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Observations and Proposal

Observations

The primary activity examined in this project is **navigation during urban mobility**, particularly cycling, running, and walking. The most frequently observed groups were commuting cyclists, pedestrians, and recreational runners, with additional cases including delivery cyclists.

Our observations revealed that **digital maps on smartphones** were by far the most common navigation tool, often the only method employed. Users repeatedly checked their phones, sometimes only seconds apart, not exclusively when approaching intersections. This suggests an element of **dependency or anxiety** rather than functional necessity

Problem

However, **road environments are inherently unsafe**, involving multiple agents such as pedestrians, runners, and vehicles. For both cyclists and pedestrians, maintaining continuous attention is essential to avoid incidents ranging from minor collisions to serious accidents. The observed navigation practice distracts users, reducing situational awareness and thereby heightening accident risk. Moreover, the ready accessibility of smartphones encourages habitual checking, reinforcing the anxiety-like behaviors noted.

The following two pictures generated by Google Gemini2.5 Pro can well demonstrate the problem.

Proposal: Glove Guide

In response to these issues, we propose **Glove Guide**, a system using haptic notifications to signal left and right turns. This approach allows users to navigate without consulting a phone, thereby enabling them to maintain attention on the road.

Personas

We identified five categories of users who could benefit from this system:

1. **High-Frequency Users** – Individuals who cycle regularly, whether for commuting or leisure.

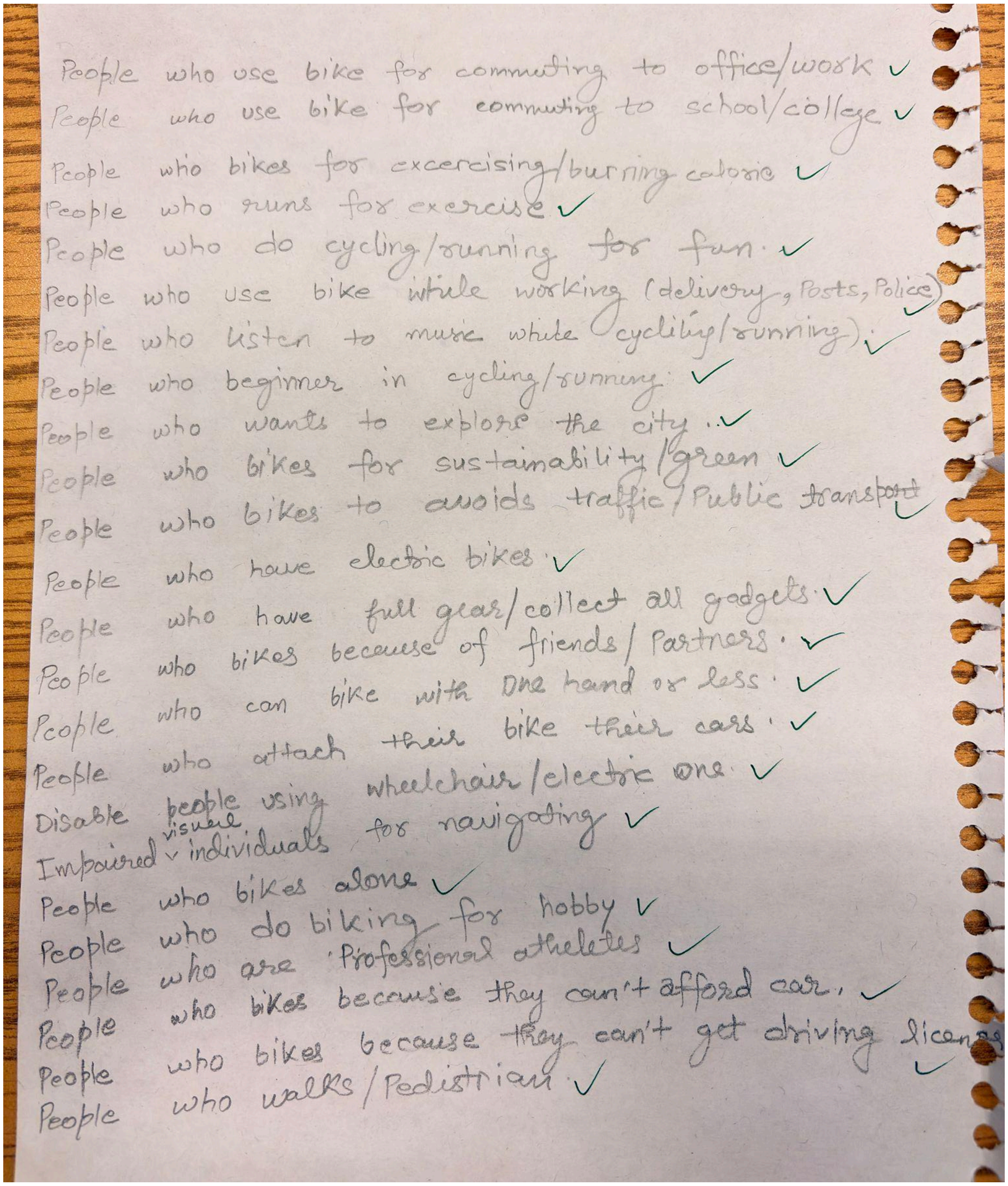
2. **Special Care Users** – Individuals requiring additional navigational support, such as older adults or those with visual impairments.

