1 Requirement

This lab involved driving the cart in a square with rounded corners. The intent of the lab was to get an hands-on experience of navigating the cart, by monitoring its sensors (like the GPS, the compass and the odometer) periodically and controlling the actuators accordingly. The goal was to keep the cart on a straight path for a fair amount of time and making it to turn around the corners.

2 Introduction

To realize the requirement of driving around the cart in a square, a driver component (called square) was written. This report details the square driver component in brief and concludes with a summary of the results obtained.

3 Implementation

The square driver is required to keep tab on the current heading and to calculate the error between the current heading and the desired heading to control the direction in which it needs to go. To achieve this, two classes were defined and instantiated. The classes and their respective functions are given below.

- The Odometer class
  - last_uptodate()
    Check if the last trip distance reading is up to date.
  - update_last(lastdist)
    Update the last trip distance reading before starting a new trip.
  - update_trip(curdist)
    Update the current trip distance.
  - reset_trip(curdist)
    Reset the current trip distance to 0.

- The HeadingController class
  - get_inv_turn_radius(cur, final, lim)
    Get the inverse turn radius depending on the current heading error.
Get the heading error (angle) which is the difference between the current heading and the desired heading.

Clamp the inverse turn radius depending on the maximum limit.

At each time step (1/10th of a second), the square driver uses the HeadingController to compute its heading error and sets the inverse turn radius accordingly. The trip distance in the Odometer is updated at each time step. When the distance equals the length of the side of the square (10m in this case), the mode of the cart is changed to turning, and the desired heading is set accordingly.

When turning, if the error goes below 15 degrees, we set the mode back to straight and reset the trip distance in the Odometer to begin the following the next side of the square. 15 degrees is sufficient to compensate the time it takes for the cart to actually start heading in the straight path.

4 Results

The table below shows a snippet of the readings collected during a field test of the cart being driven in a square. These readings confirm how the cart changes its mode from turning to straight when the heading error goes below 15 degrees.

During the field test, it was observed that the cart mostly follows a square path if the terrain is completely smooth. The speed, and consequently the dynamics of the cart are affected if the field has a slope or is uneven. The cart overshoots along the turns until it again comes back to the desired stable position following along the straight path. The p-coefficient which scales the heading error to obtain the inverse turn radius was found to be 0.012.
Table 1: Sample of the data collected during a trial run of the cart

<table>
<thead>
<tr>
<th>Heading</th>
<th>Distance</th>
<th>Speed</th>
<th>Mode</th>
<th>Turn radius</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>159.2</td>
<td>1555.85124</td>
<td>0.990970633355</td>
<td>turning</td>
<td>-0.2496</td>
<td>-20.8</td>
</tr>
<tr>
<td>160.52</td>
<td>1556.01402</td>
<td>0.994275442518</td>
<td>turning</td>
<td>-0.23376</td>
<td>-19.48</td>
</tr>
<tr>
<td>162.47</td>
<td>1556.06828</td>
<td>0.993656387343</td>
<td>turning</td>
<td>-0.21036</td>
<td>-17.53</td>
</tr>
<tr>
<td>164.73</td>
<td>1556.14967</td>
<td>0.995369776571</td>
<td>turning</td>
<td>-0.18324</td>
<td>-15.27</td>
</tr>
<tr>
<td>167.26</td>
<td>1556.25819</td>
<td>0.999992407209</td>
<td>straight</td>
<td>-0.15288</td>
<td>-12.74</td>
</tr>
<tr>
<td>167.26</td>
<td>1556.36671</td>
<td>1.00491866064</td>
<td>straight</td>
<td>-0.15288</td>
<td>-12.74</td>
</tr>
<tr>
<td>169.18</td>
<td>1556.50236</td>
<td>1.017582852</td>
<td>straight</td>
<td>-0.12984</td>
<td>-10.82</td>
</tr>
</tbody>
</table>

Figure 2: Graph depicting the route traced by the cart against the ideal route