DESIGN AND MANUFACTURING OF A TEST RIG FOR AUTONOMOUS VEHICLE APPLICATIONS

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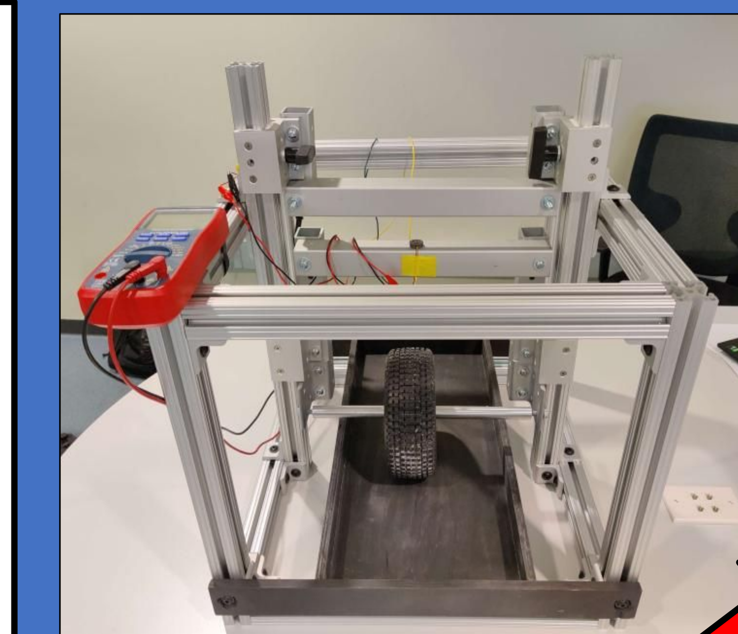
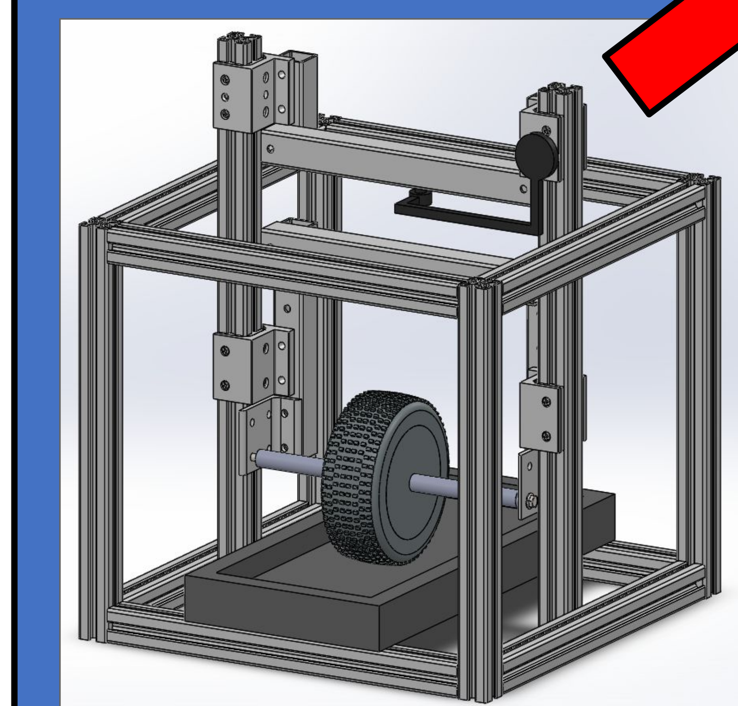
ABSTRACT

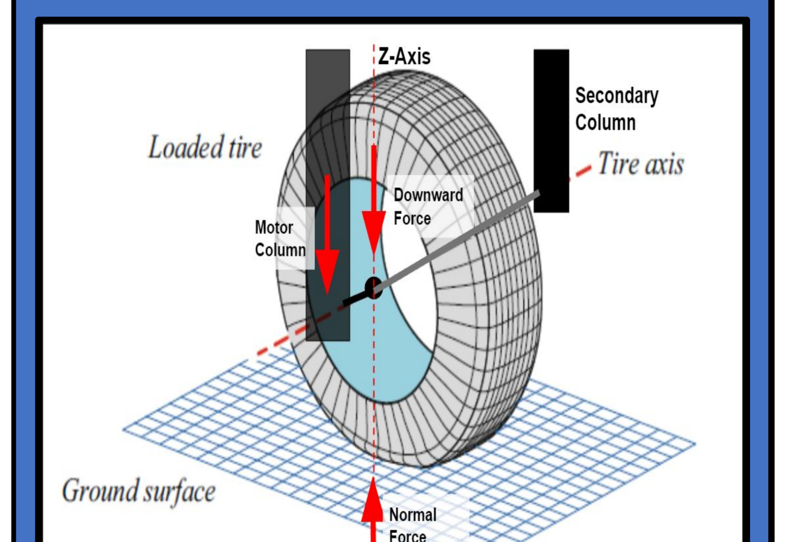
The purpose of this project was to examine and analyze the tire-terrain characteristics of a test tire. To do so, a test rig capable of performing both vertical deflection and footprint tests was designed. Finite Element Analysis (FEA) was used to design a virtual tire model, which was validated against the physical measurements obtained during physical testing. In doing this, several tire-road characteristics were obtained from the test rig. When the tire characteristics are later fully defined, the tire model will be used in the full vehicle simulation model of OTU's Scaled Electric Combat Vehicle (SECV).

