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GPS FOLLOWER LAB REPORT

In the first lab we designed a heading controller that adjusts the turn radius of the steering on each clock cycle to minimize the difference between the current compass heading and the desired heading.

In the second lab we need to use the same controller to follow a course that is defined by the list of pints in the Earth coordinate system with longitudes and latitudes.

In this assignment our component is given a list of GPS positions P=(Plat, Plon) , lat and lon stand for longitude and latitude.

We designed a GPS driver that follows GPS course as given :

```
course = [[1,39.181917,-86.5221208333,1.5,3.0],\
[2,39.1818975,-86.521724,1.5,3.0],\
[3,39.182143,-86.5217033333,1.5,3.0],\
[4,39.182199,-86.5220985,1.5,3.0],\
[5,39.1819156667,-86.522309,1.5,3.0],\
[6,39.1819645,-86.522398,1.5,3.0],\
[7,39.1820415,-86.5223095,1.5,3.0],\
[8,39.1821313333,-86.5223926667,1.5,3.0],\
[9,39.1822116667,-86.522302,1.5,3.0]]
```

The course waypoints are defined by the course code above. Each line shows the sequence number, lattitude(deg), longitude(deg) , LOB radius in meters, speed (m/s).

Here are the information of components :
1- Sequence number : an integer >= 0, that unifies the waypoint. The sequence number must be unique. The waypoints with the same positional info will have different sequence numbers.

2- Latitude : range of [-90, 90] that represents the degrees of latitude.
3- Longitude : range of [-180,180] that represent the degrees of longitude.
4- Lateral Boundary Offset is the number represents the radius in meters of a circle centered at the given lat/lon.
5- Speed Limit : the number specifies the maximum speed in meters per second. The speed is only allowed between the current waypoint to the next.

In the previous assignment we had a two state control automaton. However, in this assignment we have only one state, which is trying to reach the target waypoint. We it reaches the target waypoint, it selects a new target iterarively.

The architecture of the GPS follower system is the same with square driver, but both the GPS component and the compass component in the square driver provide a heading value.

The important difference between GPS and square driver is GPS heading is only accurate the vehicle is moving, while the Compass is always accurate. So, if the GPS is wrong at the beginning, it is better to use it instead of the Compass.

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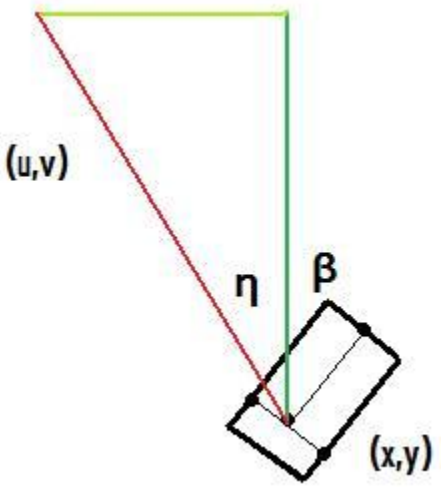
In the GPS follower we needed to take into account the bearing and distance to target waypoint. Here are some problems in calculations :
1- Latitude and Longitude units are in degrees but we use meters for measuring distance/
2- We converted the degrees to meters 1 degree = 111.122 meters. But this only for latitudes (between one latitude to the other each degree shows 111.122meters) However, for our course, due to the coordinates of the course each degree of longitude corresponds to ~86.358 meters.

Here is the formulas of Planar distance and bearing :

$$\sqrt{(u-x)^2+(v-y)^2}$$

$$\eta = \arctan\left(\frac{u-x}{v-y}\right)$$

Where you can see the parameters below :



When we ran the code on the visualizer, here are the visuals we got and the visuals from our log files.