3. **Economical Users** – Individuals who avoid alternative transportation due to cost, sustainability concerns, or traffic avoidance.

4. **High-Skilled Users** – Experienced cyclists seeking efficient and safe navigation.

5. **Non-Cyclists** – Pedestrians and runners, whose lower travel speeds do not eliminate the risk of distraction.

The following photos show our work process and intermediate results.



People who use bike for commuting to office/work
People who use bike for commuting to school/college
People who bikes for excercising/burning calorie
People who runs for exercise
People who do cycling/running for fun.
People who use bike while working (delivery, Posts, Police)
People who listen to music while cycling/running).
People who beginner in cycling/running
People who wants to explore the city ..
People who bikes for sustainability/green
People who bikes to avoids traffic/Public transport
People who have electric bikes.
People who have full gear/collect all gadgets.
People who bikes because of friends/Partners.
People who can bike with one hand or less.
People who attach their bike their cars.
People who wheelchair/electric one.
Disable people using for navigating
Impaired visual individuals
People who bikes alone
People who do biking for hobby
People who are Professional atheletes
People who bikes because they can't afford car,
People who bikes because they can't get driving license
People who walks/Pedistrian
People

This photo shows the list of different behaviors related to our activity of interest during our brainstorming.

People who bikes for commuting
office
work
school / college

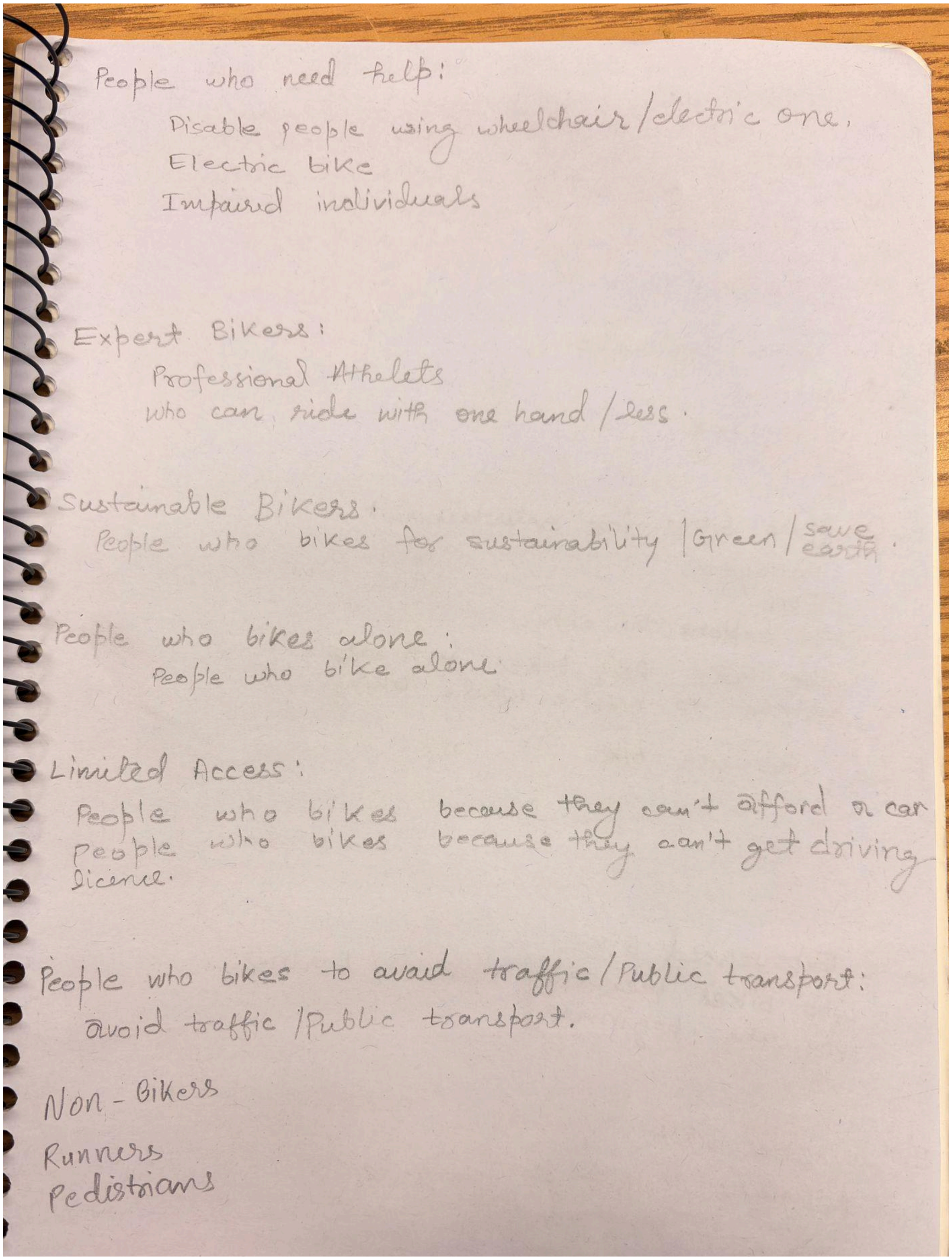
People who excercise
Biking
Running

People who bikes for entertainment
Hobbyist
Fun
to explore the city
who take their bikes with cars
Listnen to music while biking

People who use bike for work:

Less Experienced Biker:
who bikes because of friends/ partner.
who are beginners.

Enthusiastic Biker:
full gears / collect all gadgets



People who need help:

Disable people using wheelchair/electric one.
Electric bike
Impaired individuals

Expert Bikers:

Professional Athelets
who can ride with one hand/less.

Sustainable Bikers.

People who bikes for sustainability |Green/save earth.

People who bikes alone:

People who bike alone

Limited Access:

People who bikes because they can't afford a car
people who bikes because they can't get driving licence.