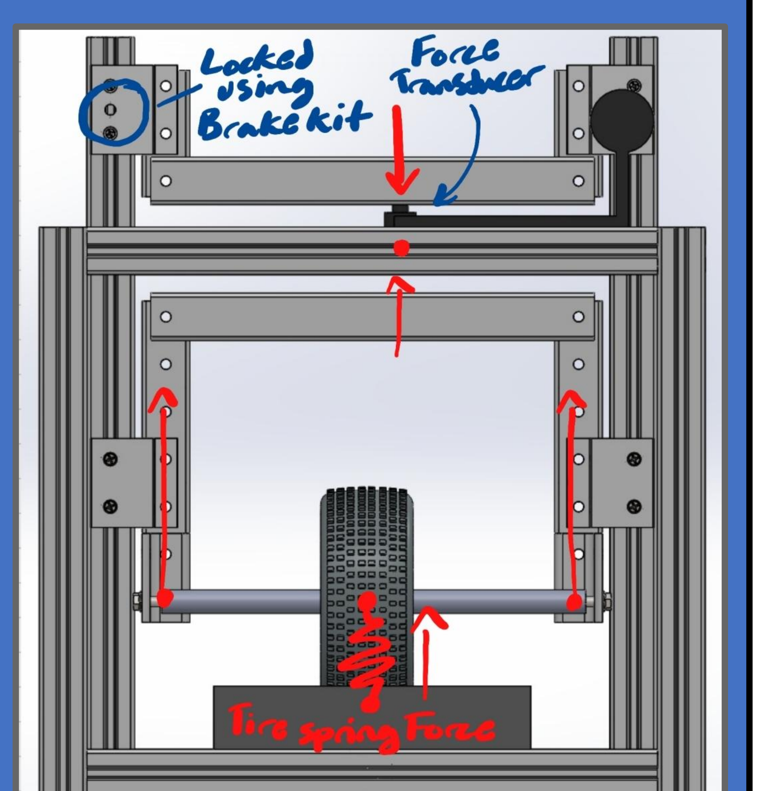




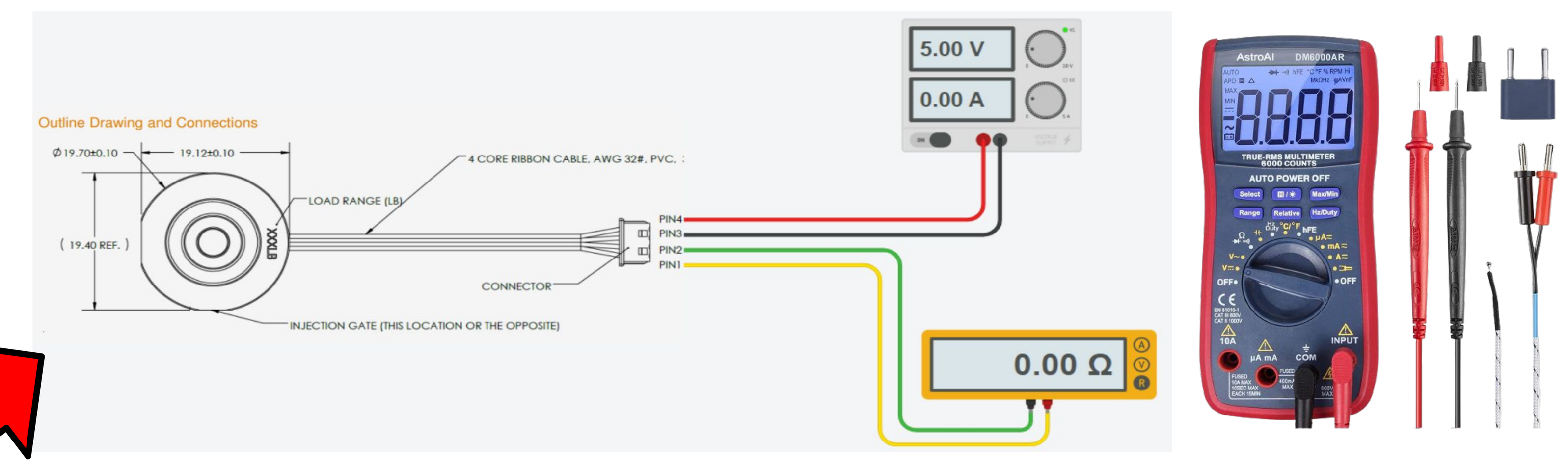
DESIGN

- The Test Rig was designed around the idea of measuring the normal force a tire exerts when vertically deformed
- A force transducer was used to measure the reactive force exerted by the tire during its deformation
- The final design and assembly of the test rig was completed in Solidworks with the use of 8020 provided part and assembly files





