Steering System Analysis and Modification of 8x8 Scaled Electric Combat Vehicle (SECV)

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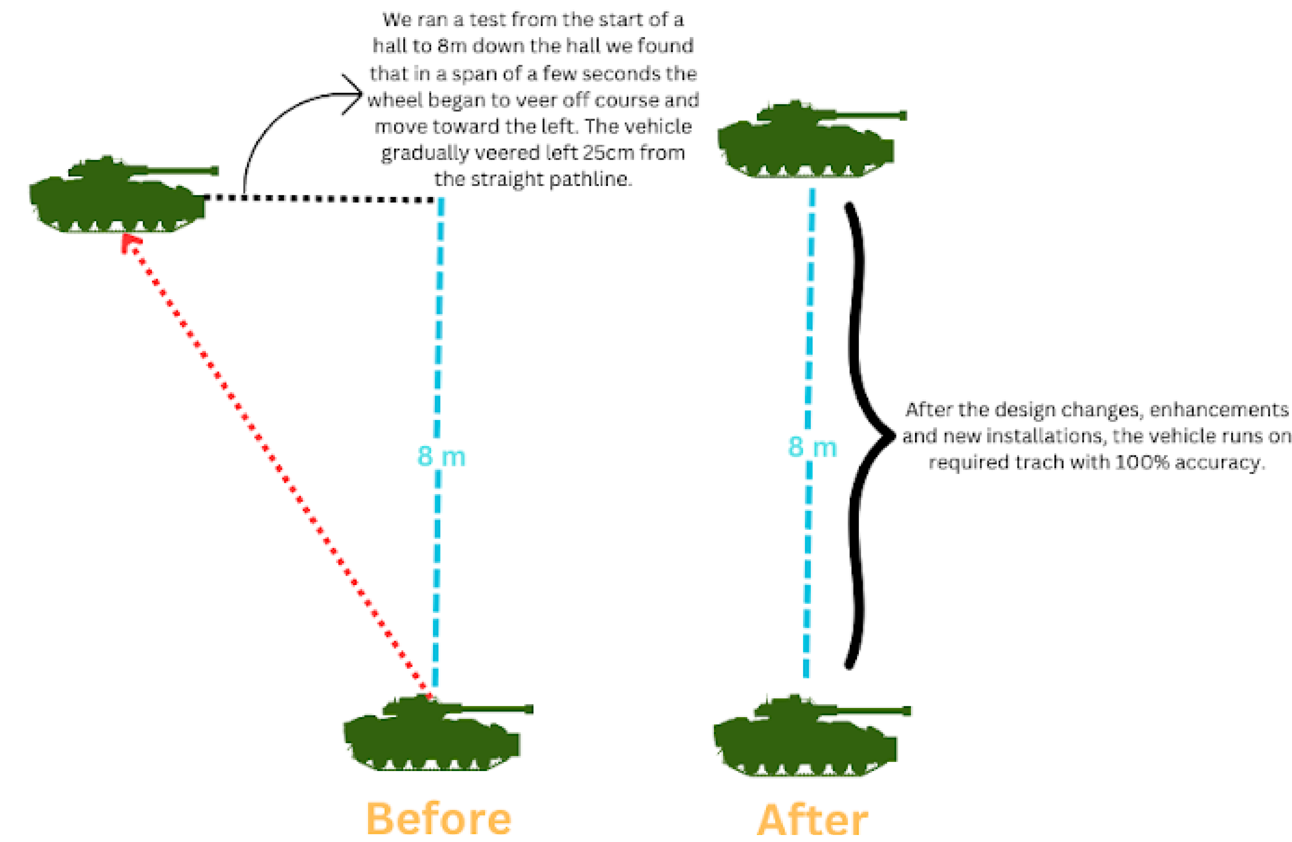
Abstract

In 2016 the Scaled combat vehicles (SECV) project was originally centered around the development of a remote controlled 8x8 Scale vehicle that would have multiple steering capabilities. This prototype took its inspiration from the General Dynamics Land Systems (GDLS) LAVIII. Since then different capstone groups have taken this project and integrated and developed new functionalities for the SECV. Some of the projects in the past include, Implementation of image processing algorithm to enable autonomous driving, object detection and avoidance capabilities to the SECV, improvements on the drivetrain, powertrain and steering mechanisms. And adjustments to the vehicle outer shell to decrease the overall weight of the SECV.

Control Arm Brackets

The L-shape bracket should not move to avoid any issues with drivability. The previous method of installation failed due to the repeated forces and vibrations that acted on it when the vehicle was in motion. The main problem was the misalignment of the wheel when the suspension was compressed. This would cause the zeroing of the wheel to be off affecting straight-line performance. To fix this issue we installed a new L-shape bracket that uses screws and nuts to secure the bracket.

