UNIVERSITY OF WATERLOO
FACULTY OF ENGINEERING
Department of Electrical and Computer Engineering

AutoGlide

Team 26

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Motivation

- Automatic suspension systems are either expensive or cannot be installed on any vehicle
- Car enthusiasts are always looking for new and innovative ways to improve their build and lap times

Project Objective

The aim of AutoGlide is to automate the adjustable dampening of traditional coilovers by:

- Controlling the dampening knob on the damper of a coilover using a series of stepper motors
- Communication to the coilover motors using a dash-mounted device that the driver can interact with while driving
- Provide automatic adjustments relative to the road conditions

Advantages of AutoGlide

- No need to manually adjust – speeds up tuning process
- Highly accurate & consistent stiffness
- Relatively inexpensive
- Easy to install
- Automatic adjustments (Customizable)

Hardware

Component	MPN
Microcontroller	R7FA4M1AB3CFM#AA0
Accelerometer	MPU-6050
Stepper Motor	Nema 17 42-34
GPS	NEO-6M
Display	ILI9488
CAN controller	MCP2515-xST
CAN transceiver	TJA1050
Motor driver	TMC2209-LA

Theory

- Schematic and layout design
- Power filtering and voltage regulation
- CAN, I^2C, SPI
- CAD design
- Statistical analysis

Principle of Operation

Central Hub

Purpose:
- Take user inputs and direct all motor assemblies accordingly
- Read sensors (accelerometer, GPS)
- Display/log data (display, serial)

