

## Bulichev Oleg HW5 SIS

1) My trajectory.

My partner is Mikhail Bortnikov.

We use the same robot, but our sensor position is different.  
So there is the area.



Max distance for ultrasonic is 250 mm, so the area is less.

I provide to Mike encoders data, gyro and dist to walls. I know that ultrasonic has the min dist which is equal 30mm, but i put the robot closer than this distance, because it can provide more interesting results for data fusing. Of cause i provide all params of robot.

2) Receiving data

I receive all params about robot. It has ultrasonic, encoders and gyro sensor. Ultrasonic sensor is installed perpendicularly to the movement.

I know, that it was controlled by velocity, but i don't have this data. So, i assume that i can use encoders data for controlling it. So i use this data as control data in the model. Also i assume that i don't have any slipping.

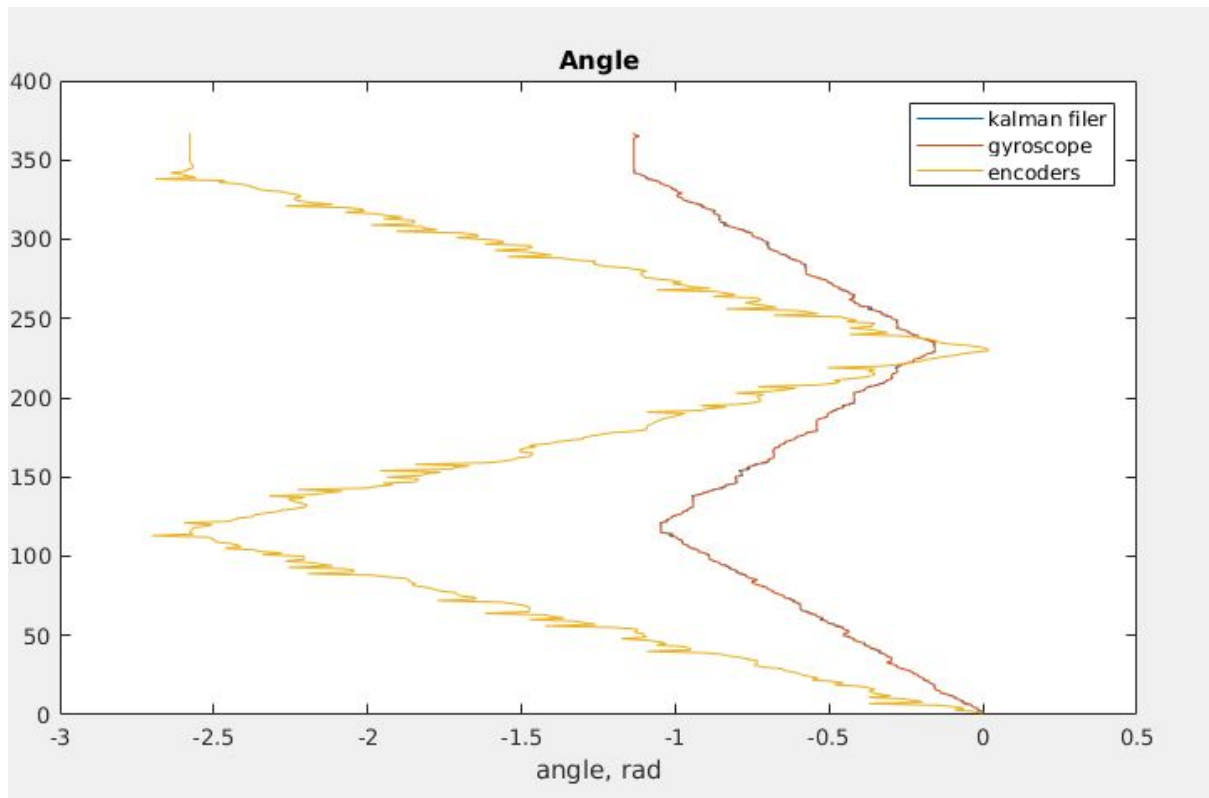
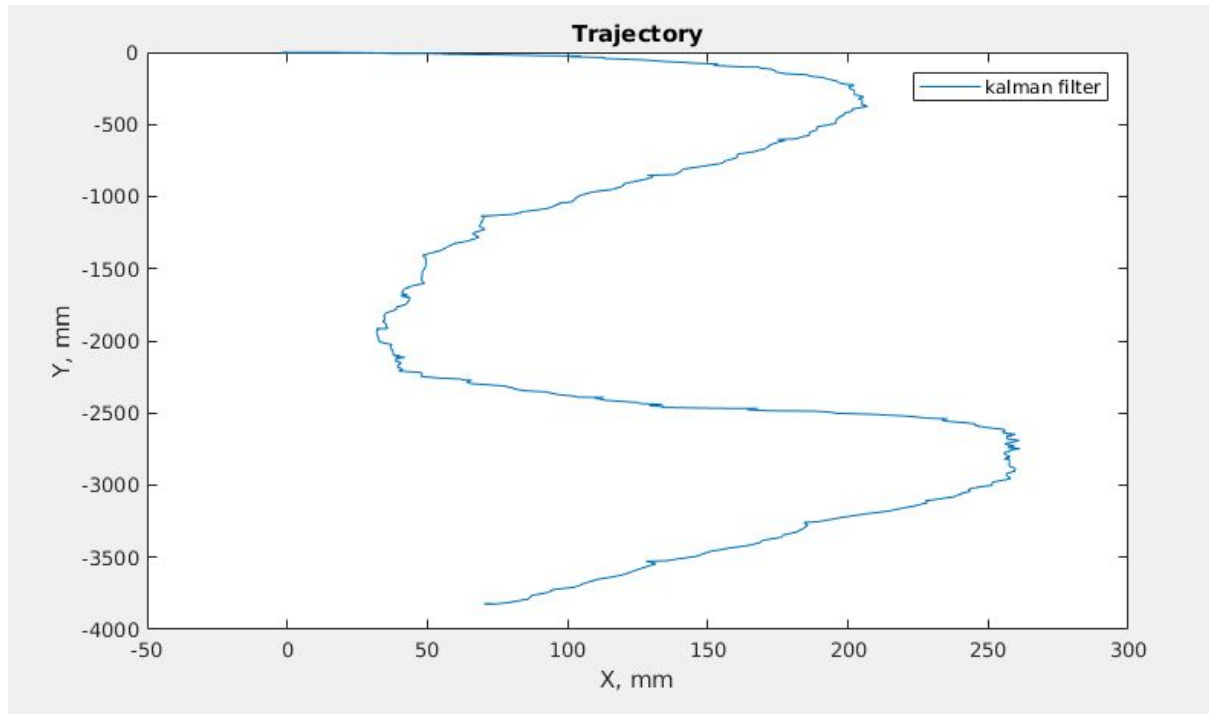
Model of this robot - common differential drive.

