Scene-aware and Social-aware Motion Prediction for Autonomous Driving

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Agenda

1. Method
   - Data collection
   - Filtering process
   - Integration Model
2. Results
   - Scenario Filtering
   - Integration Method

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Previous Integration Model

Distance and Velocity Equations (Ballistic Integration):

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\begin{aligned}
s(k+1) &= s(k) + dt \cdot v(k) + \frac{dt^2}{2} a(k) \\
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\end{aligned}
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Acceleration Equations (Rearranged):

$$\textit{From distance}: \qquad a(k) = \frac{2}{dt^2}\Big(s(k+1) - s(k) - dt \cdot v(k)\Big)$$
$$\textit{From velocity}: \qquad a(k) = \frac{1}{dt}\Big(v(k+1) - v(k)\Big)$$

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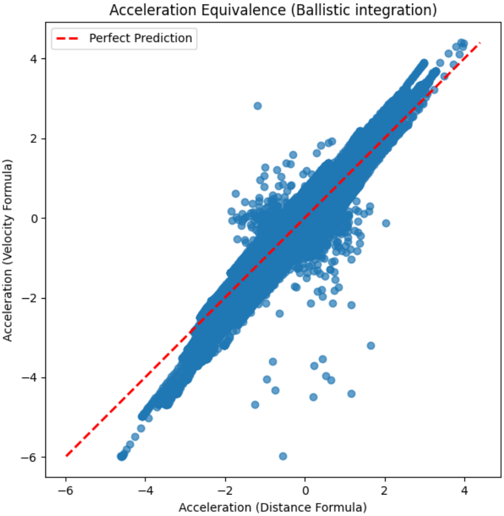
Problem: Accelerations don't add up!

Previous Integration Model - Accuracy



Our Integration Model

Our Distance and Velocity Equations:

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$$s(t+1) = s(t) + dt \cdot v(t) + c_1 a(t) + c_2 a(t-1)$$
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Our Acceleration Equations:

$$a(k) = -\overline{c_1} a(k-1) + \overline{c_2} \big(s(k+1) - s(k) - dt \cdot v(k) \big)$$
$$a(k) = -\overline{c_3} a(k-1) + \overline{c_4} \big(v(k+1) - v(k) \big)$$

Our Integration Model - Matrix Form

Acceleration from Distance formula:

$$\begin{bmatrix} a(k-1) \end{bmatrix} = \begin{bmatrix} -a(k) & v(k+1) - v(k) \end{bmatrix} \begin{bmatrix} \overline{c_1} \\ \overline{c_2} \end{bmatrix}$$

Acceleration from Velocity formula:

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$\Rightarrow$ This can be solved using linear regression.

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Video demo of the scenarios

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Reminder: Our Integration Model - Matrix Form

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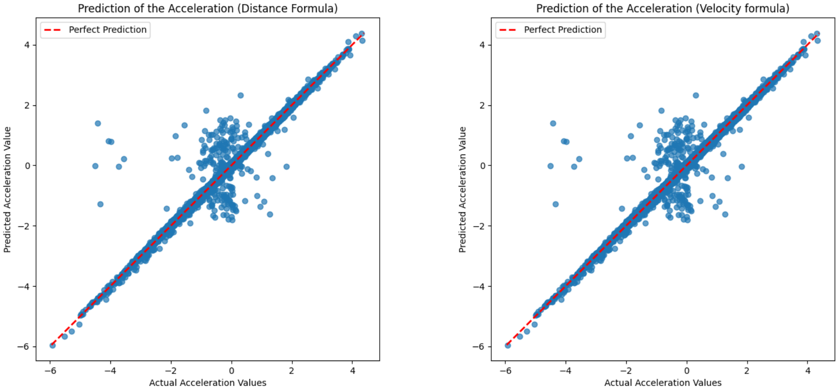
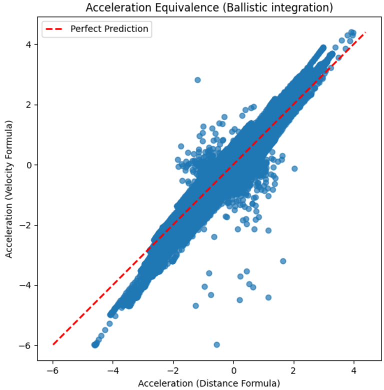
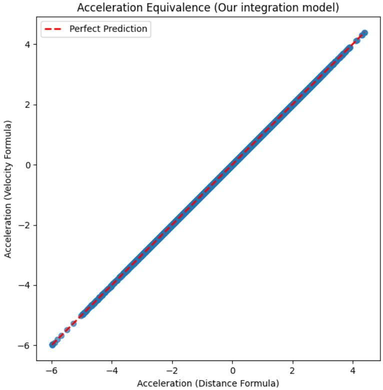
Results: Integration Method