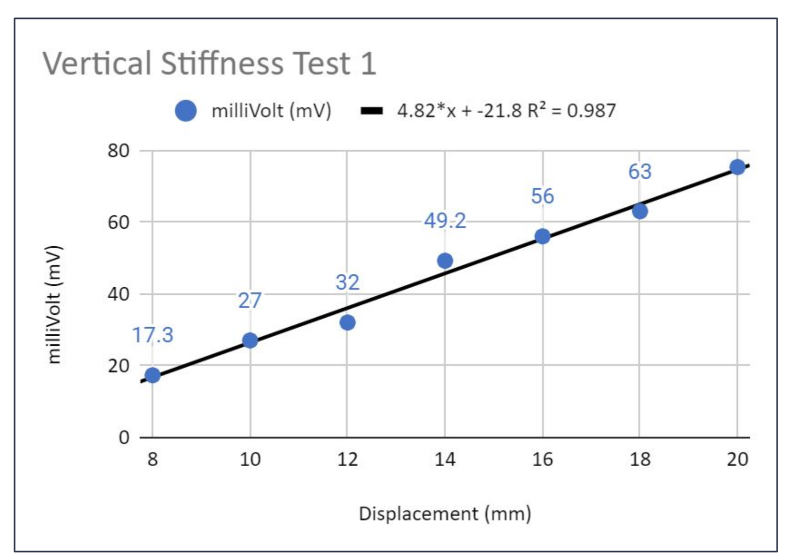
TESTING METHODOLOGY

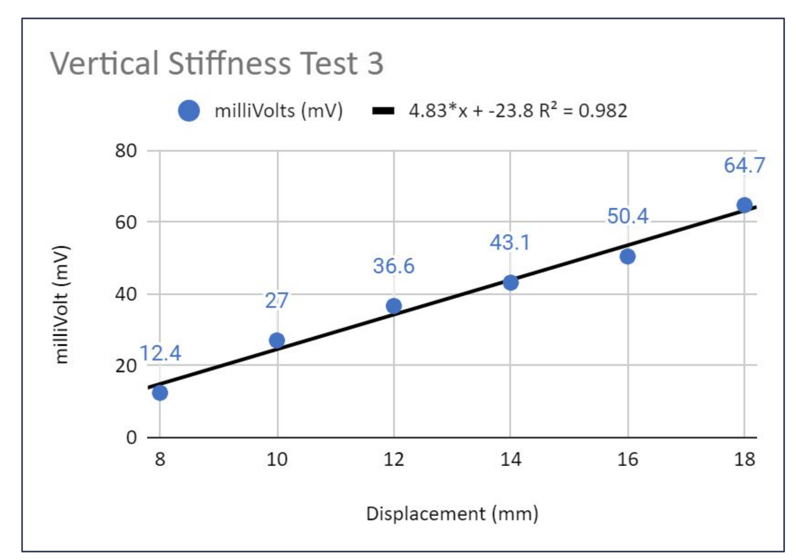


- The figure above shows the circuit layout of the force transducer
- The millivolt measurement correlates to the force measured by the force transducer
- A 5V power supply was required for the proper operation of the force transducer