Test Results



During a trial test before the enhancements and design changes to the vehicle it was discovered that the alignments of the wheels were off; as we ran a test from the start of a hall to 8 m down the hall we found that in a span of a few seconds, the wheel began to veer off course and move toward the left. The vehicle gradually veered left 25 cm from the straight path line, as shown in the figure above. These enhancements and design changes proved to be incredibly effective, as we were able to complete subsequent tests without any issues with the alignment of the wheels. Thanks to these changes, the vehicle now moves in a straight path line, without veering off course or losing stability.

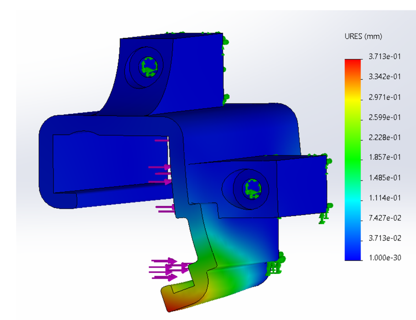
Project Objectives

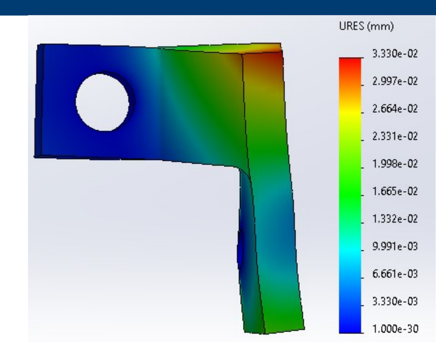
The goal of this project was to increase steering accuracy by modifying the current steering mechanism. This was accomplished by changing these 3 things:

1. The driveshafts - this is a part of the drivetrain of the scaled combat vehicle which is to transfer torque from the gearbox to the differential, which then distributes the torque to the wheels to propel the vehicle.
2. The control arm brackets - this is a part that holds the control arm in a particular spot to help support the steering system.
3. The steering housing - this is the part that the steering arm is attached to that allows the arm to slide as the wheels are turned inwards and outwards.

Changing these 3 components listed above reduced the error that was occurring and improved the accuracy within the steering system. The goal was to make the vehicle drive at a higher steering accuracy, move a lot faster, and have a much better turning capability.

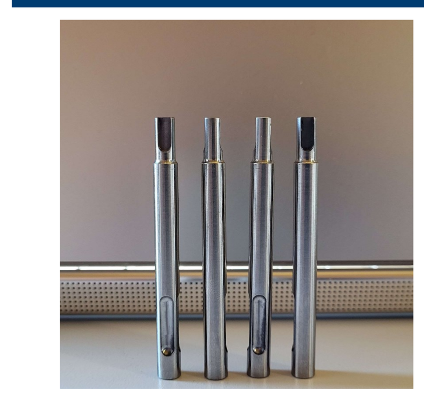
Steering Housing

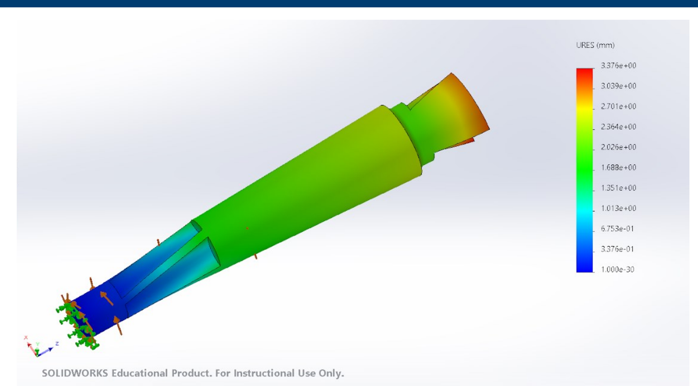


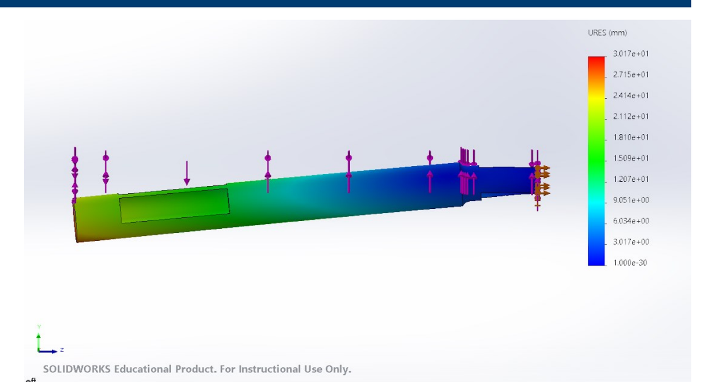


The steering guide was redesigned in a very simple way by adjusting the attachment points to compensate for the flex. The attachment points were extended and a layer of material was added to strengthen the side that will endure the most stress. This simple redesign reduced the displacement by 0.8517 mm which is a 69.64% improvement and significantly improved the failure point of failure point. To fix failure points we added material along the L-shape portion to help with the flexing of the bracket. This reduced the displacement by 0.00774 mm which is only an 18.86 % improvement but referring to the risk level table above we can see our main focus was on the steering housing.

