Senior Design Project:

Cognitive Assistance with LiDAR Localization (C-ALL)

User Manual

by

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This document serves as the User Manual for the Cognitive Assistance with LiDAR Localization (C-ALL) System, an assistive navigation device designed for visually impaired individuals. It provides a comprehensive guide on the setup, operation, maintenance, and troubleshooting of the system, ensuring users can effectively utilize its features. The manual includes step-by-step instructions for assembling the hardware, using the mobile application, and updating the software, along with best practices for safe and optimal use. The following table (Table 1) should be updated by authors whenever major changes are made. Updates are added to the top of the table. Most recent changes to the document are seen first and the oldest last.

Table 1: Document Update History

Date	**Updates**
03/08/2025	Added New Chapters: • Added Introduction (Chapter 1) (NM) • Added System Overview (Chapter 2) (NM) • Added Hardware Components (Chapter 3) (NM) • Added Setup Instructions (Chapter 4) (NM) • Added Operating Instructions (Chapter 5) (NM) • Added Maintenance and Troubleshooting (Chapter 6) (NM) • Added Safety and Best Practices (Chapter 7) (NM) • Added Contact Information (Chapter 8) (NM)
03/06/2025	User Manual Created and Shared: • User Manual document is created and shared among group members (NM)

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Chapter 1

Introduction

– Neeti Mistry

C-ALL System User Manual
Version 1.0
March 2025

The C-ALL System is a wearable assistive device designed to help visually impaired individuals navigate their environment safely and independently. It utilizes LiDAR technology, haptic feedback, and a mobile application to provide real-time obstacle detection and route guidance.

This user manual serves as a step-by-step guide to help users set up, operate, and troubleshoot this device effectively. By following this guide, users can maximize the benefits of C-ALL and ensure smooth functionality.

Chapter 2

System Overview

– Neeti Mistry

The C-ALL System consists of three primary components:

1. Mobile Application
    - Provides real-time navigation assistance
    - Allows users to calibrate and update software
    - Displays alerts for obstacle detection and route changes
2. Wearable Haptic Feedback Device (Glove)
    - Delivers directional cues via servo motor-based pointer movements
    - Worn on the wrist and attached to a glove
    - Provides vibrational alerts for hazards
3. LiDAR Sensor and Processing Unit (iPhone - not provided)
    - Detects obstacles in real time
    - Calculates the safest navigation path
    - Communicates with the wearable device via Bluetooth

Chapter 3

Hardware Components

– Neeti Mistry

3.1 Main Components

- iPhone 12 Pro (for testing) – Runs the C-ALL mobile application
- Raspberry Pi – Processes LiDAR data and controls the servo motor
- Servo Motor – Moves the directional pointer inside the device casing
- Triple Axis Compass Magnetometer Sensor – Helps determine directional positioning
- Limit Switches – Used for calibration and safety stops
- 3D Printed Enclosure (designed on Solidworks) – Houses internal hardware securely
- Wearable Glove – Holds the hardware securely for comfortable use

3.2 Accessories and Wiring

- Battery Pack – Powers the hardware components
- Wires – Used for electrical connections

Chapter 4

Setup Instructions

– Neeti Mistry

4.1 Hardware Assembly

The C-ALL wearable device comes pre-assembled and securely mounted on the glove, ensuring ease of use right out of the box. Before first-time use, follow these steps:

1. Inspect the Device – Check that all components, including the LiDAR sensor, Raspberry Pi, Servo Motor, and Compass Sensor, are securely attached to the glove.
2. Charge the Battery Pack Fully – Ensure the device has sufficient power for optimal performance.
3. Power On the Device – Press the power button and confirm that the device is functioning properly.
4. Proceed to Software Setup – Follow the next section to install and pair the mobile application.

Note: If any components appear loose or disconnected, refer to the Troubleshooting section or contact support.

4.2 Software Installation

1. Download the C-ALL Mobile App from the App Store.
2. Ensure Bluetooth is enabled on your device.
3. Follow the on-screen instructions on the C-ALL app to complete the initial setup.
4. Pair the app with the Raspberry Pi hardware using Bluetooth.

4.3 Calibration Process

1. Place the device on a flat surface.
2. Open the C-ALL Mobile App and select Calibrate Device.
3. Adjust the servo motor's pointer to its default position.
4. Test the haptic feedback mechanism by selecting a sample direction.

Disclaimer: **Due to the technical nature of the setup process, visually impaired users may require assistance during the initial installation and calibration of the C-ALL system. It is recommended to have a sighted assistant help with assembling the hardware, pairing the device, and performing the first-time calibration.**

Chapter 5

Operating Instructions

– Neeti Mistry

5.1 Using the Device for Navigation

1. Wear the glove.
2. Launch the C-ALL Mobile App.
3. Enter your destination and initiate navigation.
4. The system will process the route and send directional instructions to the wearable device.
5. The servo motor's pointer will rotate to indicate the correct path.
6. If an obstacle is detected, you will receive a vibration alert.
7. Follow the pointer movements and haptic cues to navigate safely.

5.2 Updating the Software

1. Open the C-ALL Mobile App.
2. Navigate to Settings → Software Updates.
3. If an update is available, follow the on-screen prompts to install it.
4. Restart the hardware device for the update to take effect.

Chapter 6

Maintenance and Troubleshooting

– Neeti Mistry

6.1 General Maintenance

- Clean the device casing regularly to prevent dust buildup
- Ensure the battery is fully charged before each use
- Inspect the wiring connections for any loose or damaged components

6.2 Troubleshooting Common Issues

Issue	**Possible Cause**	**Solution**
The device does not turn on	Low battery	Charge or replace the battery
No haptic feedback	Loose wiring or disconnected servo motor	Check wiring connections and restart
The app does not detect the device	Bluetooth is off or not paired	Enable Bluetooth and reconnect via settings
Inaccurate pointer movements	Misalignment during calibration	Recalibrate using the app

Table 6.1: Common Issues and Solutions for the C-ALL Device

Chapter 7

Safety and Best Practices

– Neeti Mistry

- Do not expose the device to extreme heat or moisture
- Ensure secure placement of the device on the wrist to prevent accidental drops
- Follow pedestrian safety guidelines while using the system outdoors
- Regularly update the software for improved performance and bug fixes

Chapter 8

Contact Information

– Neeti Mistry

For further assistance, please contact:

C-ALL Support Team
Email: support@callnavigation.com
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Bibliography

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