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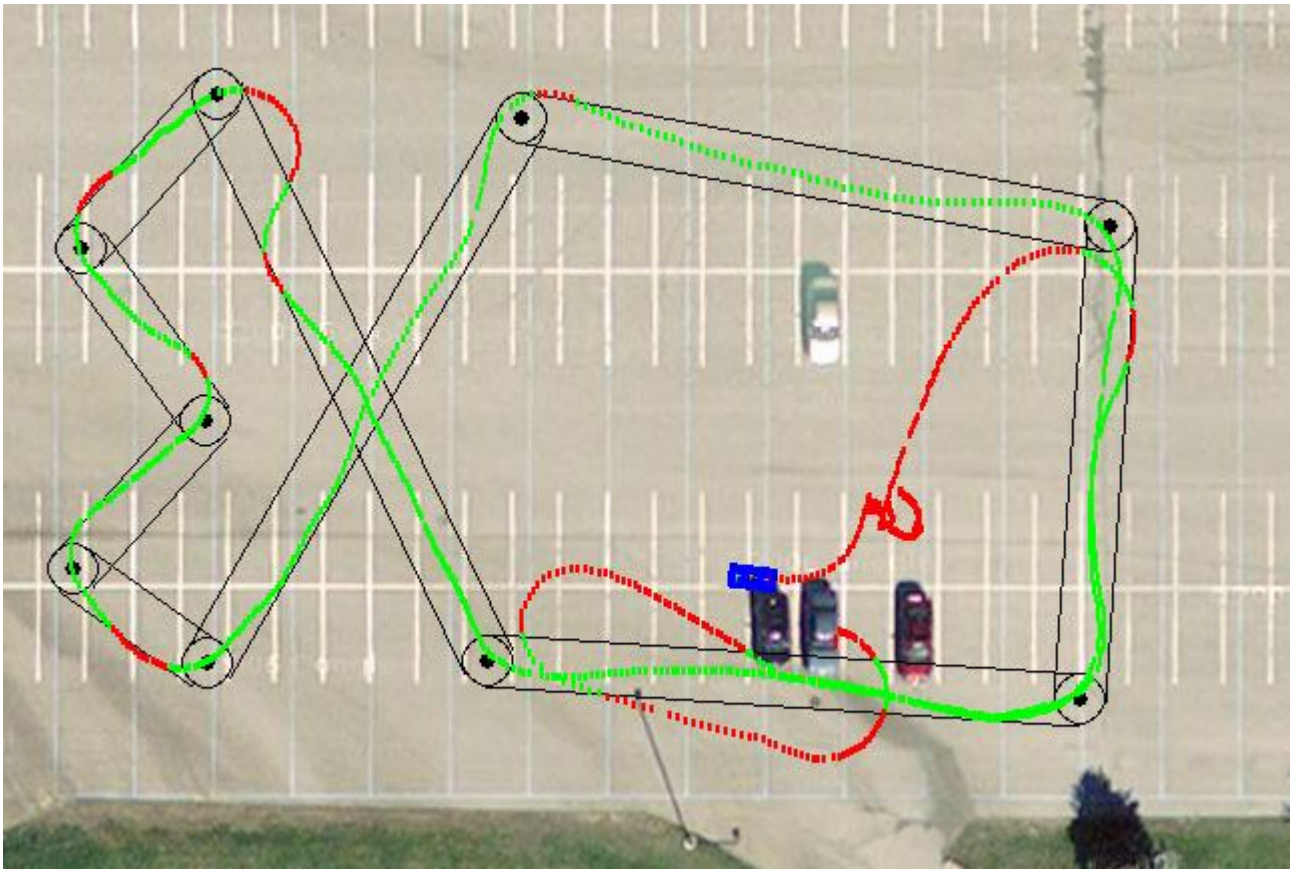

