Project Proposal

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This project focuses on developing a small, wirelessly controlled vehicle operated through a motion-sensitive glove. The vehicle will be constructed using either a 3D printer or manually assembled from wooden components, ensuring flexibility in the manufacturing process. At its core, an ESP32 microcontroller will serve as the primary control unit, managing communication and motor control. The vehicle will be equipped with four drive motors, allowing smooth and precise movement in response to user commands.

On the user side, a smart glove will feature an MPU6050 motion sensor to detect hand gestures. The glove will process motion data and transmit corresponding control signals to the vehicle via Bluetooth, ensuring real-time and intuitive control. The ESP32 on the vehicle will interpret these signals and adjust the motor speed and direction accordingly.

Both the glove and the vehicle will be battery-powered, making the system fully wireless and portable. The microcontroller will be programmed to establish a seamless bidirectional communication link between the glove and the vehicle, enabling smooth, gesture-based navigation. This project demonstrates the integration of embedded systems, wireless communication, and motion sensing to create an interactive and user-friendly control mechanism.

It also presents an opportunity to expand our understanding beyond software by exploring how different embedded system components communicate and interact. By implementing a client-server architecture, we aim to gain practical experience in designing wireless control systems, which can later be applied to more complex technological solutions. Understanding the integration of hardware and software in an embedded system will provide valuable insight into real-world applications of IoT and automation.

Our initial idea was to develop a small drone controlled by a motion-sensitive glove and gradually enhance it with additional features such as a camera and autonomous flight capabilities. However, due to the complexity of designing a stable aerial system, we decided to focus on a ground-based vehicle. This decision allows us to optimize component selection while ensuring that the vehicle can move in multiple directions, making it more versatile for future improvements.

Development Approach

The project development follows a structured workflow:

1. **Conceptualization and Sketching:** Initial design of the vehicle and glove system.
2. **Component Selection and Procurement:** Choosing appropriate motors, motor drivers, and sensors for smooth operation.
3. **Chassis Fabrication:** Constructing the vehicle's body using a 3D printer or manually assembling it from wooden materials.
4. **Hardware and Software Integration:** Connecting the ESP32 microcontroller, sensors, and motor drivers to create a functional system.
5. **Power Management:** Implementing a battery-based power system for both the vehicle and glove.
6. **Glove Development:** Integrating ESP32 and the MPU6050 motion sensor for detecting hand movements.
7. **Communication Setup:** Establishing a Bluetooth Low Energy (BLE) link between the glove (Client) and the vehicle (Server).
8. **Testing and Refinement:** Ensuring smooth operation, responsiveness, and fine-tuning control mechanisms.

System Architecture

The DCP board serves as the central connection hub, enabling smooth integration of ESP32, motor drivers, and the motors. This board can be manually assembled on a perfboard, designed as a PCB, or produced using 3D printing to ensure an efficient layout.

On the user side, the smart glove features an ESP32 and an MPU6050 motion sensor, which includes:

- **An accelerometer** (measuring acceleration along three axes: X, Y, Z).
- **A gyroscope** (measuring angular velocity).

By combining data from both sensors, the glove detects movement and orientation, allowing intuitive control of the vehicle. The MPU6050 communicates with ESP32 via I2C, ensuring real-time motion tracking. The glove's components are mounted on a 3D-printed DCP board and powered by a battery pack, making it fully wireless.

Wireless Communication

ESP32 has built-in Wi-Fi and Bluetooth modules, making it ideal for our project. Since BLE (Bluetooth Low Energy) is the most efficient option for low-power wireless control, we use a Client-Server model:

- The vehicle’s ESP32 acts as a Server, broadcasting a BLE signal and waiting for commands.
- The glove’s ESP32 acts as a Client, scanning for the vehicle and transmitting movement data.

Upon powering both devices, they automatically recognize and connect, ensuring seamless interaction. This approach eliminates the need for additional Bluetooth modules and allows low-latency, real-time control.

Components for the Vehicle:

- **ESP32** – Main microcontroller for data processing and wireless communication
- **L298 Motor Driver (2x)** – Controls the vehicle's motors
- **4x BO Motors** – Provide movement for the vehicle
- **4x Wheels** – Allow movement
- **AMS1117 - 5V Voltage Regulator** – Stabilizes power supply
- **5x 2-pin Screw Terminals** – Connects electrical components
- **Header Pins** – For connecting ESP32 and sensors
- **On/Off Switch** – Manual power control
- **Capacitors (220µF, 100µF)** – Power stabilization
- **18650 Li-ion Batteries (2x)** – Power supply for the vehicle
- **2S 18650 Battery Holder** – Secure battery mounting
- **DCP Board** – Centralized connection of all electronic components

Components for the Glove:

- **ESP32** – Microcontroller for motion detection and command transmission
- **MPU6050** – Motion sensor (accelerometer and gyroscope)
- **Header Pins** – Connect the sensor to the ESP32
- **On/Off Switch** – Manual power control
- **18650 Li-ion Battery (1x)** – Power supply for the glove
- **1S 18650 Battery Holder** – Secure battery mounting
- **DCP Board** – Connects glove components