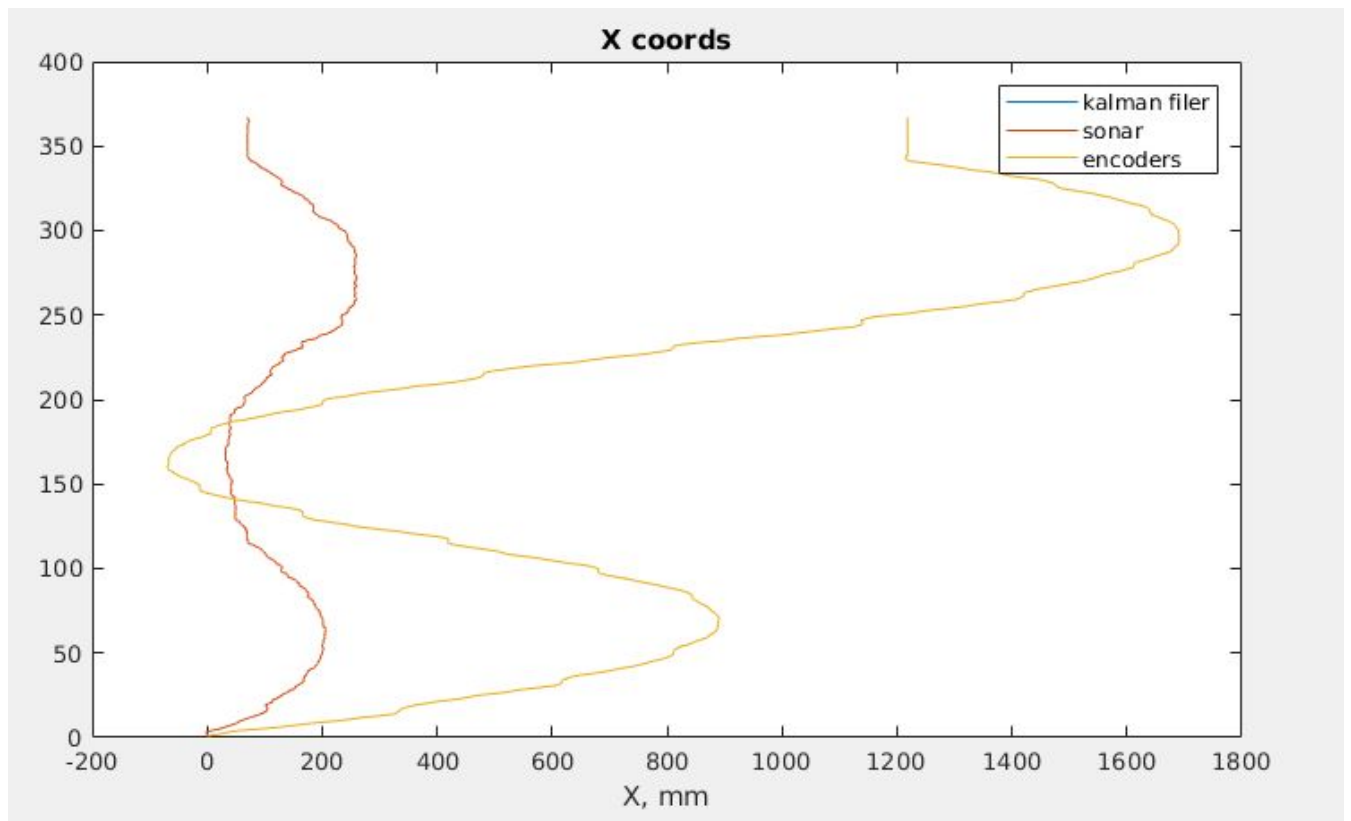
Firstly, I decided to implement pure **kalman filter**.