Results: Comparison to the old acceleration model



MSE: 4.3249e-02



MSE: 1.9220e-09

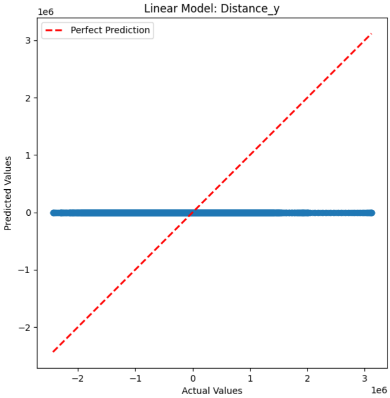
Results: Integration Method

Rearranging the formula to the distance and velocity gives us these results:

Video demo of predicted car

Questions?

Acceleration Modification in the Y-axis



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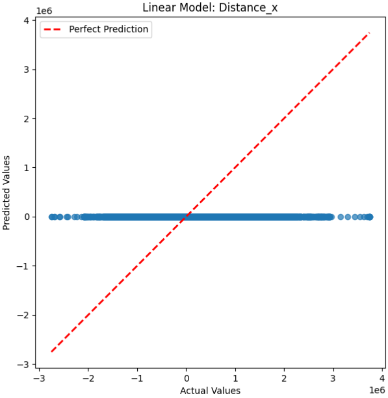

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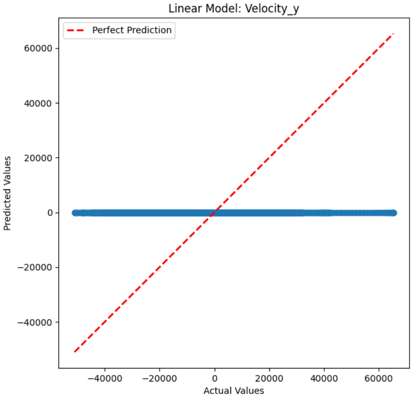

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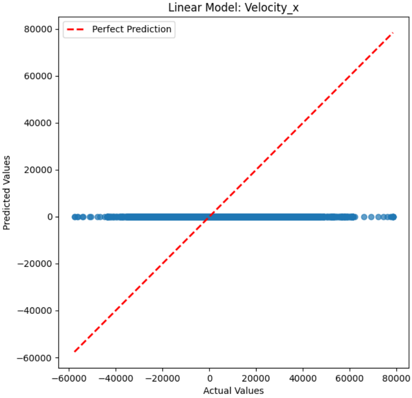
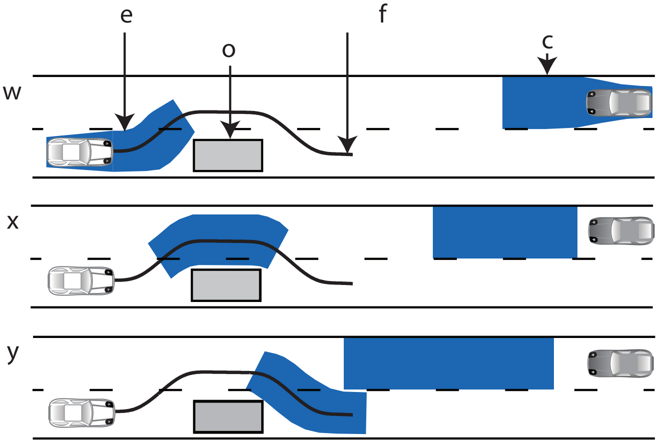


