Polaris GEM e2 Vehicle

Hang Cui

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Hardware of Polaris GEM e2 Vehicle

Velodyne VLP-16 LiDAR (Top LiDAR)
ZED2 Stereo Camera (Front Camera)
Delphi ESR 2.5 Radar (Front Radar)
ProPak6 & SPAN-IGM-S1 (GNSS/INS)
PACMod (DBW Kit)
AStuff Spectra 2 (2x RTX 2080 Ti)
Hardware of Polaris GEM e2 Vehicle
Software of Polaris GEM e2 Vehicle

**System:**

*Ubuntu 20.04 with ROS Noetic and Gazebo 11*

NVIDIA Driver Version: 450
CUDA 11.0.3
OpenCV 4.6.0
Pytorch 1.7.1
More to add ...
Simulator of Polaris GEM e2 Vehicle

**System & Software:** Ubuntu 20.04, ROS Noetic and Gazebo 11

**Environment:** Highbay

**Github:** [https://github.com/hangcui1201/POLARIS_GEM_e2_Simulator](https://github.com/hangcui1201/POLARIS_GEM_e2_Simulator)
Simulator of Polaris GEM e2 Vehicle

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Simulator of Polaris GEM e2 Vehicle

The high bay enviroment in real size **with matched GPS coordinates.**

Lat: 40.09302494  
Lon: -88.23575484  
x: -5.5  
y: -21
Simulator of Polaris GEM e2 Vehicle

The high bay environment in real size with matched GPS coordinates.
Simulator of Polaris GEM e2 Vehicle

Lat: 40.09302494
Lon: -88.23575484
Simulator of Polaris GEM e2 Vehicle
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Simulator of Polaris GEM e2 Vehicle
Steering Wheel to Front Wheel Calibration

\[
\delta_s = -0.1084\delta_f^2 + 21.755\delta_f
\]
\[
\delta_f = \arctan\left(\frac{2}{\tan \delta_l + \tan \delta_r}\right)
\]
Steering Wheel to Front Wheel Mapping
# Steering Wheel to Front Wheel Calibration

<table>
<thead>
<tr>
<th>Left Wheel</th>
<th>Right Wheel</th>
<th>Middle Angle</th>
<th>Steering Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.6</td>
<td>4.2</td>
<td>4.4</td>
<td>90</td>
</tr>
<tr>
<td>10.5</td>
<td>8.5</td>
<td>9.4</td>
<td>180</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>12.9</td>
<td>270</td>
</tr>
<tr>
<td>18.8</td>
<td>17.3</td>
<td>18</td>
<td>360</td>
</tr>
<tr>
<td>24.2</td>
<td>22.4</td>
<td>23.3</td>
<td>450</td>
</tr>
<tr>
<td>31.7</td>
<td>26.5</td>
<td>28.9</td>
<td>540</td>
</tr>
<tr>
<td>38</td>
<td>33</td>
<td>35.3</td>
<td>630</td>
</tr>
</tbody>
</table>

Steering wheel was controlled by program to rotate at a particular angles, namely 0, 90, 180, 270, 360, ..., etc.
Lane Detection and Tracking - Bicycle Model
Lane Detection and Tracking - Pure Pursuit Controller

\[ \dot{x} = v \cos \theta \]
\[ \dot{y} = v \sin \theta \]
\[ \dot{\theta} = \frac{v}{L} \tan \delta_f \]
\[ \dot{\nu} = a \]
\[ \delta_f = \tan^{-1} \left( \frac{2L \sin \alpha}{l_c} \right) \]
Lane Detection and Tracking - Stanley Controller

\[
\delta_e = \tan^{-1}\left(\frac{ke}{v}\right)
\]

\[
\theta_{ref} = \theta_{ref} - \theta
\]

\[
\delta_f = \theta_e + \delta_e
\]

\[
e = [\sin\theta_{ref}(x-x_{ref}) - \cos\theta_{ref}(y-y_{ref})]
\]

$L$: wheelbase
$e$: cross track error
$\theta_e$: heading error
$\delta_e$: cross track steering
Demo of Pure Pursuit Controller in Simulator

Github: https://github.com/hangcui1201/POLARIS_GEM_e2_Simulator
Demo of Pure Pursuit Controller in Real World

Github: https://github.com/hangcui1201/POLARIS_GEM_e2_Real
Demo of Stanley Controller in Simulator

Github: https://github.com/hangcui1201/POLARIS_GEM_e2_Simulator
Demo of Stanley Controller in Real World

**Github:** [https://github.com/hangcui1201/POLARIS_GEM_e2_Real](https://github.com/hangcui1201/POLARIS_GEM_e2_Real)
Others

Lab Safety Certificate: [https://old.drs.illinois.edu/Training/TrainingChecklist](https://old.drs.illinois.edu/Training/TrainingChecklist)

Safety Procedures and Documents: [https://wiki.illinois.edu/wiki/display/GAG/a%29+Safety+roles+and+procedures](https://wiki.illinois.edu/wiki/display/GAG/a%29+Safety+roles+and+procedures)
Thanks!