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ECE 5780
Embedded Systems Design
Mini-Project: Proposal
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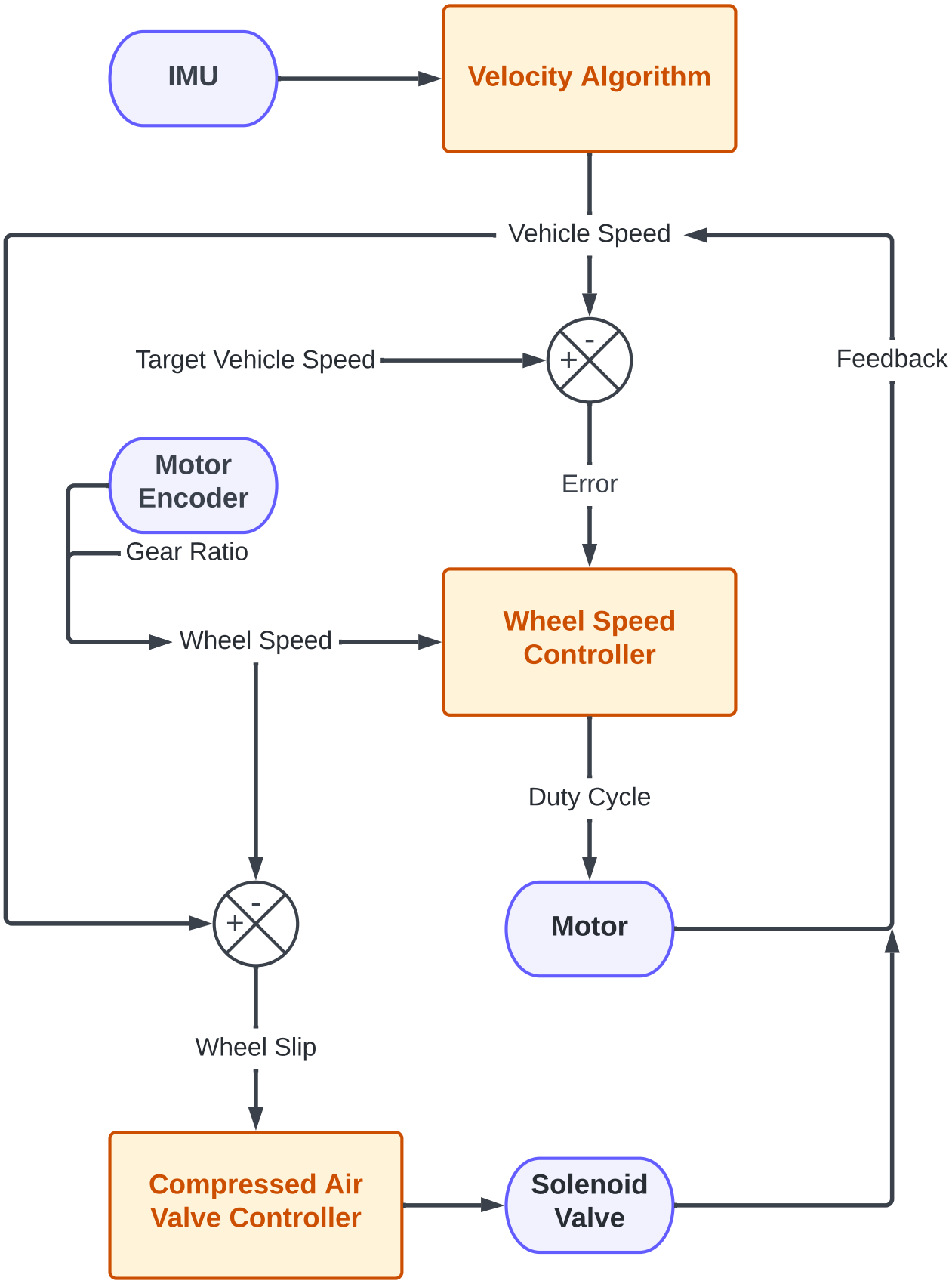
In 2018, Elon Musk announced that the next Tesla Roadster will have an option for a “SpaceX package” that will include a 10,000 PSI COPV and several cold gas thrusters arranged around the vehicle improving acceleration from an impressive 14 m/s^2 (1.4 G) to a staggering 24 m/s^2 (2.5 G). The use of rocket thrusters to improve automobile performance is clever, fascinating, and a bit insane. Most high-performance vehicles’ acceleration, breaking, and handling is limited by the friction between the tires and the track. It doesn’t matter how much power a vehicle has if the tires can’t transfer it to the ground. Rockets have no such limitation.

For my project I’m proposing a proof-of-concept vehicle that demonstrates, on a small scale, how cold gas thrusters can significantly improve vehicle performance. I will build a small car using electric motor(s) that can accelerate and decelerate along a straight path. In addition, it will house a tank with pressurized air to power some number of nozzles.

The control experiment will determine the minimum stopping distance the vehicle can achieve with motor breaking and tire friction alone. This will be compared against the hybrid system which will engage the compressed gas nozzles when wheel slip is detected. A stretch goal, time permitting, will be to improve vehicle acceleration as well.

MILESTONES:

1. Collect the necessary components and construct the vehicle.
2. Integrate the microcontroller with vehicle motor(s) and implement PID controller.
3. Use accelerometer(s) or IMU to detect when vehicle is slipping (i.e. vehicle speed is greater than wheel speed).
4. Integrate the microcontroller with pressure system valves and program it to power the nozzles when necessary.


IMU
Velocity Algorithm
Vehicle Speed
Target Vehicle Speed
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+
Feedback
Motor Encoder
Error
Gear Ratio
Wheel Speed
Wheel Speed Controller
Duty Cycle
-
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Motor
Wheel Slip
Compressed Air Valve Controller
Solenoid Valve