System Verification and Validation Plan for CVT Simulator

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April 4, 2025

Revision History

Date	Version	Notes
October 11th, 2024	0	First version of VnV extra report
April 1st, 2025	1	Added real-world data into VnV extra

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1 Symbols, Abbreviations, and Acronyms

acronym	definition
CVT	Continuous Variable Transmission
GPS	Global Positioning System
IMU	Inertial Measurement Unit
VnV	Verification and Validation

Table 1: Verification and Validation Acronyms

2 General Information

2.1 Summary

This document will go into detail on the real-world data validation performed for the CVT Simulator. As per Dr. Smith's instructions, it will be completed prior to the course's end. This document currently serves as a placeholder for the final VnV extra report.

3 Functional Tests Evaluation

3.1 Simulation Model

3.1.1 Position

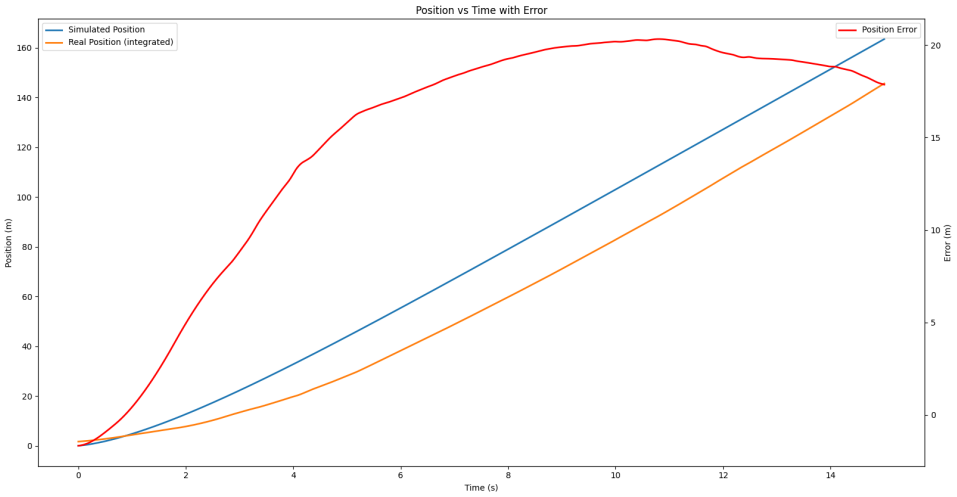

Figure 1: MSE of simulated position vs integrated experimental data.

- Car go fast... still! Explained by poor modelling of air resistance and other resistive forces such as rolling resistance, frictions, etc - At the end you can see error decreases a bit. Perhaps the final force of air resistance was estimated too high, but the other

forces were estimated too low, giving a slightly different final value, so final speed was too high. - Also note the poor tests mentioned later about no max velocity

Car position over time

3.1.2 Velocity

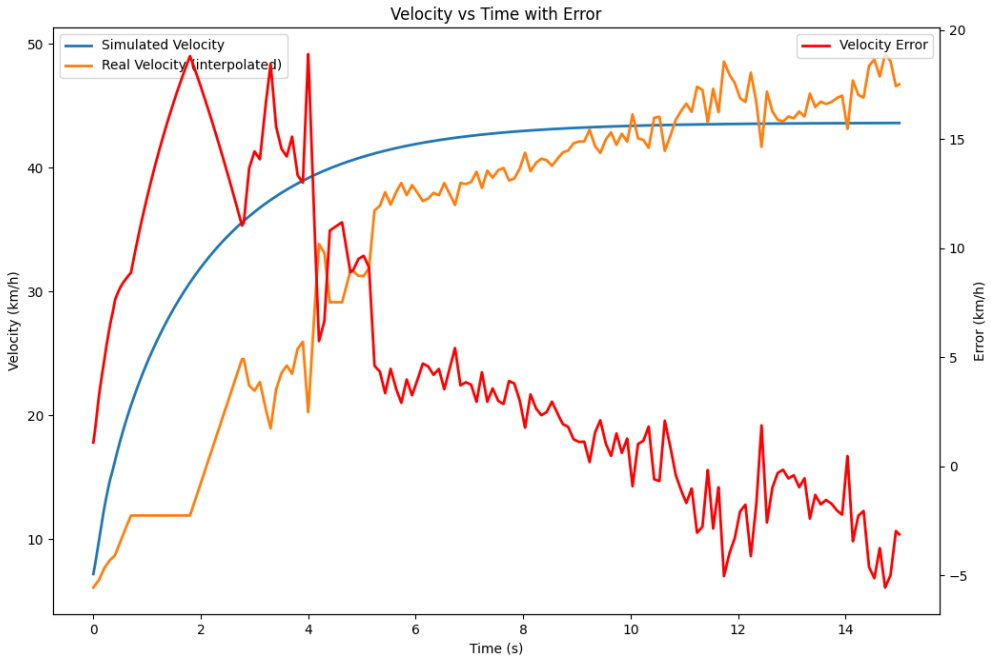

Figure 2: MSE of simulated vehicle velocity and experimental data.

