车轮直径：0.55m

车体质量：135kg

人：70kg

阻力：可以定一个常数

力矩：3.0Nm

减速器：30：1，15：1

转换速度18km/h

a=(tau/r=F_go)/m-F_drag

```
m_car=130;
m_per=70;
tau=90;
d=0.55;
r=d/2;
F_go=tau/r
```

```
F_go = 327.2727
```

```
a=F_go/(m_car+m_per)/1.4
```

```
a = 1.1688
```

```
```

```
<!-- Ecocar plugin -->
<gazebo>
  <plugin name="EcocarPlugin" filename="libEcocarPlugin.so">
    <steering_p_gain>6000</steering_p_gain>
    <steering_i_gain>0</steering_i_gain> <!-- PID parameters selected arbitrarily -->
    <steering_d_gain>100</steering_d_gain>
    <steering_max_force>5000</steering_max_force>
    <max_brake_pressure>15</max_brake_pressure>
    <gravity>9.8</gravity>
    <rho_air>1.15</rho_air>
  </plugin>
</gazebo>
```

```
//const double A_front = 0.8575;

//const double Cd = 0.1874;

math::Vector3 dragForce = -0.5 * rho_air * A_front * Cd * linearVel.GetSquaredLength() * linearVelNormalized;
```

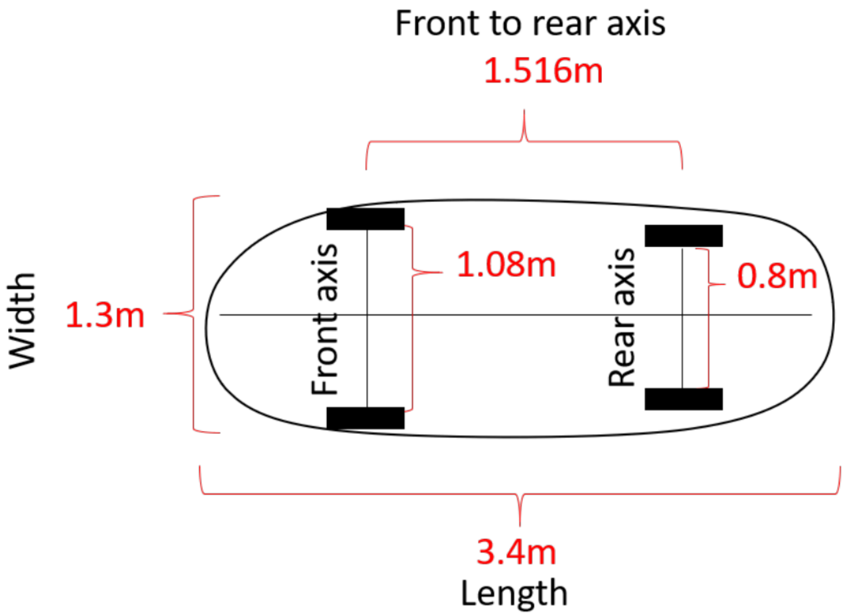


Figure A.1: The dimensions of the Ecocar

As can be seen in figure 10.15 the speed is between 25 and 24 kmph during the turn. The turn signal is given at t=22.8s and the smooth and stable steering output can be seen in figure 10.16, showing the stable steering output throughout the turn. From this it can be seen that it is possible for the car to clear a 90-degree turn with turn radius 7.5m at 25kmph, however the high speed pushes the car right from the middle of the road and closer to the right hand barrier. This can be a problem after the turn as the reason for driving in the middle of the road is to have as much steering margin as possible.

Drag force

The drag force is modeled by the following equation:

$$\vec{F}_{drag} = -\frac{1}{2}\rho A_{front} C_d |v|^2 \hat{v} \tag{2.7}$$

where ρ is the density of air, A_{front} is the cross-sectional area, C_d is the drag coefficient and v is the relative velocity between the air and vehicle. The vector $\hat{v}$ is the normalized velocity vector, giving the direction of the relative velocity. The drag is always working against the direction of the vehicle.

```
A_front = 0.8575;
Cd = 1.0;
rho_air=1.15;
g=9.8
```

