CSCE-452-500 Project#4

Tropical Storm Ofo:
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Project Summary

For project 4, our team created a program that simulates steering mechanics for a car from a top down perspective. The user is presented with an interface as shown below. Note, the car has been highlighted in yellow in the “Track View” pane and its corresponding icon has been highlighted in the “Minimap” pane.

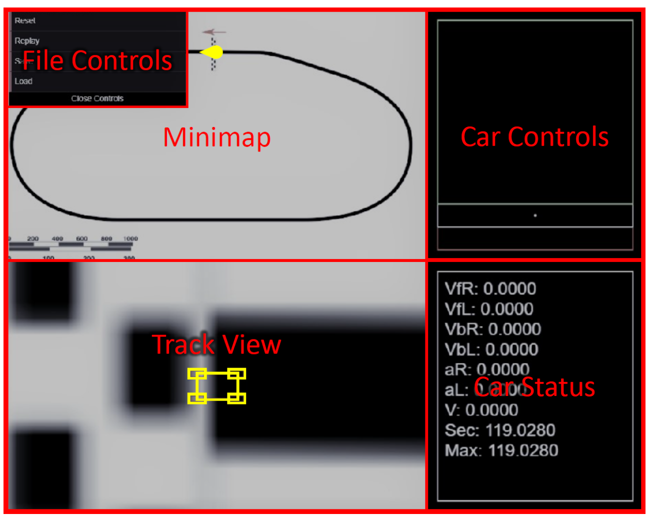

Figure 1: Screenshot of our project showing the different panes.

The various panes and their function will be discussed below. Then, there will be a section dedicated to explaining the underlying driving mechanics.

Interface Panes

The GUI contains five panes, each of which has its own controls and functionality. The following sections are ordered as the panes appear from top left to bottom right.

File Controls

The "File Controls" menu is located in the top left corner, floating above the "Minimap" pane. While driving the car around the track, a background process constantly logs the car's position and rotation. The buttons under the "File Controls" menu allow you to interact with that log. The buttons are as follows:

- *Reset* – This will reset the car and the session log.
- *Replay* – This will replay everything stored in the log since the beginning of the session.
- *Save/Load* – These will save the current log and load a past log respectively. After loading a previous log, it can be replayed.

This menu can also be collapsed by clicking "Close Controls".

Figure 2: Screenshot of the "File Controls" menu.

Minimap

The "Minimap" pane occupies the top left corner of the GUI. It displays the entire track as well as a small icon representing the car and its current heading. This icon is highlighted in yellow in Figure 1.

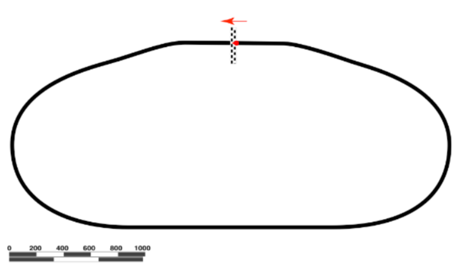

Figure 3: Screenshot of the "Minimap".

Car Controls

The "Car Controls" pane occupies the top right corner of the GUI. It contains a control in the style of a touch pad. By clicking and dragging across the control, the user can change the car's speed and steer. Draggin the mouse upwards through the green section will increase the car's speed from 0mph to 200mph. The grey section stops the car, and the red section reverses the car at 5mph. Dragging the mouse left and right will steer the car.

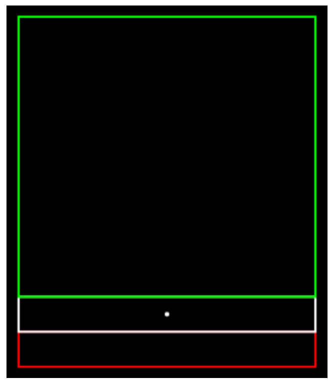

Figure 4: Screenshot of the "Car Controls" pane.

Track View

The "Track View" pane occupies the bottom left corner of the GUI. It simply displays the car and track on a closeup level.

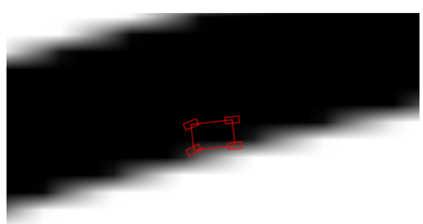

Figure 5: Screenshot of the "Track View" pane.

Car Status

The "Car Status" pane occupies the bottom right corner of the GUI. It displays realtime information about the car's status.