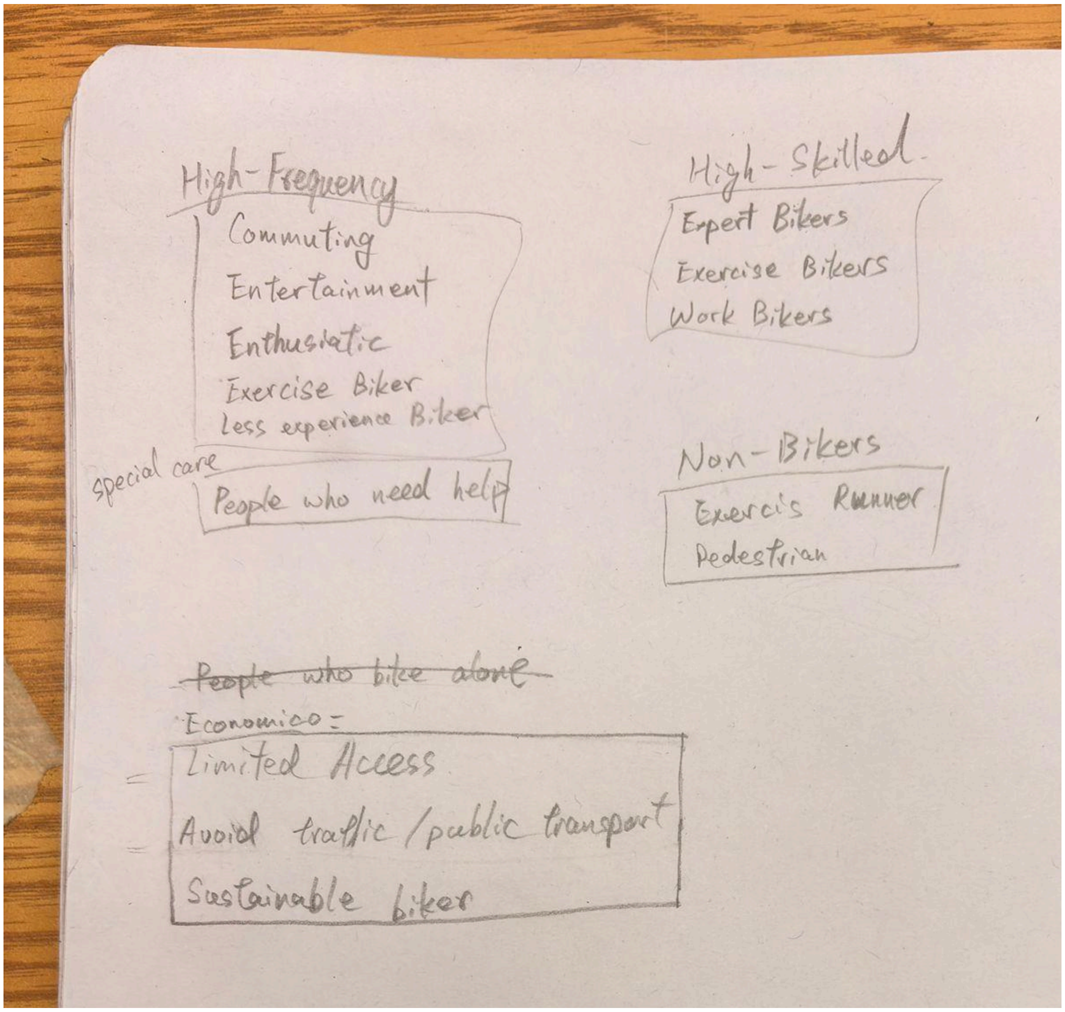
People who bikes to avaid traffic/Public transport:

avoid traffic/Public transport.

Non-Bikers

Runners
Pedistrians

These two photos above demonstrate how we group the behavior that are more likely to belong to one type of user.



This above figure demonstrates how we further grouped and named each Persona.

Use-Case Scenario

To illustrate functionality, consider the following example:

- **Alice**, a newcomer to the city, plans to visit multiple destinations by bicycle.
- Before departing, she selects her first destination on her smartphone, then stores the device securely in her pocket.
- Equipped with a helmet and Glove Guide, she begins her ride.
- Upon approaching an intersection, Alice maintains her standard safety routine—checking for vehicles and pedestrians—while receiving **haptic feedback from**

her gloves.

    - A vibration on the left glove indicates a left turn, which she executes after ensuring the road is clear.
    - The vibration ceases once the turn is complete.

- Throughout her trip, Alice receives turn-by-turn haptic cues without needing to consult her phone, allowing her to remain attentive to her surroundings while navigating efficiently.

Comparison with Related Products

- **Google Maps**: Requires frequent visual attention, distracting users from their environment.
- **Audio Guidance**: Instructions are often obscured by environmental noise.
- **Earphones**: Improve audibility but block external sounds such as horns, while also being prohibited for cyclists in some jurisdictions.
- **Handlebar-Mounted Smartphone Holders**: Reduce the difficulty of accessing phones but still require visual attention, perpetuating distraction risks.