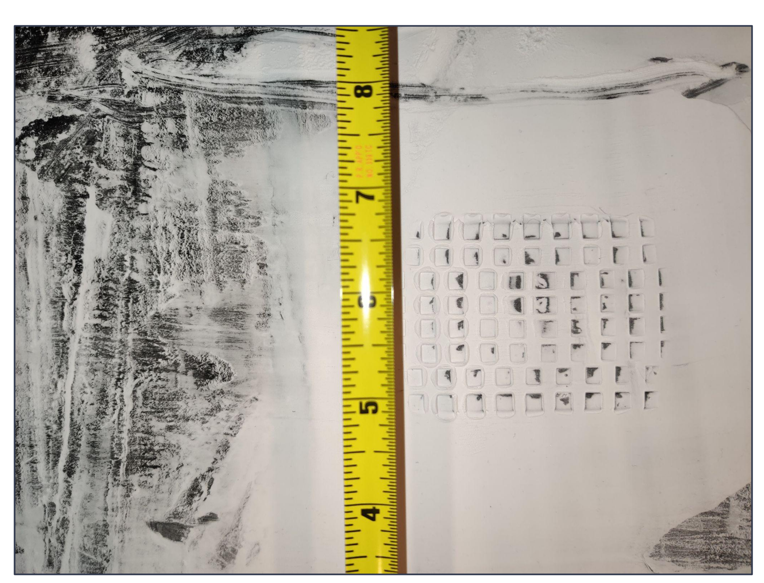
TESTING RESULTS

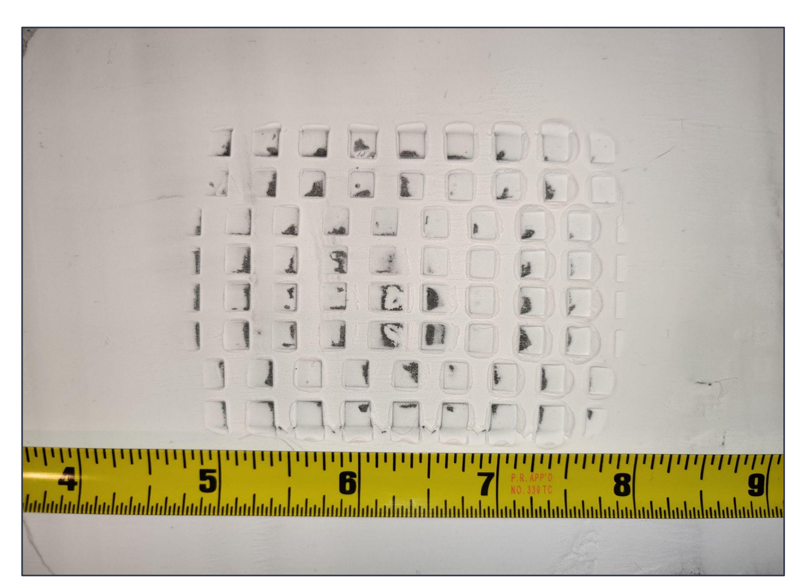
Test 1 - Vertical Stiffness: A measure of the slope of the vertical load applied vs displacement plot





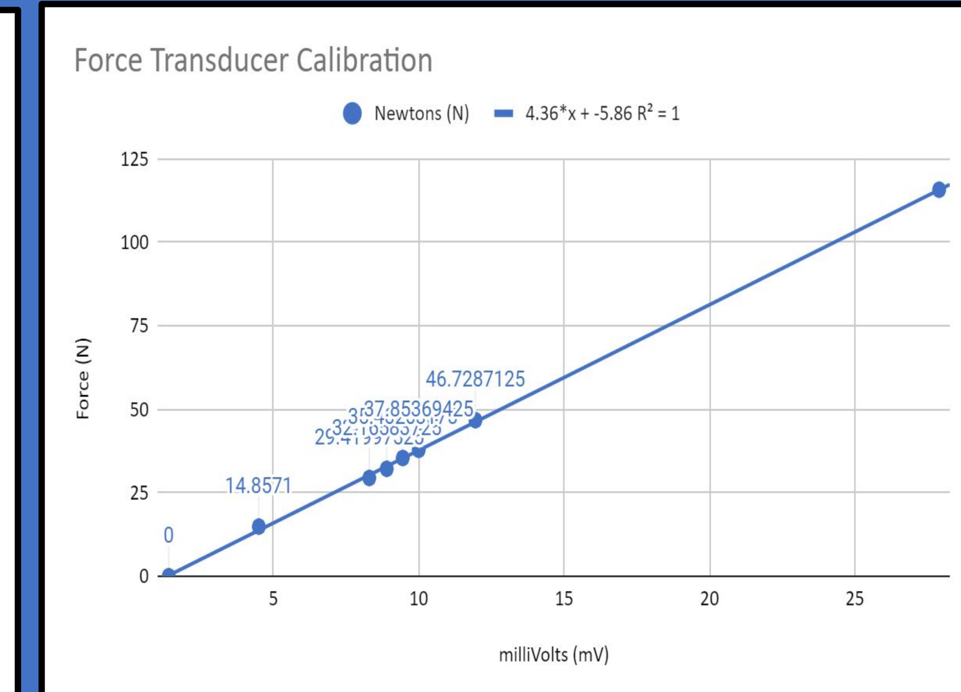
Test 2 - Contact Patch: A measurement of the tire's performance, shown by length and width of the tire contact patch