So, the purpose is receiving X,Y, Theta variables.

According to my datasets, i decide that i can measure only X and theta variables. X variable is receiving by solving geometry task (  $\text{dist from ultrasonic} * \cos(\text{data from gyro})$  ).

There is the results.





This results looks strange. I spent about 2 day and i don't solve this problem. It can be seen that qualitatively, both X coords and angles plots look the same. But The data from encoders calculates incorrectly, because the angle cannot be more than 1.4 rad (Bortnikov said that robot's trajectory looks like wave (as received trajectory)).

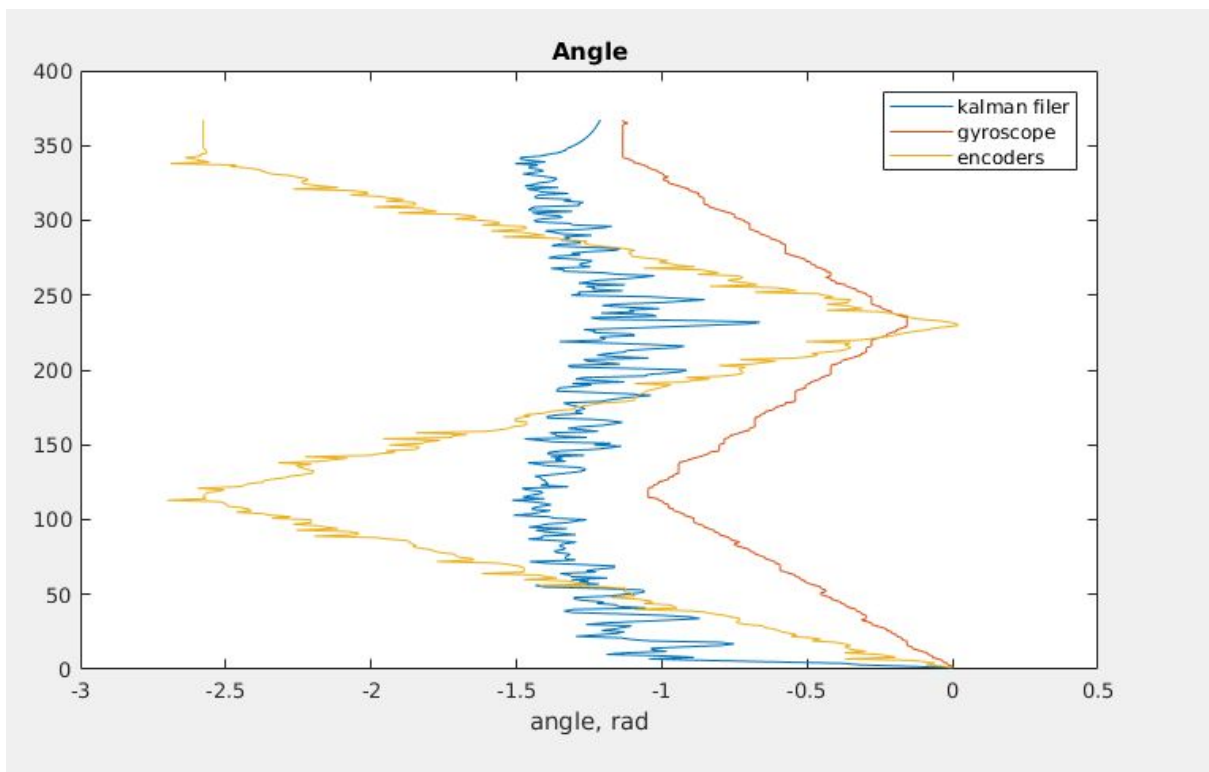
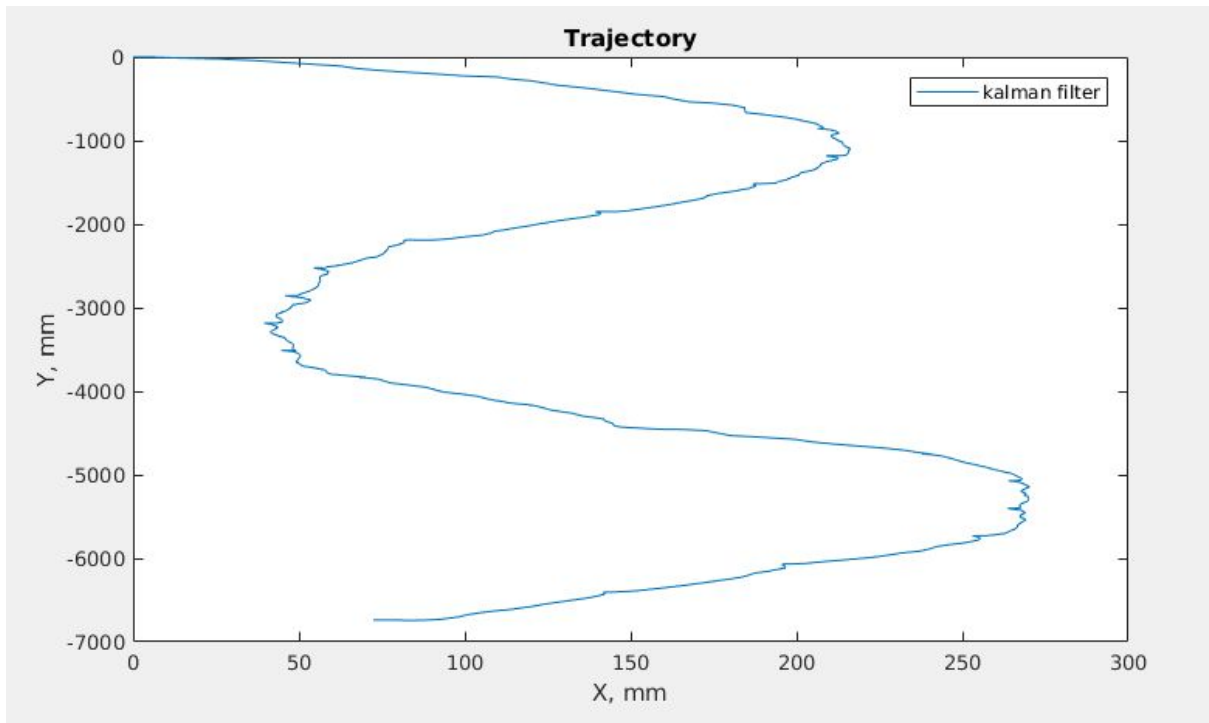
So, according this information, i tuned the filter, that i don't trust encoders. At the result, the data from sonar and gyro, almost the same as resulting of filtering.

