Project Proposal
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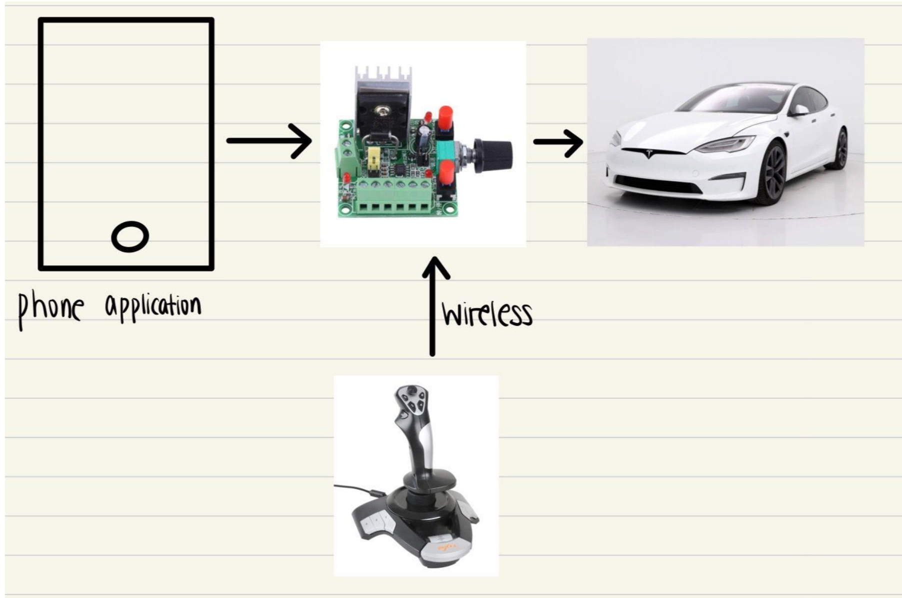
1. Introduction
    a. Problem
        i. The need for efficient and convenient motor control is prevalent in various applications, such as robotics, automation, and remote-controlled vehicles. Existing solutions often lack simplicity and ease of use, making them less accessible to a broader range of users. Therefore, there is a demand for a wireless remote motor controller that is simple, user-friendly, and suitable for a variety of applications, including robotics and small wireless carts.

    b. Solution
        i. Our project aims to develop a Wireless Remote Motor Controller that provides an adjustable speed range of 0 to 100%. This controller will be designed to work with a simple wireless remote control using either infrared (IR) or radio frequency (RF) technology. The key features of the controller will include functions like start, stop, accelerate, and decelerate, making it intuitive and easy to learn for users of all skill levels. Additionally, it will be designed to send a single signal that can be used in conjunction with the immediately preceding motor control project, facilitating compatibility with existing systems.