- *VfR, VfL, VbR, VbL* – Velocity of the wheels relative to the ground (VfR = velocity of front right wheel).
- *aR,aL* – Angle of front wheels (aR = angle of front right wheel).
- *V* – Velocity of car.
- *Sec,Max* – These keep track of timing during replays. They can be ignored for the most part as they are "not really important" - Gabriel Stella 2018.

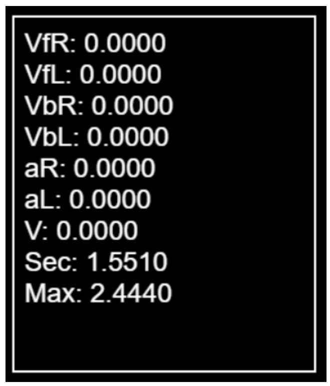

Figure 6: Screenshot of the "Car Status" pane.

Driving Mechanics

For our steering model, we implemented the Ackerman model of steering. Please refer to Figure 7.

In this figure, $V_{FL}, \cdots, V_{BR}$ represent the wheel's velocities, α_L, α_R the front wheel's angles, r the turning radius, d the distance between any wheel and the middle of its axel, and g the distance from the back wheels to the front. Notice also the Y and X vectors.

Notice that, in order to prevent slippage, each wheel needs a different velocities, and the two front wheels need to have different angles. Below are the equations we used for determining these values.

$$\begin{aligned} r =& \frac{g}{\tan(\alpha_R)} + d && \\ \frac{\omega g}{\sin(\alpha_R)} =& V_{FR} && \text{Determines } \omega \\ \frac{\omega g}{\sin(\alpha_L)} =& V_{FL} && \text{Determines } V_{FL} \end{aligned}$$

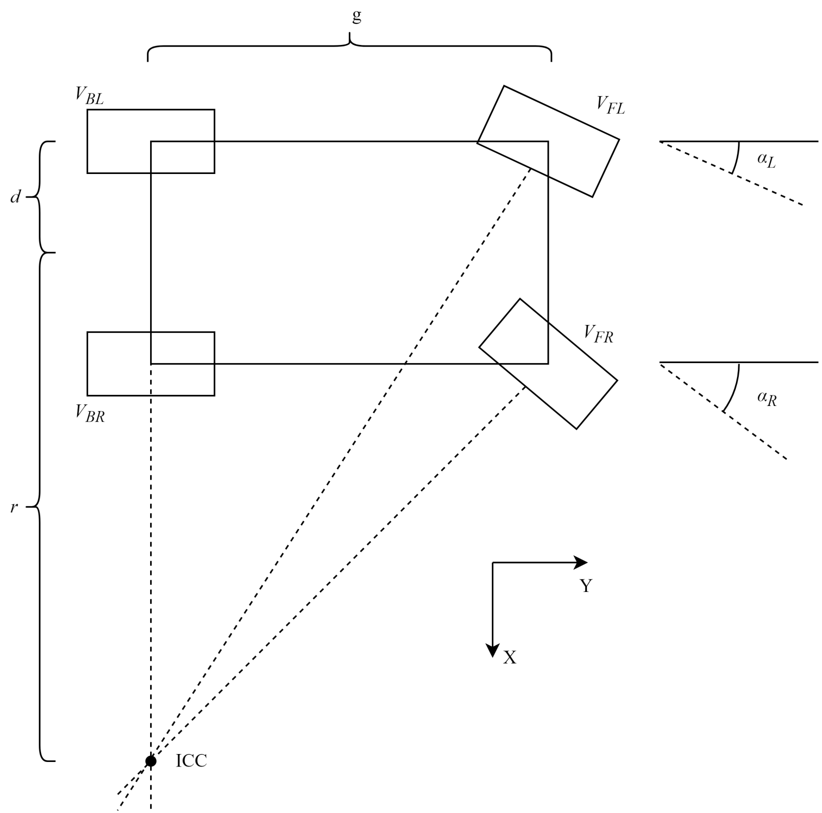

Figure 7: Ackerman diagram

$$
\begin{aligned}
\alpha_L =& \tan^- 1 \left(\frac{g}{r+d}\right) \\
\omega(r-d) =& V_{BR} \\
\omega(r+d) =& V_{BL}
\end{aligned}
$$

Once these values are determined, we calculate the total vehicle velocity $V = \omega r$ and use V and ω to calculate the position and rotation.