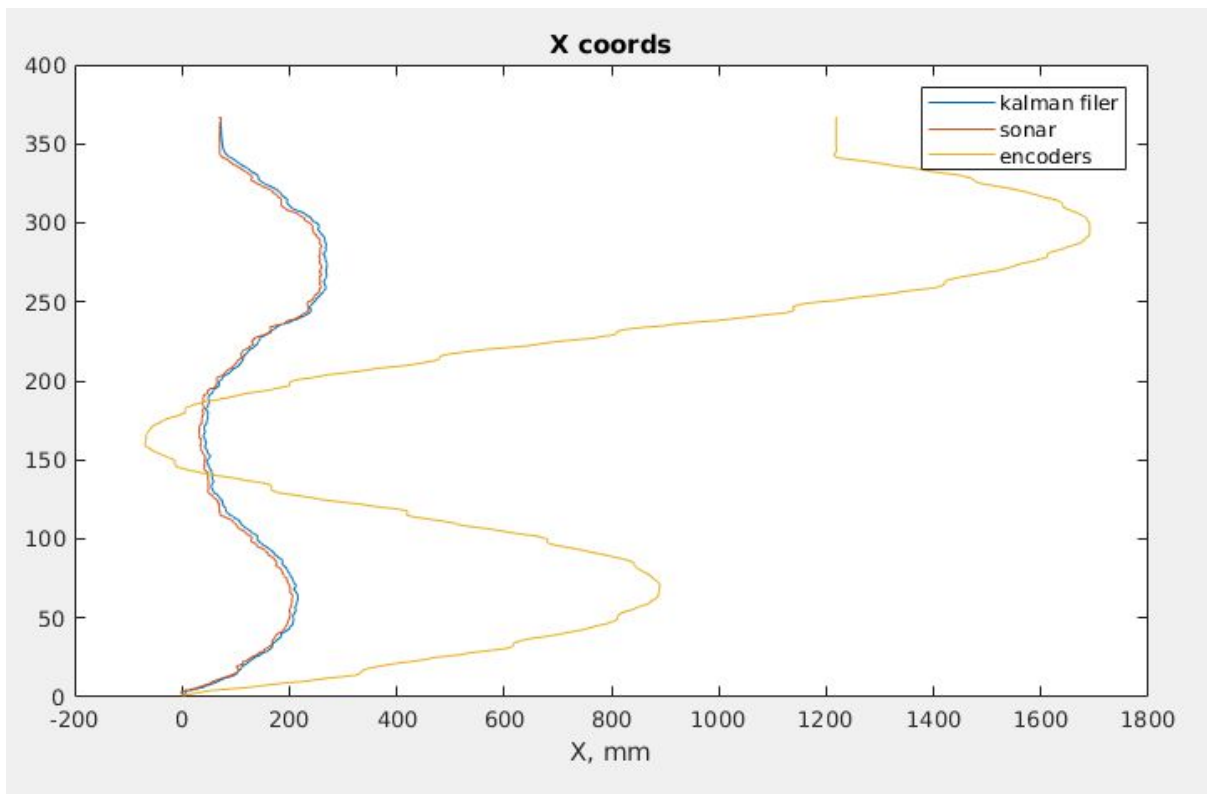
## Extended Kalman

Interesting moments -

- 1) I need to find jacobians only for control matrix, because in other places it is become identity.
- 2) Firstly, I calculated it for each step and i need to wait about 39 seconds. But after this i change my code and calculate it only ones, and in code I just change the params for it.

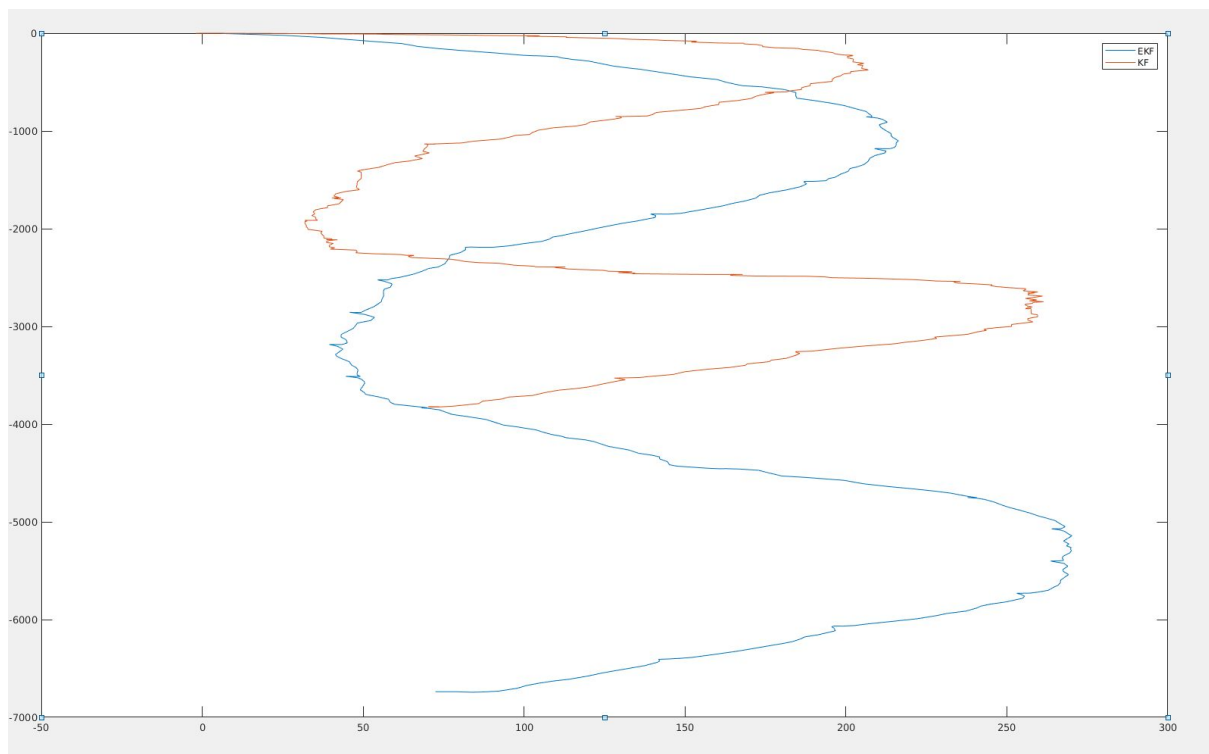
There are plots.





I don't change the variance.

This plot compare trajectories from both kalmans.

