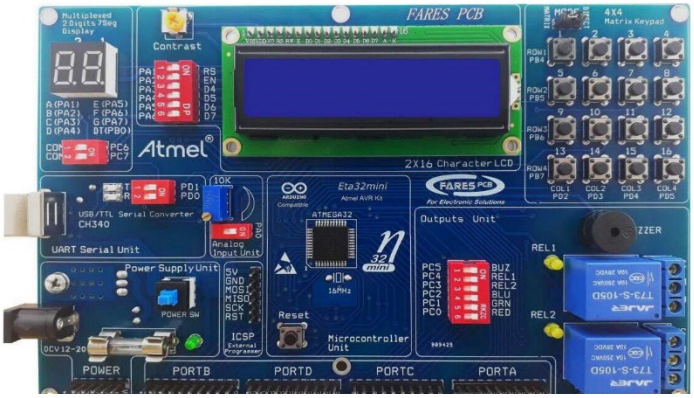


Figure 7ATmega32 (Receiver)

Circuit wiring

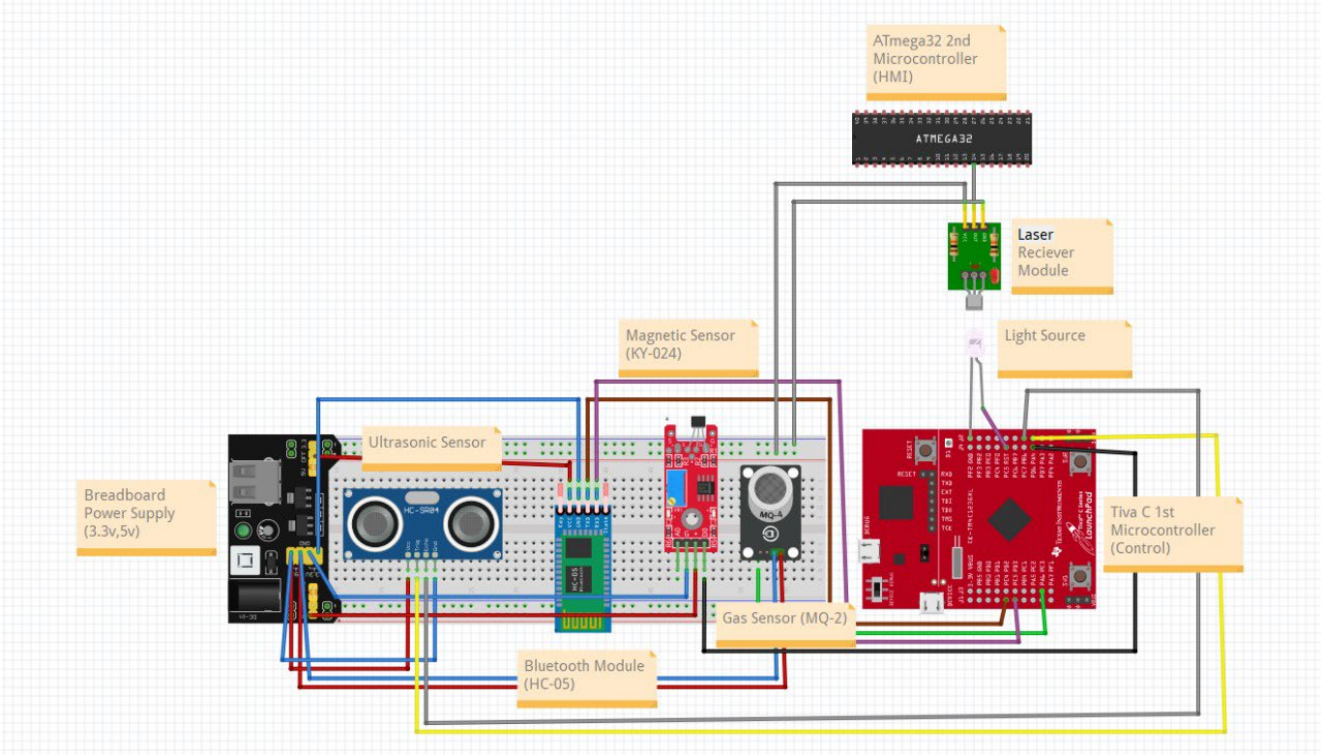
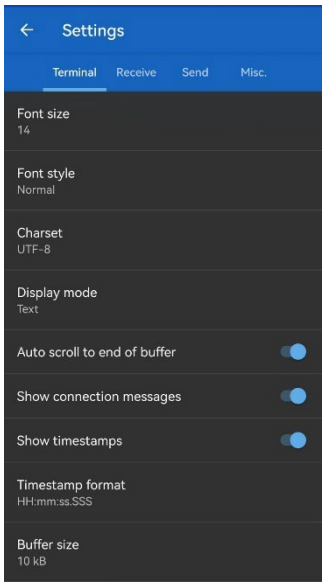
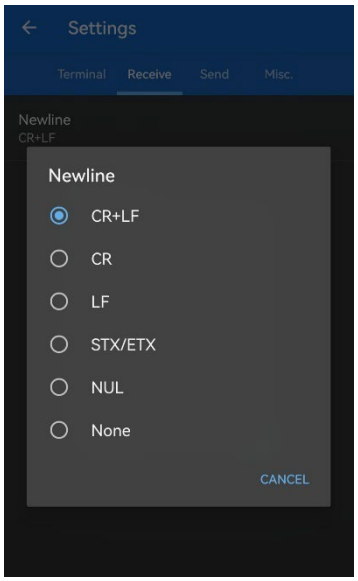