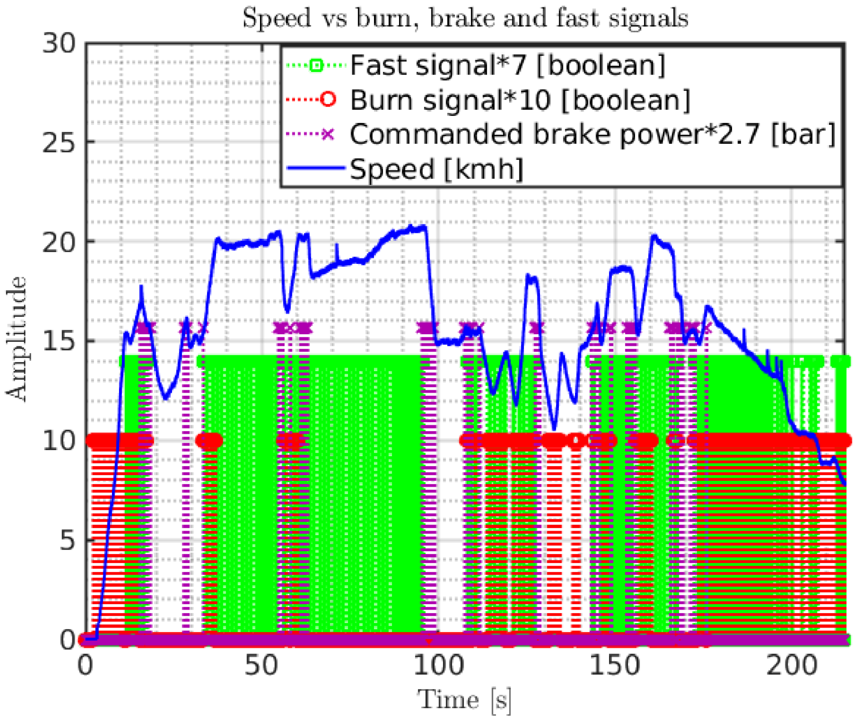
```
g = 9.8000
```

```
F_drag=-0.5*A_front*Cd*rho_air*36
```

```
F_drag = -17.7502
```

```
a_drag=F_drag/130
```

```
a_drag = -0.1365
```



In figure 11.1 the speed control throughout the lap can be seen. The amplitudes of burn and brake signals are amplified for visual purposes. Braking is only done when either switching from fast to slow speeds, or if the car is coasting downhill and accelerating above the maxspeed, whether fast or slow. It should be noted that throughout the lap the speed measurements are seen to occasionally spike. These spikes take 200ms to settle. Furthermore, at t=12s a switch from 1st to 2nd gear can be seen. In 2nd gear the car accelerates significantly slower.

```
a_1_gear=15/3.6/8
```

```
a_1_gear = 0.5208
```

```
a_2_gear=3/3.6/3
```

```
a_2_gear = 0.2778
```

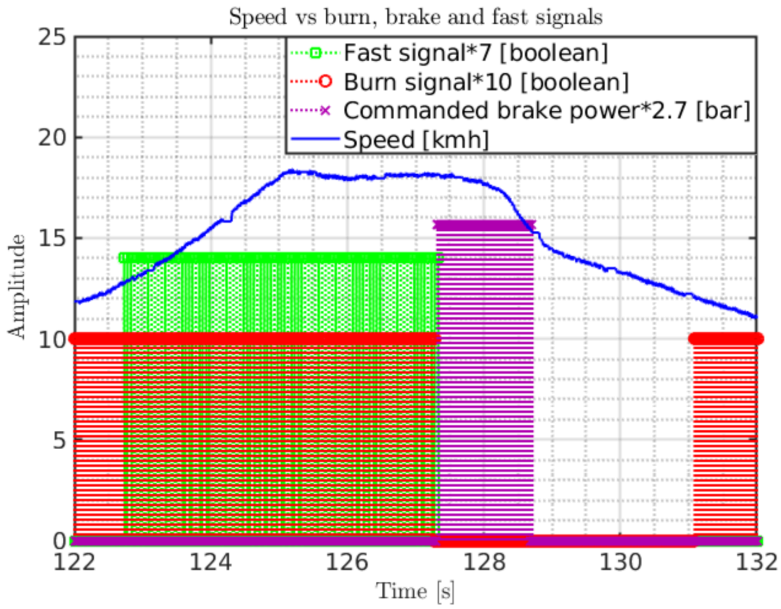


Figure 11.15: Speed control at t=122s to 132s (Challenge 1)

Another thing to note is that at t=125s the electronic system switches to 2nd gear while still driving uphill, resulting in the inability to accelerate up to 20kmph.

```
a_1_gear_test=6/3.6/3
```

```
a_1_gear_test = 0.5556
```