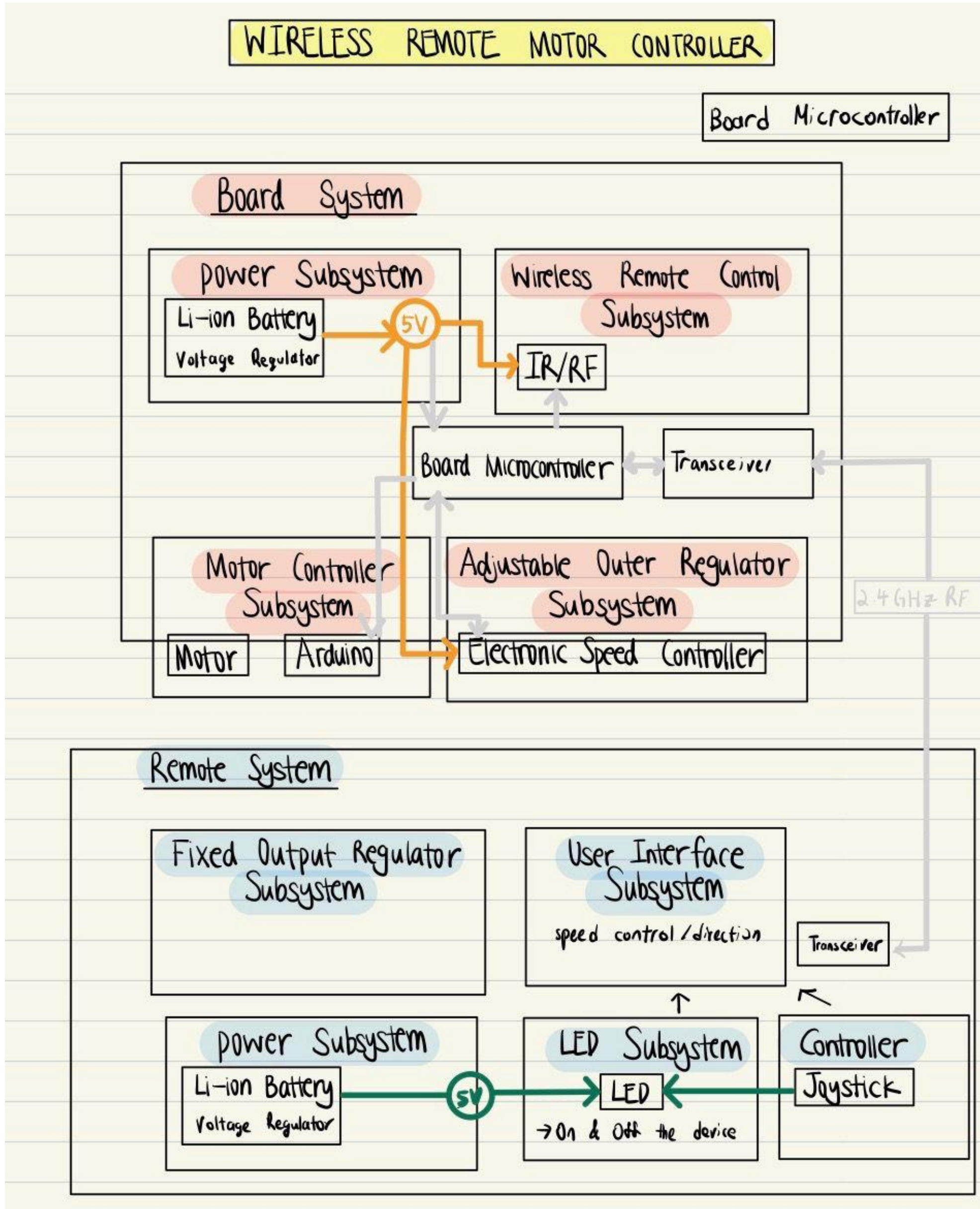
           Furthermore, as an alternative design, we will explore the possibility of controlling a pair of motors to support steering, opening up the potential for building highly efficient robotic platforms or small wireless carts. Besides, it should feature closed loop speed control, current limiting control and this machine will be operated under 24DC.

    c. Visual Aid

i. 

d. High-level requirements list
   i. Wireless Control
      1. The system must provide reliable wireless control of the motor, enabling users to operate it remotely from a distance, improving convenience and accessibility for various applications. This requirement ensures that the primary goal of wireless motor control is met, enhancing the versatility and practicality of the system.
   ii. Voltage Control
      1. The motor controller must support operation under a specified voltage range, preferably 24DC, to ensure compatibility with a wide range of motors and applications. This requirement guarantees that the controller can handle the required power supply, allowing it to work effectively with different motor types and configurations.
   iii. Speed Control
      1. The motor controller must offer precise and adjustable speed control ranging from 0 to 100%, allowing users to vary the motor's speed as needed for their specific application. This requirement ensures that the controller meets the essential functionality of providing fine-grained control over the motor's performance, making it suitable for a variety of tasks.

2. Design
   a. Block Diagram

i. 

b. Subsystem Overview

i. Board Subsystem:

1. The Power subsystem is responsible for managing the electrical power supply to the entire system. It connects with the other subsystems by providing the necessary voltage and current for their operation. Without a stable power supply, none of the other subsystems can function effectively.
2. The Wireless Remote Control Subsystem focuses on designing and developing the wireless remote control interface. We will use either infrared (IR) or radio frequency (RF) technology for communication. Component selection will include IR/RF transmitters, receivers, and microcontrollers for signal processing.

Specific part numbers will be determined during the component selection phase.

3. The motor controller subsystem will include the hardware and software necessary to control the motor's speed, direction, and braking. It will consist of microcontrollers, motor driver ICs, power electronics, and control algorithms.
4. The Adjustable Outer Regulator Subsystem is responsible for fine-tuning the motor's speed based on user input. It connects directly to the Motor Controller Subsystem and adjusts the motor's power output to achieve the desired speed. This subsystem ensures that the system can provide precise speed control, which is a high-level requirement for the project.

ii. Remote System Subsystem:

