

## Project Unscented Kalman, Project 2 Term 2

I worked on two files:

ukf.cpp  
tools.cpp

### 1. ukf.cpp

Here I did the following steps:

- 1.1. Initialization
- 1.2. Prediction
- 1.3. Update

#### 1.1 Initialization

First, I change the parameters

```
std_a_ = 2;  
std_yawdd_ = M_PI/10;
```

Next I initialize the matrices X and P starting with line 70 to 162.

I pay attention to the type of sensor, if it is Lidar or Radar and I initialize accordingly.  
I set dt in line 153 in milliseconds.

In lines 131 to 161 I set the control flow of the program.

If I measure Lidar, I call the prediction and update function for Radar and if I measure Lidar I call the prediction and update for Lidar.

I also set the R-Matrix, next to setting it in ukf.cpp I also have to declare it in ukf.h.

#### 1.2. Prediction

Prediction works with Sigma-points so I have to declare the matrix Xsig.

I also have to define the augmentation and then generate the Sigma-points with augmentation starting in line 251.

Creating new means and Covariance P with new augmented Sigma-points starts in line 289.

#### 1.3. Update

Update Laser:

The update takes the new Sigma Points and projects them into Z-space. See lines 348 and following.

The matrix  $S=S+R_{\text{Laser}}$  is created as an updated matrix in line 371 using the update for Laser.

Update Radar"

The update with Radar follows in lines 403.

The updated S-matrix is in line 472,  $S=S+R_{\text{Radar}}$

Calculate NIS

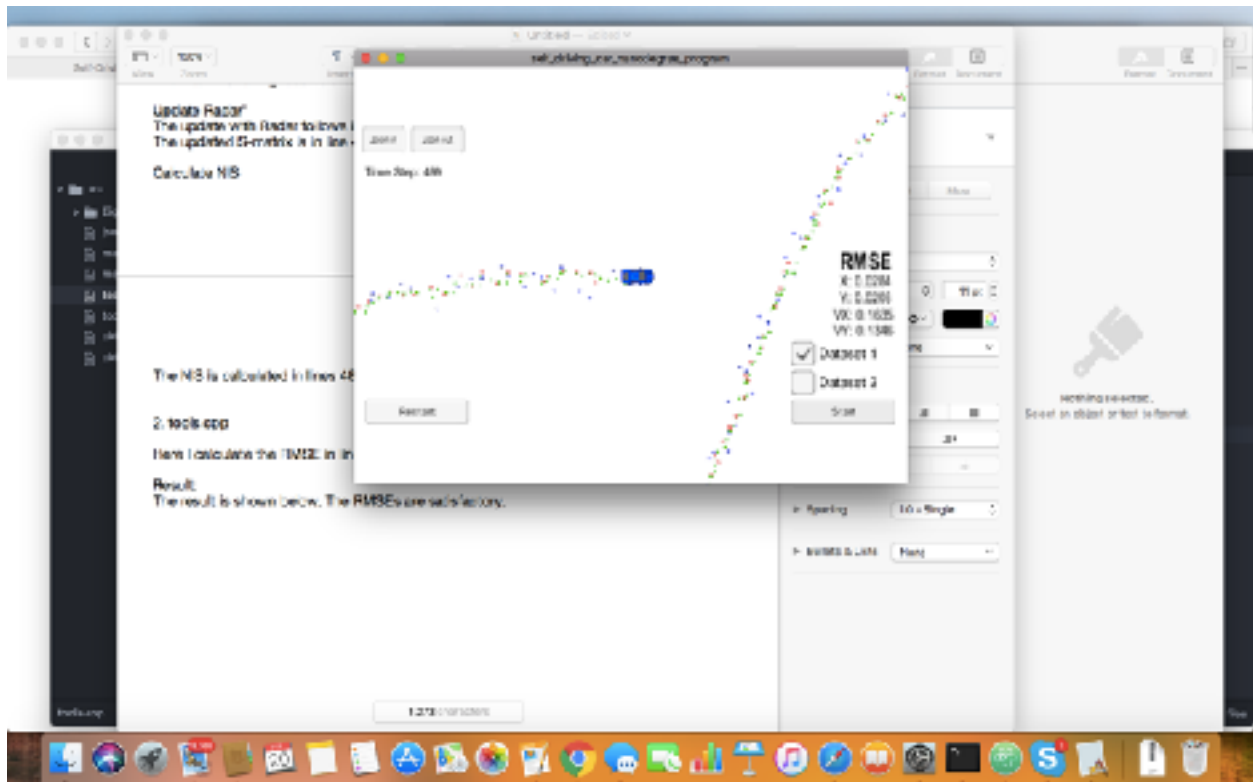
The NIS is calculated in lines 489.

## 2. tools.cpp

Here I calculate the RMSE in lines 15 and following.

Result:

The result is shown below. The RMSEs are satisfactory.



## Further thoughts

This project was more straightforward since it was similar to the EKF project. I believe I could learn more about the specifics of measurements and updates with Radar vs. Laser. Also, what about Sonar.

Fundamental Question?

I still don't understand why we use Lidar. It is similar to vision in the sense that we work with light. What is the value added in Lidar? Can't we just use vision, Radar and maybe sonar? The reason I am questioning Lidar is that it is still very expensive to actually implement in real self driving cars.

