Power and Sense Management for the Self-Driving Car

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# Introduction

We have taken extreme care to ensure that we efficiently manage power consumption while ensuring reliable sensor data collection for navigation and obstacle avoidance. The components that we used, like the Arduino Mega, Raspberry Pi with Camera V2, GY-271 (a magnetometer), HC-SR04 (ultrasonic sensor), L298N (motor driver), and a servo motor, require careful planning of power distribution and sensor data collection.

For the self-driving car, we used a rechargeable battery pack (11.1V lithium-polymer (LiPo) battery to provide a good balance between capacity, rechargeability, and voltage compatibility with the components. The Arduino Mega and Raspberry Pi are powered via voltage regulators that step down the 11.1V to the required 5V. The L298N motor driver can handle the 11.1 V directly for driving motors.

# Power Management

1. **Voltage Regulation**: We used voltage regulators to step down the 11.1V to 5V for the Raspberry Pi, Arduino Mega, and sensors that require 5V.
2. **Power Distribution**: We used a breadboard to manage connections between the battery, regulators, and components. This ensured a clean setup and reduced the risk of short circuits.
3. **Video Processing:** The Raspberry Pi Camera V2 is powered directly from the Raspberry Pi via the camera serial interface (CSI) connector, which does not significantly increase the overall power consumption of the system. However, the processing of video data is computationally intensive and will increase the power demand on the Raspberry Pi. To ensure that the power supply is capable of handling this additional load, we used a 11.1 V 2200mAH LiPO battery with a step-down converter to 5V.

# Sensor Management

The sensors were carefully selected to ensure the right balance of efficient data acquisition and stability. The following sensors were used for the development of the self-driving car.

1. **GY-271 (Magnetometer)**: Provides orientation relative to the Earth's magnetic field. Useful for navigation and heading correction. It's low power and communicates via I2C, which is supported by both Arduino and Raspberry Pi.
2. **HC-SR04 (Ultrasonic Sensor)**: Detects and avoids obstacles. It measures the distance by emitting ultrasonic waves and measuring the time it takes for the echo to return. Multiple sensors may be used around the vehicle for 360-degree coverage. They are inexpensive and have a low power draw.
3. **Servo Motor**: Controls steering. A servo motor is chosen for its ability to move to specific angles, essential for precise steering control. It's powered directly from the battery through the L298N, with signal control from the Arduino.
4. **L298N (Motor Driver)**: Drives the car's motors, receiving control signals from the Arduino. It can handle the high current required by the motors and allows for speed and direction control.

# Bill of Materials

The Bill of Materials would include:

* Raspberry Pi (1x)
* Raspberry Pi Camera V2 (1x)
* Arduino Mega (1x)
* GY-271 magnetometer (1x)
* HC-SR04 ultrasonic sensors (multiple, depending on coverage needs)
* L298N motor driver (1x)
* Servo motor (1x)
* 12V LiPo or Li-ion battery (1x)
* Voltage regulators (5V) (multiple, for each component requiring 5V)
* Power distribution board or breadboard (1x)
* Various cables and connectors for I2C, GPIO, and power connections
* Voltage and current sensor module for power monitoring (1x)