1. The Fixed Output Regulator Subsystem manages the power supply for the Remote System. It connects to the Power Subsystem of the Board Subsystem to receive the necessary voltage and current. This connection ensures that the Remote System receives a stable power supply for its operation.
2. The User Interface Subsystem is responsible for user interaction on the remote side. It connects with the Controller (Joystick) and communicates user commands to the Fixed Output Regulator Subsystem, which then relays these commands to the Board Subsystem. It may include an LCD screen, LED indicators, and user-friendly buttons for control. We will be developing a mobile phone app if we have extra time.
3. The Power Subsystem on the remote side is responsible for managing the power supply for the Remote System. It connects to the Fixed Output Regulator Subsystem, ensuring that the Remote System has the necessary electrical power to operate.
4. The LED Subsystem serves as a visual feedback mechanism for the user. It connects to the Controller (Joystick) and provides visual indicators based on the motor's status and user commands. This subsystem enhances the user experience by providing real-time feedback.
5. The Controller (Joystick) is the user's input device, connecting to the User Interface Subsystem. It allows users to send commands to control the motor's speed and direction. This subsystem is the primary means of user interaction with the system.

c. Subsystem Requirements
    i. Board Subsystem:
        1. Power Subsystem: We are supplying 48 V from the battery to the speed controller. However, we need to step down the voltage using linear voltage regulators to supply voltage to the microcontroller. This is because the ESP32 microcontroller will be operated at 3.3V.
        2. Motor Controller: The motor controller subsystem will include the hardware and software necessary to control the motor's speed, direction, and braking. It will consist of microcontrollers, motor driver ICs, power electronics, and control algorithms.
        3. The Wireless Remote Control Subsystem: After consulting with the head TAs, we will only be using the ESP32 microcontroller for wireless bluetooth connectivity. However the calculation for the airtime to transmit the data is too complicated. Single-board computers like Raspberry Pi should not be required for this project.
        4. The Motor: It should be able to have a voltage rating of 48V and in a relatively small size so it will be portable. The current rating for this motor should be 5A. This indicates the motor' power rating should be 48*5=240V. We have not decided on the rotational speed and torque of the motor.
    ii. Remote System Subsystem:
        1. Fixed Output Regulator Subsystem: It should receive the required voltage and current from the Board Subsystem's Power Subsystem to guarantee uninterrupted operation.
        2. User Interface Subsystem: It may include an LCD screen and LED indicators to provide real-time visual feedback to the user. The LCD screen should display essential information, while the LEDs should convey the motor's status and other relevant information.
        3. Power Subsystem: The Power Subsystem on the remote side is responsible for managing the power supply for the Remote System.
        4. LED Subsystem: It should display LED to provide visual indicators that reflect the user commands or any relevant information.
        5. Controller (Joystick): Controller would need a joystick to transmit to the fixed output regulator subsystem in the board subsystem.

d. Tolerance Analysis
    i. Maximum power a linear regulator can output before failing
        1. The motor will have a voltage rating of 48V, current rating at 5A, power rating at 240W. Therefore, the shunt resistance of the motor should be approximately 9.6 ohms. This will prevent

the motor from overheating and thus decreasing the efficiency of the motor. Besides, a linear voltage regulator will be sufficient instead of a switch voltage regulator. This is because the power dissipation, P=(48V-Vout)*5A. We should not need a heatsink. We would like to prevent a minimum voltage drop to ensure the linear regulators are efficient. Since our applications will be something like controlling toy car, the linear regulators should be sufficient to provide a steady output voltage but not precise and stable output voltage. https://www.ti.com/lit/an/slva118a/slva118a.pdf?ts=1675772650693&ref_url=https%253A%252F%252Fwww.google.com%252F

2. We have not been able to calculate the thermal resistance of the circuits because not all components have not been determined yet. 16.4 Thermal Resistance Circuits

ii. Fastest sample rate your microprocessor can handle (how many cycles will it take to process your data?)

1. Programming Manual for the ESP32 ESP32 Technical Reference Manual
2. The ESP32 microcontroller is a dual-core processor, Wi-Fi and Bluetooth connectivity, and a variety of I/O options. The ESP32 typically offers a maximum ADC (Analog-to-Digital Converter) sample rate of around 200 kHz to 400 kHz.

3. Ethics and Safety

a. In the development of the Wireless Remote Motor Controller project, we are committed to upholding the highest ethical and safety standards as outlined in the IEEE and ACM Code of Ethics. Specifically, we will prioritize safety, health, and the welfare of the public by ensuring the device complies with ethical design and sustainable development practices, protects user privacy, and promptly discloses any factors that might endanger the public or the environment. We will also strive to improve public understanding of the technology's capabilities and societal implications and avoid conflicts of interest while disclosing any existing conflicts. Additionally, we pledge to avoid unlawful conduct and bribery, seek and offer honest criticism, maintain technical competence, and treat all individuals fairly and respectfully, refraining from discrimination, harassment, or causing harm to others. I, Aaron Chen, Kyungha Kim, and Lee Boon Sheng Adhere to this.