Driveshaft

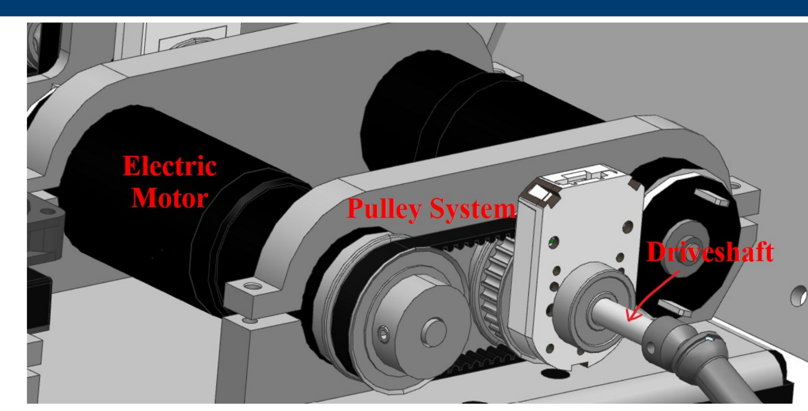






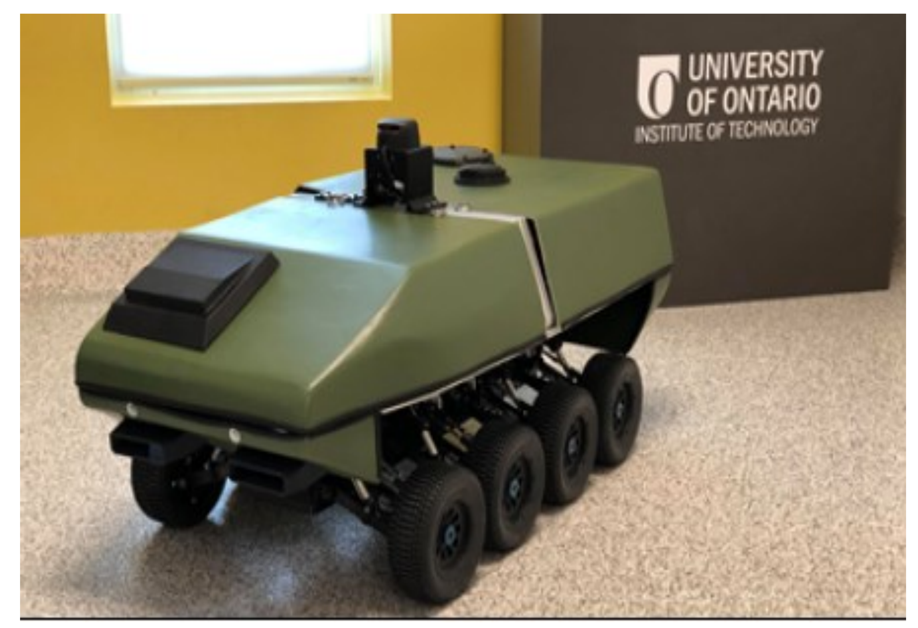
The main objective was to redesign the drive shaft due to the screws attached to the universal joint driving the wheel becoming loose over time due to the vibration caused when the vehicle is moving. To remedy this problem, the driveshaft had to be redesigned along with fixing how the drive shaft is attached to the joints to stop the screws from backing out and causing the driveshaft to start slipping in the universal joint. The redesigned drive shaft had to be the same in terms of length, and width in the same places on the shaft, while the slots for the set screws had to be redesigned to make the slots a better shape to try and limit the effect of the vibration backing out the screws out of the slots in the drive shaft. The designed drive shaft was able to withstand the force applied by the motors and screws connecting the drive shaft from the motors to the wheels.

Function



The driveshaft's main purpose is to transfer power from the electric motors to the driveshaft. We had to redesign this part as it was slipping, causing issues in transferring power to the wheels. As the electric motors spin, it transfers the power to the pulley system through a belt. The driveshaft is connected to the second pulley attached by screws. The other end of the driveshaft is connected to a cv joint which allows for the power to be transferred through a variable angle.

Future Development



- Use a protractor table setup with a laser connected to a tire to gather data which can be analyzed to determine level of misalignment in wheels.
- Change materials of parts on the vehicle to increase durability, i.e. stainless steel, aluminum.