In contrast, **Glove Guide** provides a discreet and intuitive haptic navigation system that minimizes distraction, preserves environmental awareness, and enhances safety for a wide range of urban road users.

High Level Design

The Glove Guide system integrates hardware and software components into a wearable navigation aid. Its high-level architecture is summarized below:

Hardware Components

- **Gloves** – Base wearable platform; optionally waterproof/insulated.
- **Vibration Actuators** – Provide left/right haptic feedback cues.

- **ESP32 Microcontroller** – Central processing unit; handles Bluetooth communication and actuator control.
- **Battery + Connector** – Portable power supply for ESP32 and actuators.
- **Driver Circuit** – Converts microcontroller signals to drive actuators effectively.

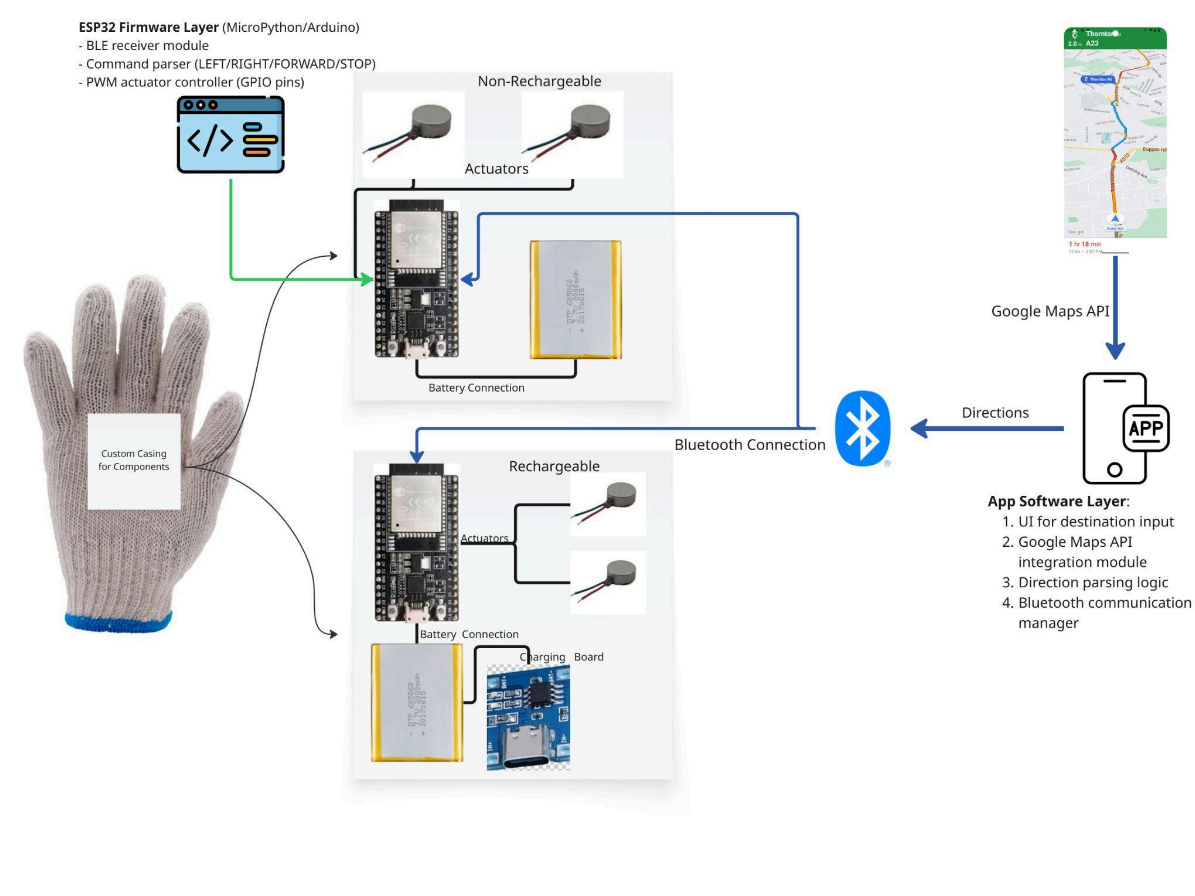
Software Components

