CruiseAuto Project – Milestone 4
Technical Brief

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Date: April 29, 2025

RE: Milestone 4 Technical Brief

Introduction

CruiseAuto asked our team for this technical brief that contains a technical analysis and recommendations on their tires for the next model to ensure they meet the standards. Our criteria are that our parameters are within the range of the benchmark parameters. Our constraint was that we had to give periodical updates to CruiseAuto. Our algorithm finds the criteria parameters through the use of four different subfunctions while also finding the SSE that displays the accuracy of these parameters. It also plots the benchmark model data, left bound, right bound, and the raw benchmark data for a visual representation of if the ACC is within its performance boundaries. The critical decisions our group made to find the parameters were how we cleaned our data, found our initial velocity, and choose to average the time constants rather than the data set values. We cleaned our data by looping through the velocity values, removing the NaN, and then replacing it with an average of the values around it. This smoothed the data without completely altering the data like the smooth function does. This helped our model become more accurate as it removed any gaps in the data set and replaced them with an approximation. We found our initial velocity by finding the median of the data points from the first index to the acceleration start time. This was vital as we had previously used the mean of these points which created a large percent error. Finally, we changed the way we found tau, as none of our time constants were within the bounds. However, after we averaged each time constant, rather than the data set, many of our time constants were within the bounds.

Parameter Identification Procedure

Our algorithm first creates the model for the left and right bound. It then puts the data through subfunction two to remove all the NaN values that are replaced with the average of the two values around it. If there is only one value around the NaN, it takes that value. Then we found all the parameter values by running the third and fourth subfunctions and printed the values. Next, it plots all the raw benchmark data. Finally, SSE and percent error are found and printed. This is done for each tire type and car type.

Results

The M4 algorithm was applied to five test runs for each vehicle–tire combination. After cleaning and averaging the data, CruiseAuto models were compared to performance bounds. Figure 1 shows nine subplots, one per configuration, of the averaged CruiseAuto model plotted against the left and right bounds. Table 1 lists the experimental parameters from the M4 algorithm.

Figure 2 shows the five Winter test runs for each vehicle plotted against the bounds. These results are consistent with other tire types but only Winter is shown due to space constraints. All values are reported in seconds (s) and meters per second (m/s), rounded to two decimal places. All averaged models and test runs remained within the performance bounds after acceleration.

Interpretation

The error was mainly due to sensor noise and minor imperfections in parameter detection. Replacing NaNs with neighbor averages preserved trends, and using medians for initial speed reduced outliers. These changes improved percent error from M3 to M4. CruiseAuto can report that the ACC system performs reliably with all three new tire types, consistently staying within performance bounds. With more time, the algorithm could benefit from dynamic acceleration detection and more advanced outlier filtering.

References

No external references used in this technical brief.