- Car go fast, shocker! Ignored many resistive forces, no slipping so early on its most noticeable.

Car velocity over time

3.1.3 Acceleration

Not availabel (no data gotten from IMU)

3.1.4 Shift

3.1.5 Velocity

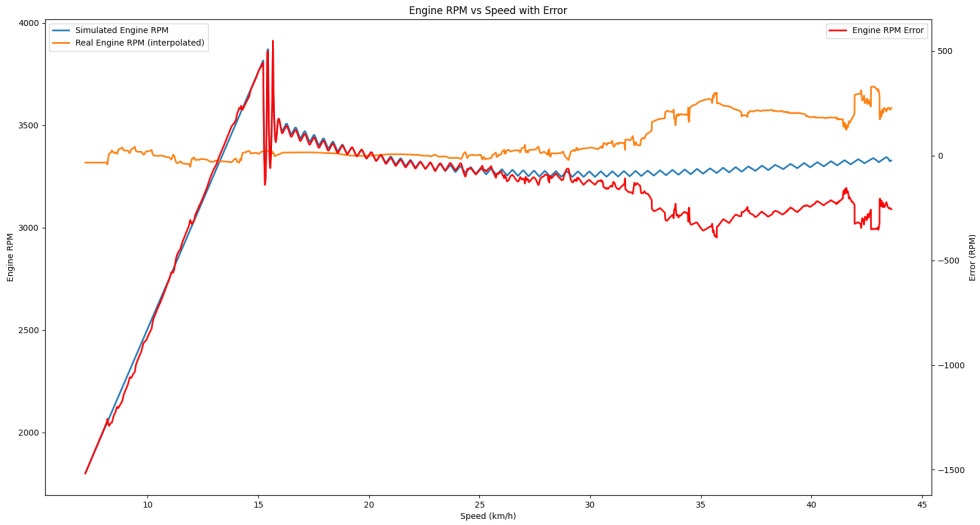

Figure 3: MSE of simulated shift curve and experimental data.

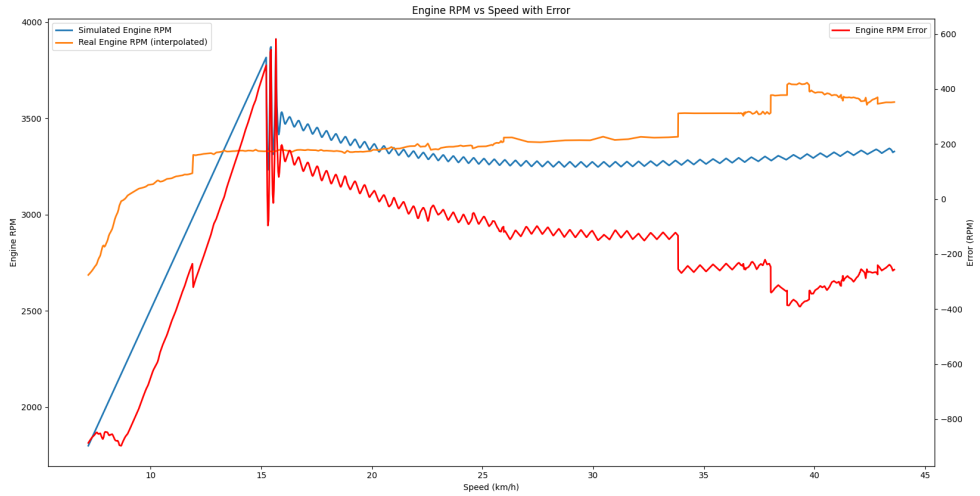

Figure 4: Second dataset at a different tune, showing the shift curve and experimental data.

- We see generally a flat shift in both, which is great! - Both also have a low ratio, although slight differences, they definitely both exist well

- Low ratio is somewhat different in calculations (causes: Wrong geometry, precision in machined parts, assumption of slip) - Through the shift, we see some curve. A subtle change in ramps could cause this, or a poor understanding of the springs in our system. Potential in the real CVT system for spring to bind as it compresses, bringing unknown forces - Don't see max shift much, this is due to poor data collection tests - Limits on the length of track we have access to mean we dont see our top end of the speeds our vehicle can acheive.

1 and 2 (What is 1?)

4 Trace to Requirements or Modules