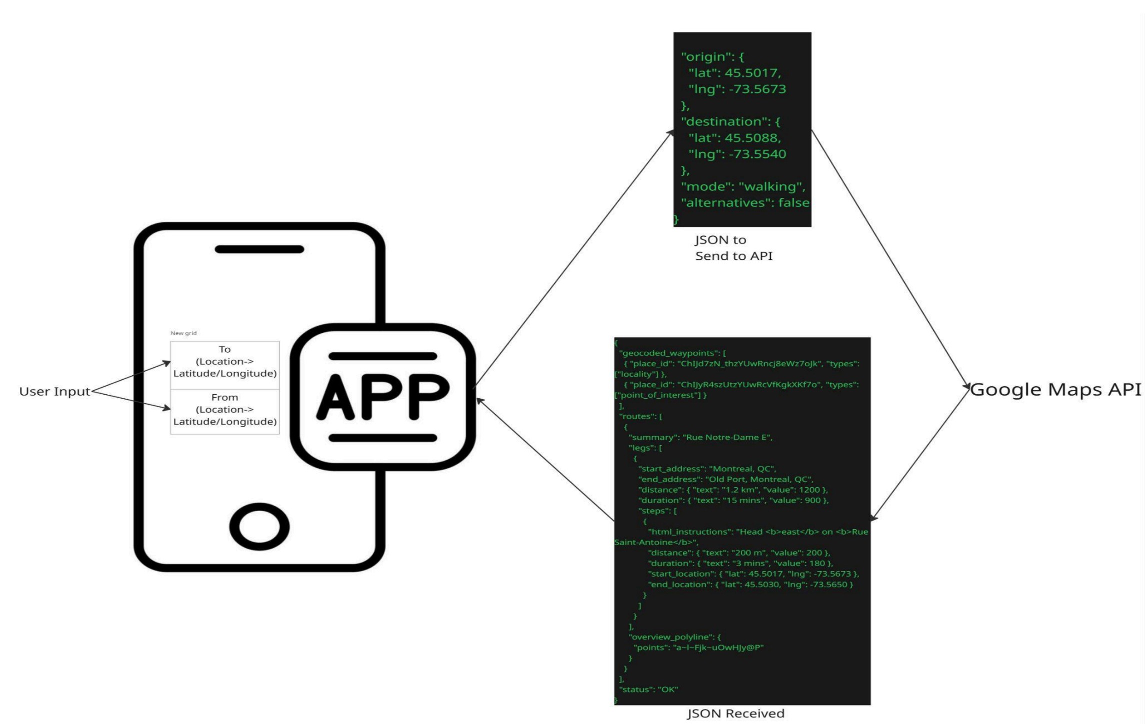
- **Google Maps API** – Supplies real-time navigation and turn-by-turn directions.
- **Custom Mobile Application** – Interfaces with Google Maps, extracts navigation instructions, and transmits them via Bluetooth.
- **Bluetooth Communication Protocol** – Ensures reliable data transfer between smartphone and ESP32.
- **ESP32 Firmware** – Decodes Bluetooth signals and activates the appropriate glove actuator to deliver haptic feedback.

Integration Flow

1. The user sets a route in the smartphone app.
2. App retrieves directions from Google Maps API.
3. Instructions (e.g., “turn left”) are encoded and sent over Bluetooth.
4. ESP32 receives and decodes signals.
5. Corresponding glove actuator vibrates, guiding the user safely without visual distraction.

The following two diagrams further visualize the system architecture.