Inputs:
- User input (rotary encoder)
- GPS
- Accelerometer

Outputs:
- CAN frames (to motors)
- Color Display

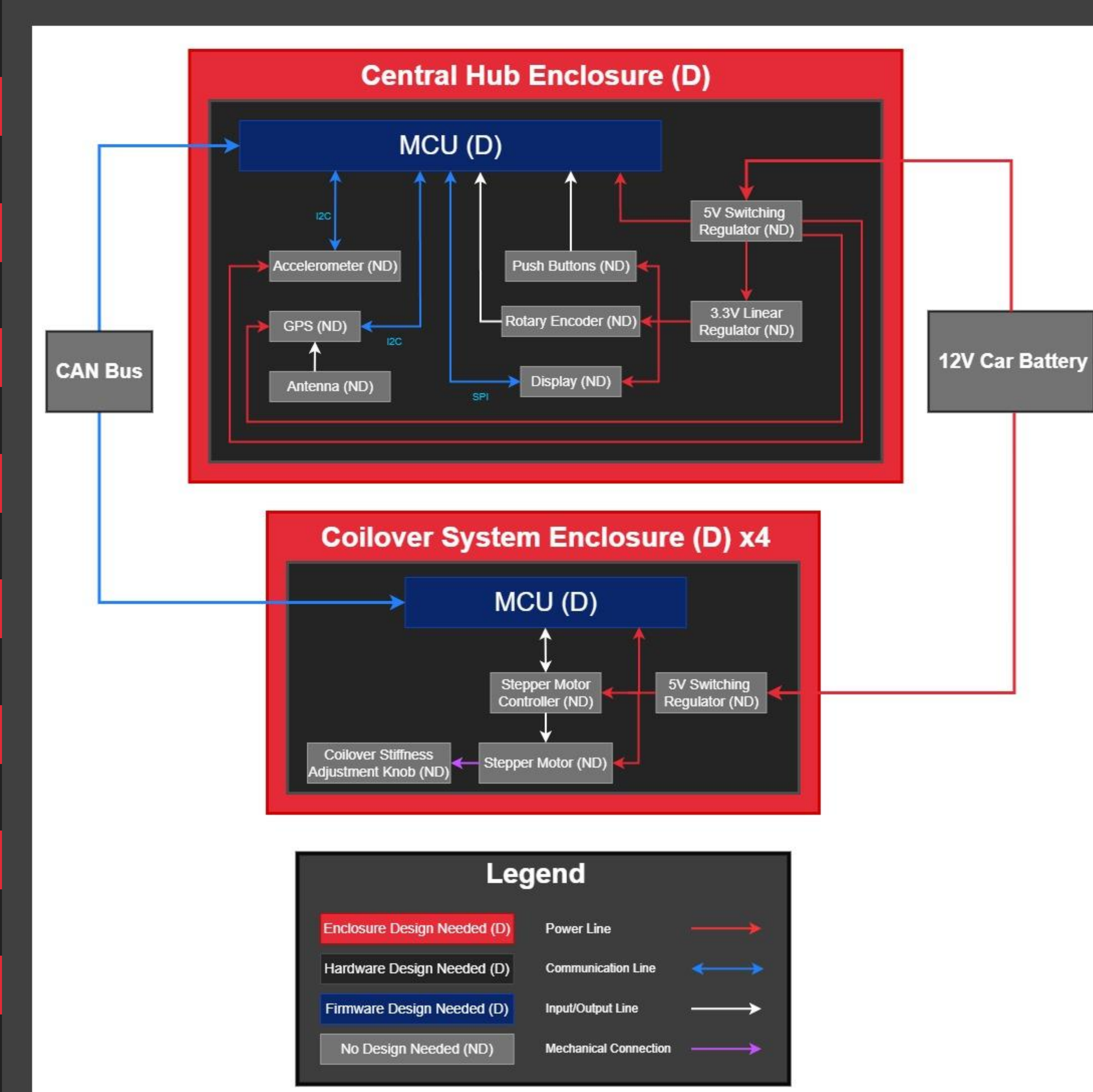
Motor Assembly

Purpose:
- Listen for directions from the central hub
- Adjust coilover dampening using stepper motor

Input:
- CAN frames (from central hub)

Output:
- Stepper motor

System Block Diagram



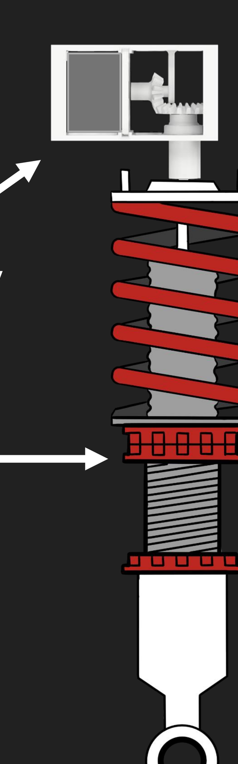
Design Iterations

Initial Prototype V.S. Final Design

Initial Prototype	Final Design
Breadboard Off the shelf breakout boards Prototype gearing system with LEGO	Custom PCBs Minimal off the shelf subsystems Custom made enclosures and mechanical systems

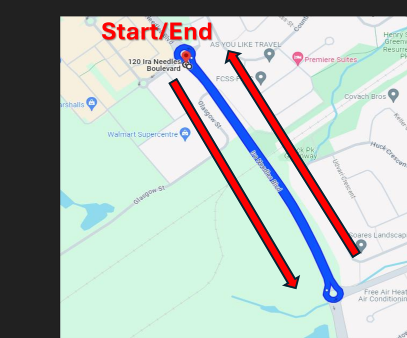
Considerations & Alternatives

- Arduino MCU V.S. Raspberry Pi
- Potentiometer V.S. EPROM for storing motor position