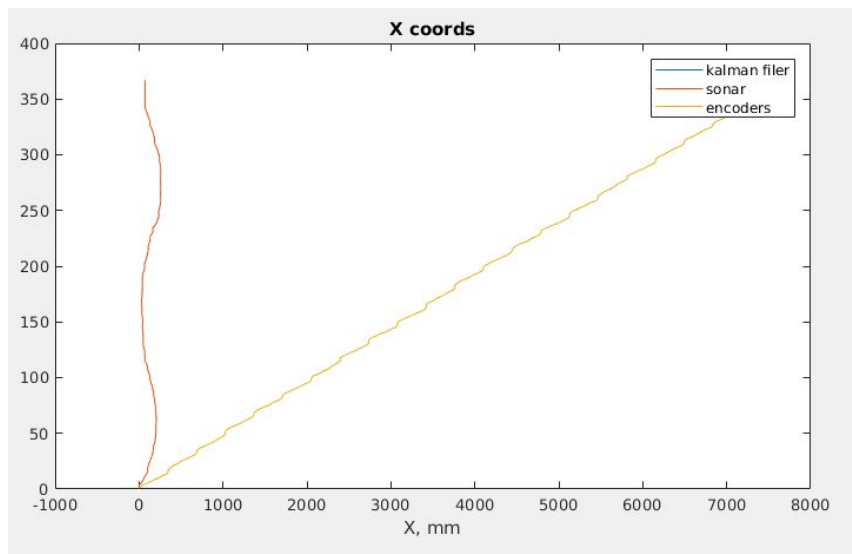
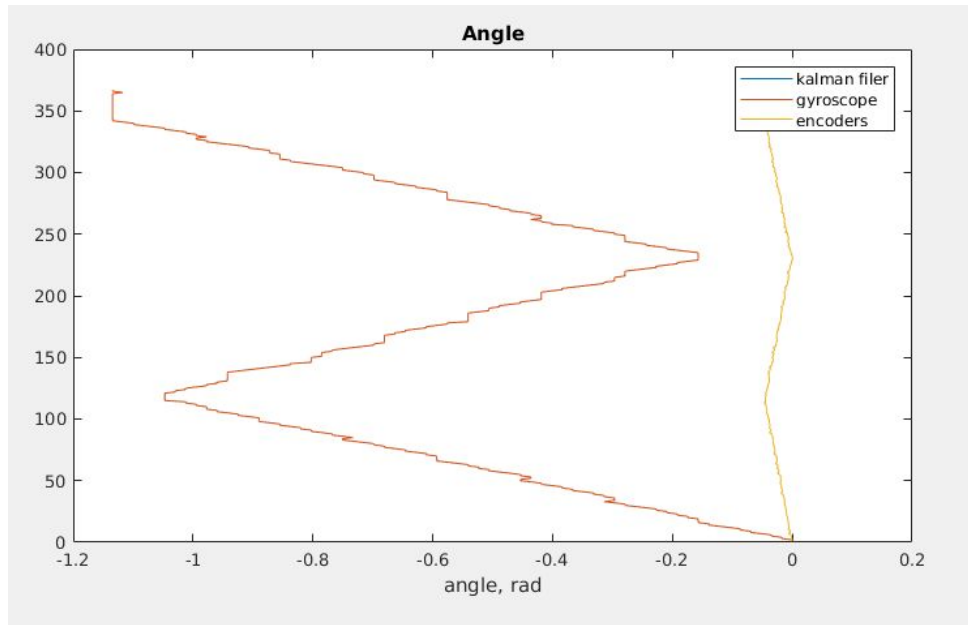


Y coordinate don't have ground truth sensor (only encoders), and this problem can be seen on the plot. It looks the same in general, but with shift in y coordinate.

**At the result**, i understand that i don't have good data set and implementing other filters does not make sense. I cannot compare them correctly.

### Problems

The strange moment that encoders calculates in degrees, but if i change it to rad measurement (funny moment, that i can't use deg2rad function, because it has limits in 360 degree. I waste about 1 hour to find this bug. I solve it using this relationship "1 rad - 57.3 deg") , i receive this plots, which looks more strange than previous plots.



Probably, this robot cannot be calculated as differential drive robot, but this assumption looks silly, by the way, i cannot to find the solution for it.

**Code activation** - use matlab and just run \*.m files