ESP32 Firmware Layer (MicroPython/Arduino)
- BLE receiver module
- Command parser (LEFT/RIGHT/FORWARD/STOP)
- PWM actuator controller (GPIO pins)
Non-Rechargeable
Actuators
Battery Connection
Custom Casing for Components
Rechargeable
Actuators
Battery Connection
Charging Board
Bluetooth Connection
Directions
Google Maps API
App Software Layer:
1. UI for destination input
2. Google Maps API integration module
3. Direction parsing logic
4. Bluetooth communication manager


User Input
To (Location-> Latitude/Longitude)
From (Location-> Latitude/Longitude)
APP
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"alternatives": false
}
JSON to Send to API
Google Maps API
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}
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"points": "a~l~Fjk~uOwHJy@P"
}
}
],
"status": "OK"
}
JSON Received

Justifying Feasibility

We believe the proposed **Glove Guide** system is feasible to implement within the scope of the semester project. The required functionality can be achieved by combining accessible hardware components with well-documented software platforms, making the system both practical and achievable within the given timeframe.

System Components and Development Effort

The system relies on low-cost, readily available building blocks:

- **Hardware**: Gloves, ESP32 microcontroller, vibration actuators, portable battery, and a simple driver circuit. These are widely available and compatible with common development tools.

- **Software**:

    1. A **mobile application** to interface with the Google Maps API and extract turn-by-turn navigation instructions.

    2. A **Bluetooth communication protocol** to transmit instructions from the smartphone to the ESP32.

    3. **Firmware** on the ESP32 to interpret incoming Bluetooth signals and control the glove actuators.

None of these components require custom hardware manufacturing or complex low-level development, which keeps the overall effort manageable.

Team Skills and Alignment

Our team of three members has a strong foundation in **software development**, with proficiency in Python and Java. These skills align directly with the project's software demands:

- **Mobile application development** (leveraging Android Studio/React Native and APIs).

- **Bluetooth protocol implementation** for communication between smartphone and ESP32.

- **Firmware development** for ESP32 in C++/Arduino IDE.

Although our background is primarily software-oriented, the hardware integration tasks (e.g., wiring actuators, configuring power supply, and connecting the ESP32) are straightforward and well-supported by tutorials, reference projects, and ESP32 documentation. This makes the hardware side accessible even with modest prior experience.

Time Effort and Work Distribution

The estimated workload is consistent with the course guideline of **20–30 hours per group member**, distributed as follows:

- **Mobile Application Development (≈25 hours)**
  One member builds the Android app to query Google Maps API, parse directions, and transmit signals via Bluetooth.

- **Bluetooth Protocol and Firmware (≈20 hours)**
  A second member develops ESP32 firmware to decode Bluetooth signals and control actuators.

- **Hardware Integration and Testing (≈20 hours)**
  A third member assembles the hardware (gloves, ESP32, actuators, battery, driver circuit) and conducts functional tests.

- **System Integration and Group Testing (≈10 hours per member)**
  Joint sessions ensure smooth interoperability between hardware and software, refine usability, and validate the final prototype.

Conclusion

Given our team's strong software expertise, the accessibility of required hardware, and the modest scope of integration tasks, we are confident that a **functional Glove Guide prototype** can be built and demonstrated successfully by the end of the semester. The estimated implementation effort, at approximately **25–30 hours per member**, is well within the feasible range.

REB Ethics Information

Group G : Kevin Wu, Mohammad Adnaan, William Goyens

Title of Project Glove Guide

Project/Study Description (2-3 sentences)
This project proposes the design of navigation gloves for cyclists and motorcyclists that use vibration feedback to deliver turn-by-turn directions without relying on visual or auditory cues. By embedding small vibration motors into biking gloves and connecting them with a map application, cyclists can receive intuitive left or right turn signals while keeping their focus on the road. This approach reduces distraction, improves safety, and leverages equipment cyclists are already likely to use.

Number and type of participants (gender, age range, other particulars such as athletes, farmers, musicians, etc.)
5–10 participants, gender neutral, ages 17–70, anyone capable of cycling.

How and from where are they recruited
Campus students, friends, and family

What risk could this study entail for participants?
The risks are the same as those typically associated with biking. **Potential Risk:** Participants could fall off their bike or encounter other biking-related hazards.

How can these risks be mitigated?
Recruit only experienced cyclists as test participants.