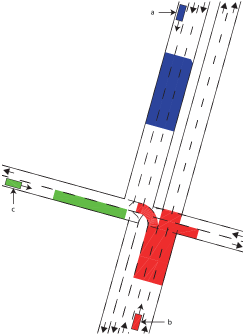
Motivation for Set-Based Prediction [1]



[1] M. Althoff and S. Magdici, "Set-based prediction of traffic participants on arbitrary road networks," IEEE Transactions on Intelligent Vehicles, vol. 1, no. 2, pp. 187–202, 2016.

SPOT

SPOT: A tool for set-based prediction of traffic participants [2]



Initial configuration and $\mathcal{O}(t)$ for $t \in [1.5\,\mathrm{s}, 2.0\,\mathrm{s}]$

[2] M. Koschi and M. Althoff, "SPOT: A tool for set-based prediction of traffic participants," in Proc. of the IEEE Intelligent Vehicles Symposium, pp. 1679–1686, 2017.

Conclusions

- Item
- Item
- Item

beginframe

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onslide¡2¿

Acceleration Equations:

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endframe

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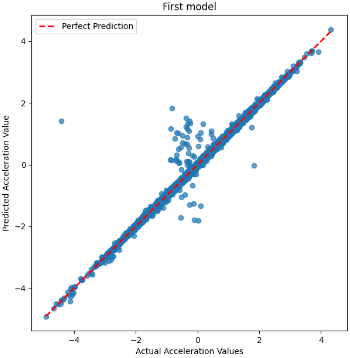

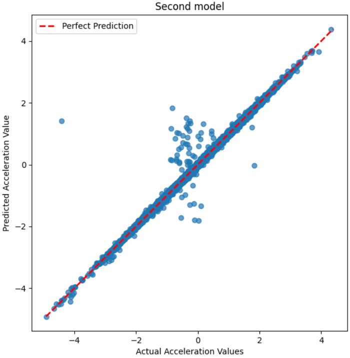

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Model in matrix form:

$$\begin{bmatrix} a(k) \\ a(k) \end{bmatrix} = \begin{bmatrix} -a(k-1) & s(k+1) - s(k) - dt \cdot v(k) & 0 & 0 \\ 0 & 0 & -a(k-1) & v(k+1) - v(k) \end{bmatrix} \begin{bmatrix} \overline{c_1} \\ \overline{c_2} \\ \overline{c_3} \\ \overline{c_4} \end{bmatrix}$$

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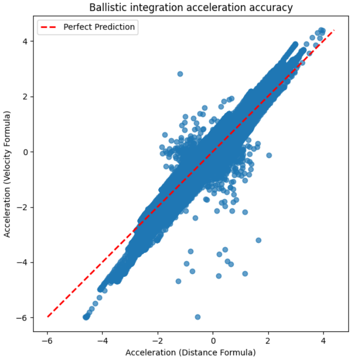
$\Rightarrow$ This can be solved using linear regression.

Results: Integration Method

Accuracy of the prediction for the acceleration using the Ballistic Integration method (MSE): 4.3249e-02



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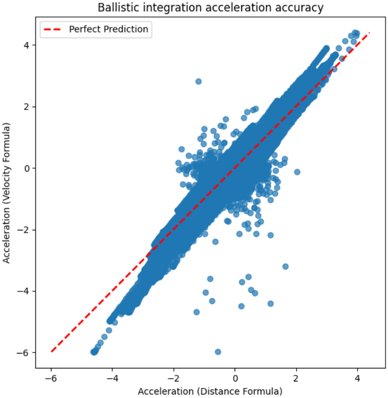

Results: Integration Method

Accuracy of the prediction for the acceleration (MSE): 3.0955e-03