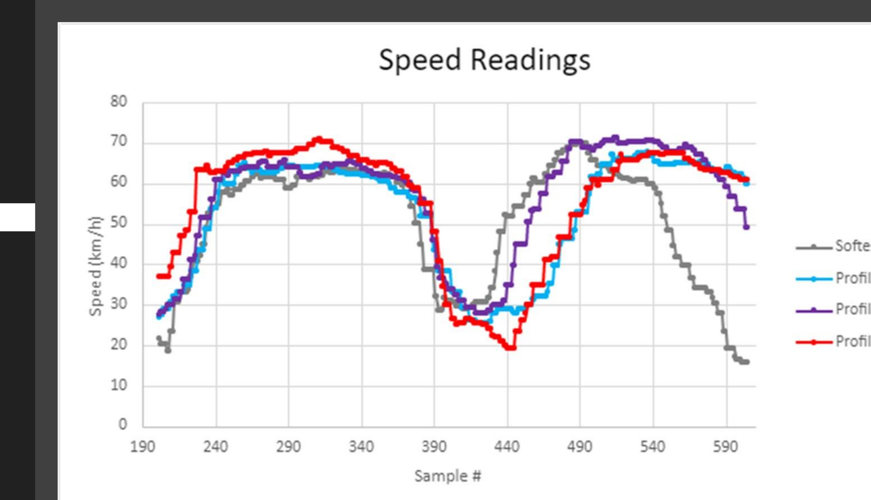


Testing Analysis Results

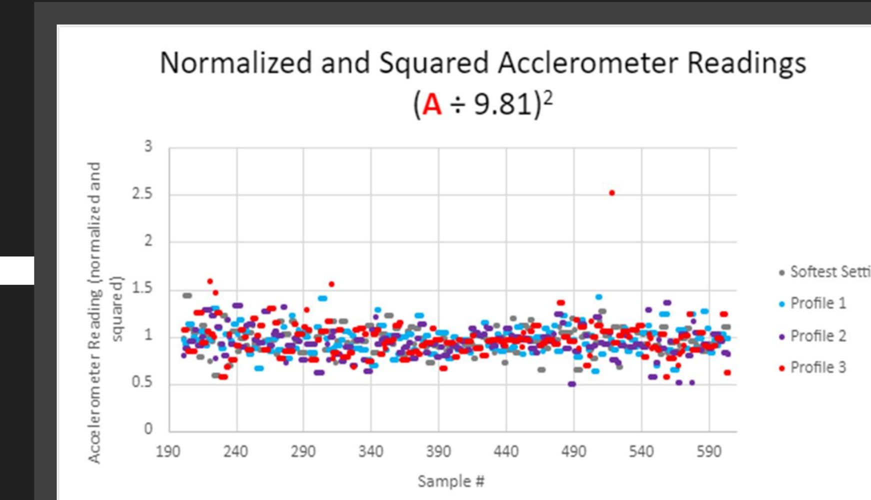
1. "Lap" while changing stiffness profiles (total of 4)
2. GPS → overlap speed data points
3. Accelerometer → plot and analyze readings



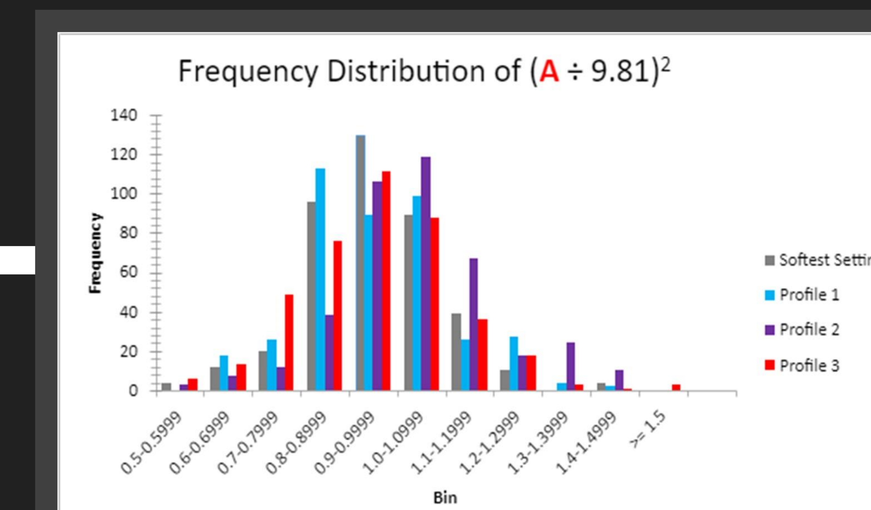
By overlapping the speed readings, we can then differentiate the accelerometer readings between the 4 stiffness profiles as shown below.



Here are the accelerometer readings for the 4 stiffness profiles; the values are normalized and squared to exaggerate the discrepancies.



By plotting a histogram, we can see that each stiffness profile gives a normal/Gaussian distribution of the bumps in the road with different standard deviations.



STIFFER PROFILE →

Profile	Softest	Profile 1	Profile 2	Profile 3
Mean	0.9549	0.9583	0.9345	0.9533
Standard Deviation	0.1357	0.1482	0.1567	0.1733

LARGER STANDARD DEV. →

Acknowledgements

- Kim Pope – Consultant
- Kiwi & Otis – Ethan's cats