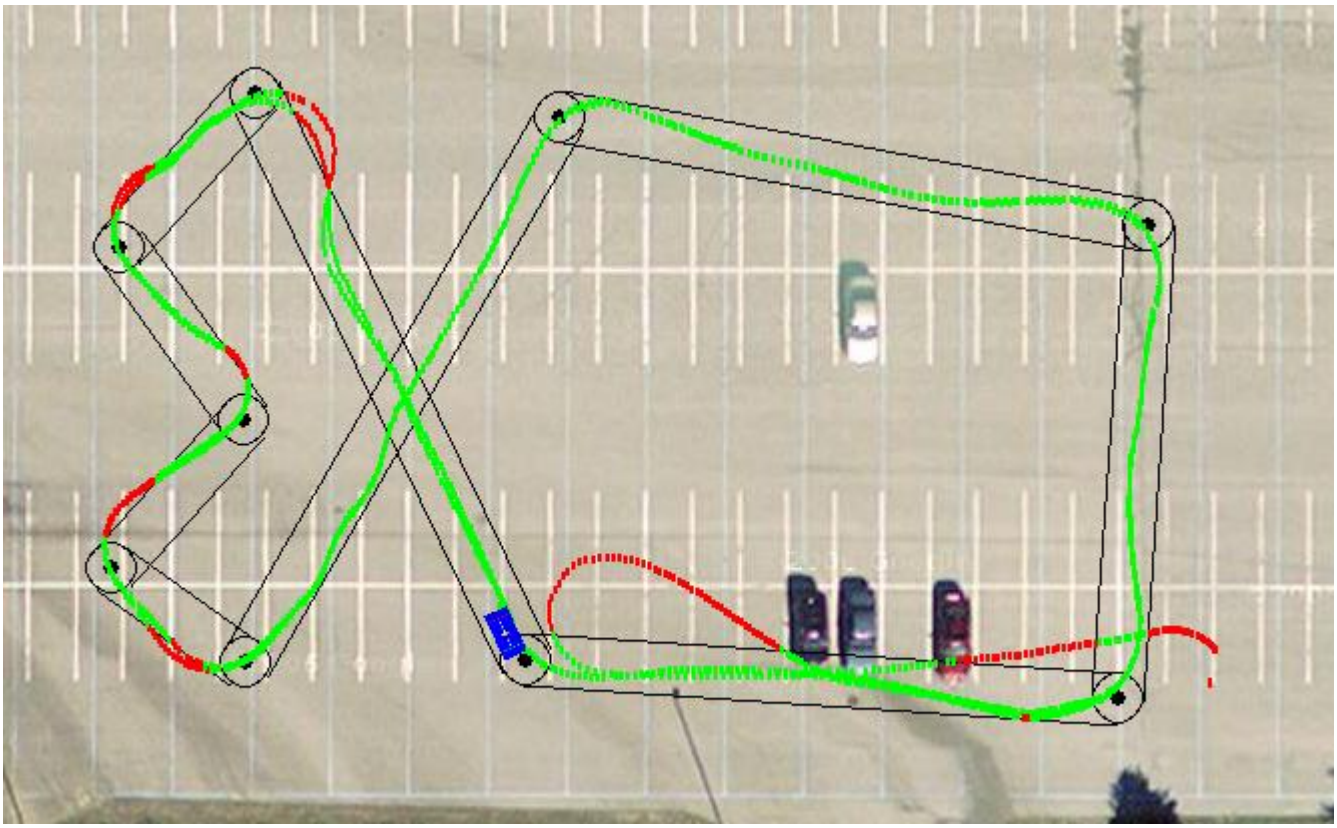

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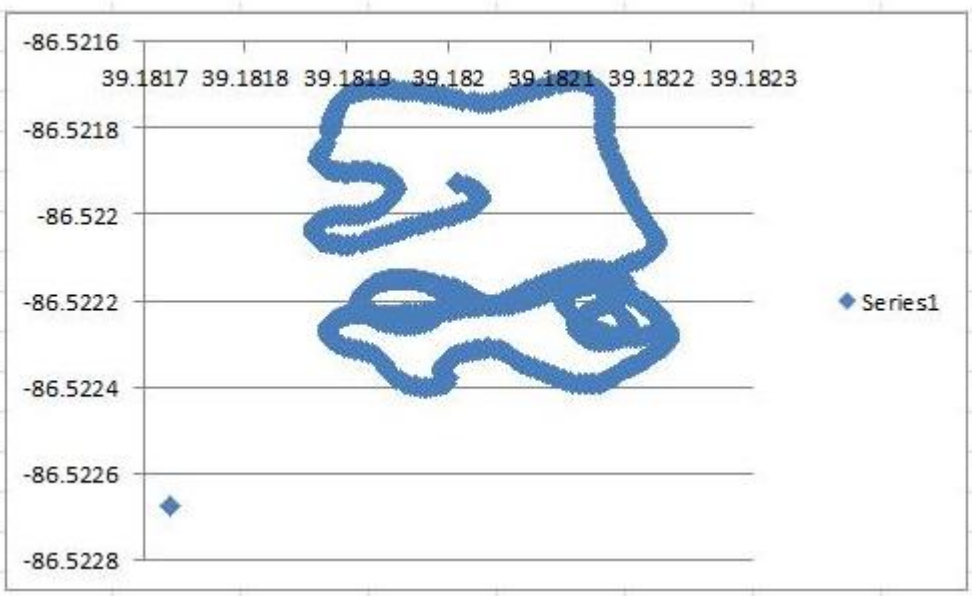

As you see in the visuals, even we start from the wrong GPS, the cart is able to correct by using GPS heading. We have small steering off the road, but generally our cart successfully follows the GPS coordinates.