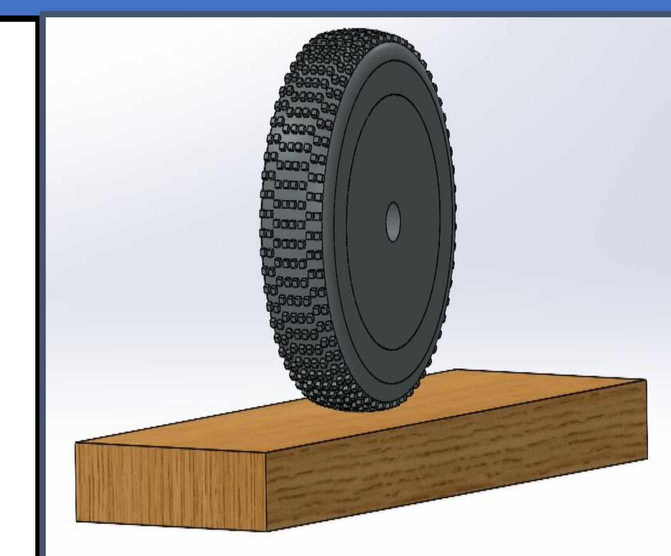
CALIBRATION

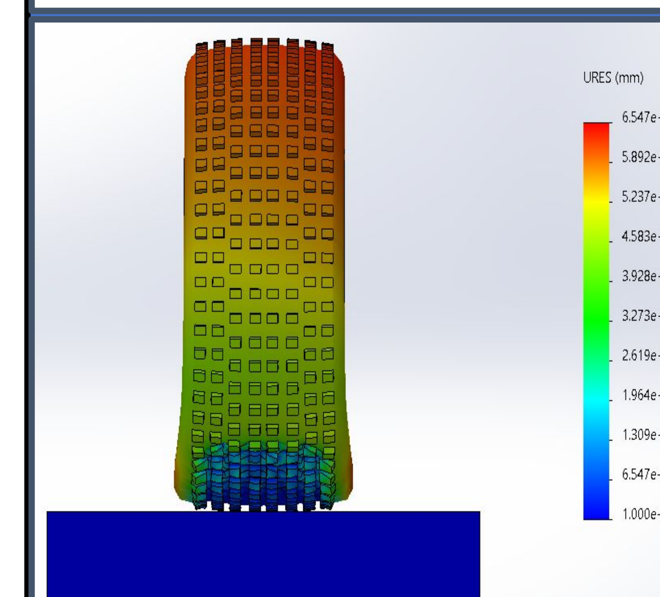
- Commonplace objects were used for the calibration of the force transducer
- At 0 N, voltage reads 1.4 mV
- As the load increases, the voltage changes
- The weight and voltage was found to be linear



SIMULATION

- FEA was conducted to match the results of the physical testing
- The physical tire was scanned using a 3D scanner. The dimensions for the scan were used to create a CAD model of the tire
- An assembly was created that consisted of the tread and rim of the tire as well as a contact surface
- Once everything was mated into place boundary conditions were set
- A bearing load was applied downwards into the rim
- Properties of the tread were altered until the results matched the physical test results
- The properties of the tire can be seen in the table below





Property	Value	Units
Elastic Modulus	37,000	N/m^2
Poisson's Ratio	0.45	N/A
Mass Density	940	kg/m^3
Tensile Strength	245,400,000	N/m^2

FUTURE WORKS

- Addition of a displacement sensor for measurement of the tire's deflection
- Integration of a load cell amplifier and arduino kit for advanced force measurement
- Tests for other tire characteristics (Lateral, Longitudinal deflection, tread-wear analysis)
- Use a more specialized CAD software for the simulation of the tire, such as Pam-Crash/ANSYS