Data Acquisition on Rugged Vehicles

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Mission/SOW

This project involves designing and manufacturing a data acquisition system for monitoring and recording various performance parameters encountered on an off-road vehicle. The NMSU Mini Baja project car was used to integrate and test the sensors.

Research

- **Objective** – Develop a universal data acquisition system that is adaptable to a variety of vehicles.
- **Customer Needs** – Measure various performance specifics such as suspension travel, vehicle velocity/acceleration, braking force, throttle position and engine temperature.
- **Market Research** – High demand for on and off-road vehicle performance data.
- **Technology -** Use off-the-shelf data logger and sensors.
- **Academic Insights** – Research on signal processing, noise interference reduction, data algorithms, and mechanical integration of sensors.
- **Conclusion** – A reliable system was developed to record various performance parameters. This system is adaptable to a variety of vehicles.

Sensor	Equation
CVT Belt Temp	$T = M(V - V_0) + T_0$
Potentiometer	$\frac{s}{s_{max}} = \frac{V}{V_{max}}$ $Force = k * s$
Brake Pressure	$P = m * (\mathrm{V} - \mathrm{V}_0)$
Throttle Position	$\theta = m * (\mathrm{V} - \mathrm{V}_0)$
Wheel speed	$RPM = 60f$ $Velocity = (2\pi R * RPM)/60$

$T = Temperature$
$T_0 = Initial\ Temperature$
$V_0 = Initial\ voltage$
$V = Voltage$
$s = Displacement$
$k = Spring\ Constant$ of shocks
$P = Pressure$
$\theta = Pedal\ angle$
$m = slope$
$f = Rotation\ Frequency$
$R = Radius\ of\ the\ wheel$

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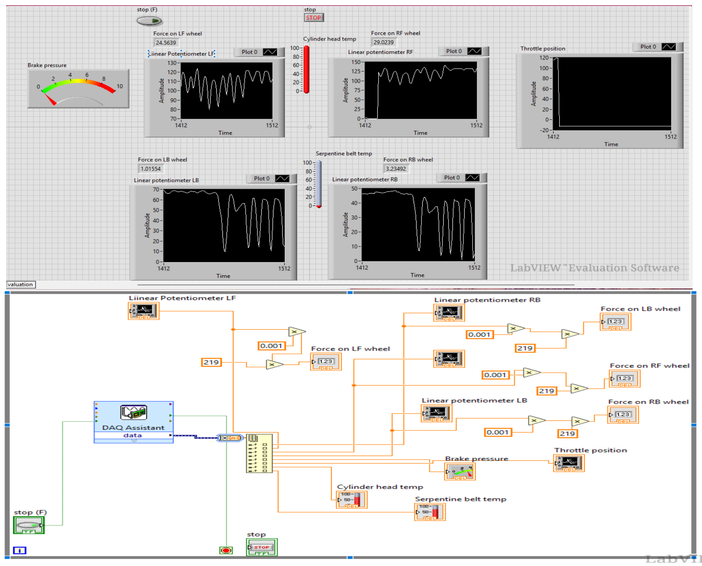
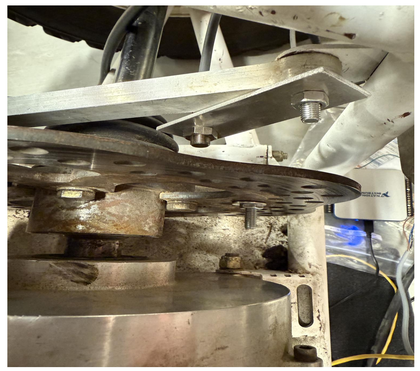
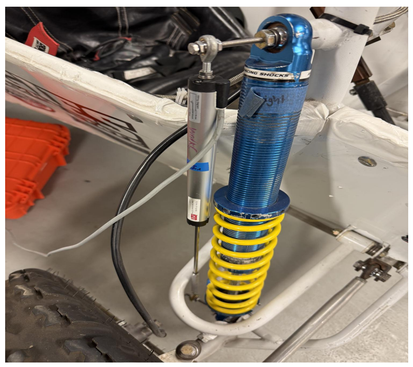
Final Design







Sensor

- **Wheel Speed Sensors:** Mounted at each wheel hub, these magnetic sensors track the rotational speed of each wheel, providing critical data for traction control, velocity, and stability systems.
- **Throttle Position Sensor (TPS):** Connected to the accelerator pedal, this sensor measures how far the pedal is pressed and translates that input into engine throttle response, helping regulate RPM and power output based on driver demand.
- **Brake Pressure Sensor:** Installed in the hydraulic brake system, this sensor measures braking pressure in real time, providing accurate data for performance analysis, brake tuning, and advanced vehicle control systems.
- **Engine RPM & Temperature Sensors:** Integrated into the engine, these sensors monitor engine speed and temperature to ensure optimal performance, fuel efficiency, and early detection of overheating.
- **CVT Belt Temperature Sensor:** Located near the CVT housing, it tracks the operating temperature of the transmission belt, helping prevent overheating and maintain smooth gear transitions.
- **Suspension Travel Sensors:** Installed within the suspension system, these sensors measure the suspension travel. The spring force between the tires and the ground is then calculated. This data helps evaluate traction, load distribution, and vehicle stability during various driving conditions.

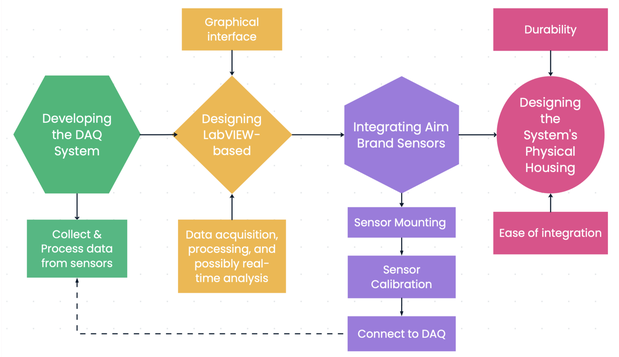
Concept Development

1. Developing the DAQ (Data Acquisition) System: Development initially started with an off-the-shelf data logger and sensor system. Initial testing proved this system wasn't friendly for exporting and displaying the data in various formats. A new data logging system was developed using a universal DAQ and software.

2. Customizing LabView Software for Data Acquisition and Processing: LabView software provides the user to customize how the data is displayed. This can be graphical, numerical or simply using warning lights display. For example, temperature can be displayed using a line graph, numerical value, and an overtemperature light all at the same time.

3. Integrating Off-The-Shelf Sensors: This system allows a variety of readily available off-the-shelf sensors to be integrated into the data logger. You are not restricted from having to use sensors from a single manufacturer.

4. Mechanical Integration: Being able to use a vast variety of sensors allows multiple options when it comes to mounting the sensors onto the vehicle. Interface brackets were designed for easy installation, adjustability, and maximum resolution of the output data.



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