Figure 8Circuit Wiring of the whole system

Mobile App:





Here's a breakdown of the essential features and functions typically found within Serial Bluetooth Terminal applications, which serve as versatile tools for wireless communication with electronic devices.

Establishing Connections:

- Device Discovery: Like a skilled scout, the app effortlessly locates and presents a list of nearby Bluetooth devices ready for interaction.
- Secure Pairing: A secure handshake is initiated, ensuring a trusted bond between your device and the chosen target device.

Device Configuration:

- Baud Rate Adjustment: Acting as a language interpreter, the app allows you to precisely match the baud rate to the specific needs of the target device, ensuring smooth communication.
- Data Format Fine-Tuning: Data bits, stop bits, and parity settings can be customized to align perfectly with the requirements of the connected device, fostering a seamless dialogue.

Interactive Terminal Interface:

- Streamlined Conversation: Dedicated input and output panes provide a clear and intuitive space for sending commands and receiving real-time feedback, fostering a dynamic exchange of information.
- Dual Language Support: The app flexibly supports both human-readable ASCII and code-focused hexadecimal modes, catering to diverse data representation needs.

Enhanced Control:

- Customizable Buttons: Programmable buttons empower you to trigger specific actions on the connected device with a single tap, streamlining workflows and simplifying device control.
- Personalized Command Creation: Craft and send custom commands tailored to your unique needs, unlocking a deeper level of device interaction and customization.

Communication History:

- Detailed Data Logging: The app diligently records communication logs, creating a valuable archive for later analysis, debugging, or revisiting past interactions.
- Knowledge Sharing: Export and import logs seamlessly, enabling knowledge transfer, collaboration, and troubleshooting among teams.

Connection Management:

- Connection Control: Easily initiate or terminate Bluetooth connections as needed, maintaining full control over the communication channel.
- Convenient Auto-Reconnect: Enjoy the convenience of automatic reconnection to frequently used devices, saving time and effort.

User-Friendly Customization:

- Personalized Settings: Adjust font sizes, color schemes, and other preferences to create a comfortable and visually appealing workspace that matches your individual style.

Cross-Platform Availability:

- Broad Accessibility: Ideally, the application extends its reach across major mobile platforms (iOS and Android), and potentially desktop environments, ensuring accessibility for a wide range of users and devices.

Secure Communication:

- Data Guardian: The app prioritizes data privacy by implementing robust security measures, safeguarding sensitive information during all communication exchanges.

Obstacles

Implementing a Li-Fi project, especially one involving the integration of various sensors and microcontrollers, can encounter several challenges:

1. **Interference and Environmental Factors:** Light, the backbone of Li-Fi, can be susceptible to interference from ambient light sources. Natural light variations, artificial lighting, and even obstructions can disrupt the communication channel, leading to data loss or corruption.

2. **Alignment and Line of Sight:** The effectiveness of Li-Fi heavily depends on maintaining a clear line of sight between the LED transmitter and the receiver. Any misalignment or obstruction between the two can result in signal loss, limiting the range and reliability of communication.

3. **Data Rate and Stability:** While Li-Fi promises high-speed data transfer, achieving consistent high data rates over extended distances can be challenging. Factors like the quality of components, signal degradation, and the complexity of the transmitted data might affect the stability and speed of communication.

4. **Security and Privacy Concerns:** Despite the advantage of light not penetrating walls, interception of the light signals outside the intended area of communication remains a potential security risk. Ensuring robust encryption and authentication mechanisms is crucial to prevent unauthorized access to sensitive data.

5. **Power Consumption:** LED transmitters and receiver modules require power, and optimizing their energy efficiency without compromising on performance becomes critical, especially for devices intended for continuous operation or in battery-powered setups.

6. **Compatibility and Standardization:** Ensuring compatibility and standardization across different devices and manufacturers might pose a challenge. Aligning protocols, standards, and hardware components to facilitate seamless communication between different Li-Fi-enabled devices could be a hurdle.

7. **Integration Complexity:** Integrating multiple sensors, microcontrollers, and communication protocols can be complex. Ensuring smooth interoperability between these components and mitigating potential conflicts or inconsistencies in the system's operation requires careful planning and testing.

Addressing these challenges through rigorous testing, fine-tuning hardware and software components, and continuously refining the system design can help overcome obstacles in a Li-Fi project implementation.