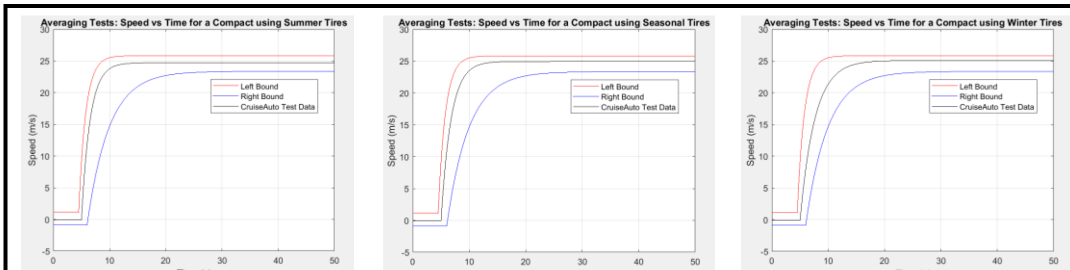
Appendix: Figures and Tables

Table 1. Experimental Vehicle and Tire Type Parameters Using M4 Algorithm

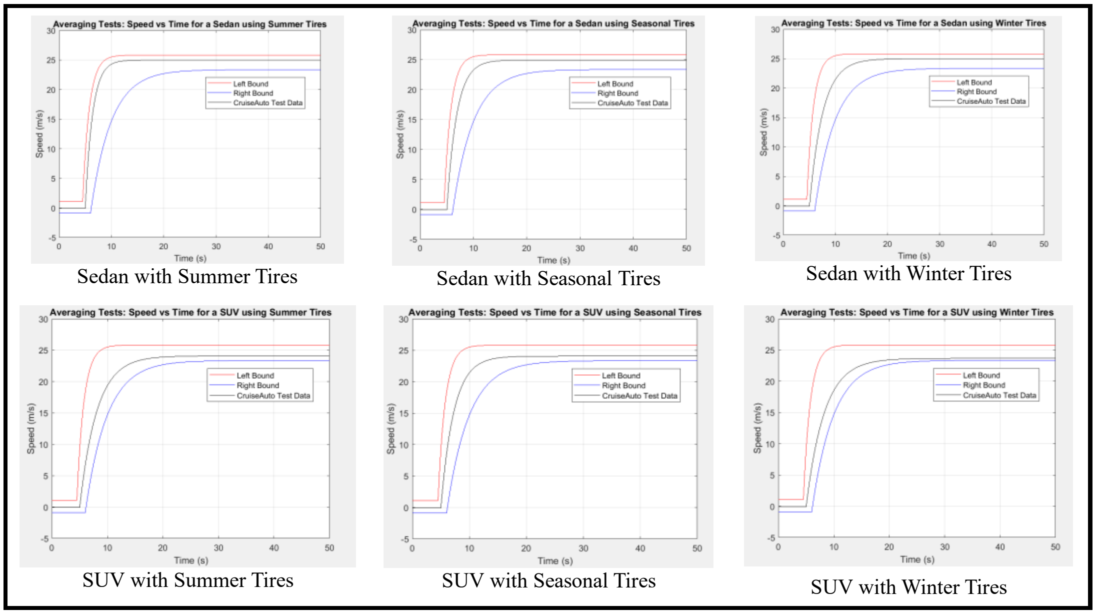
Vehicle	Tire Type	M4 Algorithm Parameters			
		Start time [s]	**Time constant [s]**	**Initial speed [m/s]**	**Final speed [m/s]**
Compact Hatchback	Summer	7.73	1.53	-0.0741	24.7084
Compact Hatchback	All-Season	7.75	1.76	-0.0543	24.9618
Compact Hatchback	Winter	8.09	2.62	-0.0791	25.0864
Midsize Sedan	Summer	7.80	1.39	-0.0676	24.9741
Midsize Sedan	All-Season	6.17	1.84	-0.0747	24.9316
Midsize Sedan	Winter	8.27	2.57	-0.0777	24.9844
Large SUV	Summer	7.45	3.06	-0.0650	24.0992
Large SUV	All-Season	7.26	2.27	-0.0789	24.0790
Large SUV	Winter	7.66	3.27	-0.0585	23.6758

Averaged parameters calculated from five cleaned test runs per configuration. Time in seconds (s), speed in meters per second (m/s), rounded to two decimal places.

Figure 1. Averaged CruiseAuto Models vs. Bounds by Vehicle–Tire Combination

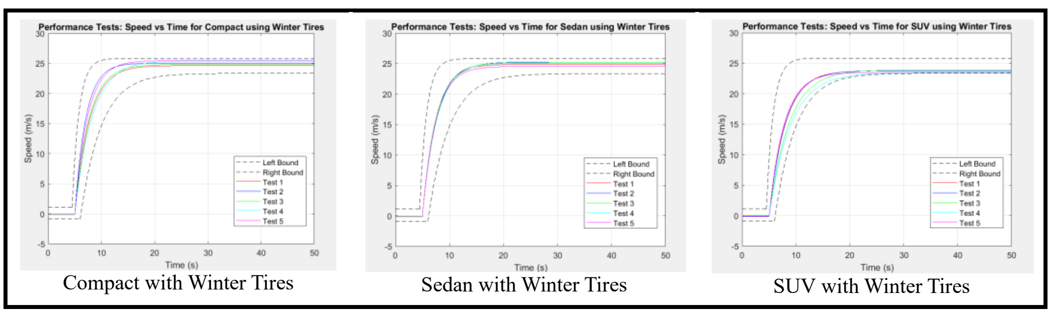


Compact with Summer Tires | Compact with Seasonal Tires | Compact with Winter Tires



Each subplot shows the CruiseAuto model (averaged over five test runs) plotted against the left and right performance bounds for each vehicle–tire combination.

Figure 2. Performance Plots for Five Test Runs Per Vehicle Using Winter Tires



Each subplot shows the five Winter test runs for each vehicle type, plotted against the left and right performance bounds. These results demonstrate the system's consistency under the most challenging tire condition and are representative of the other configurations with similar results.