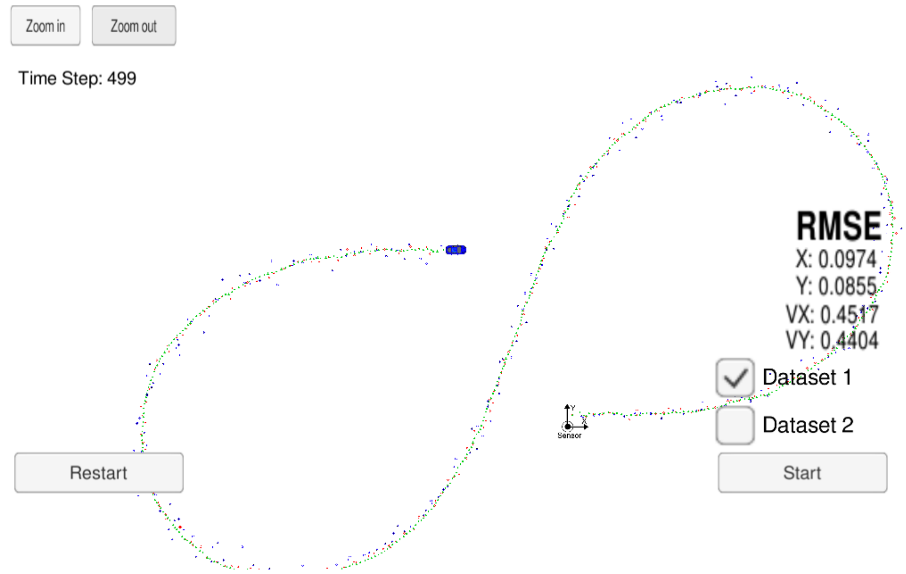
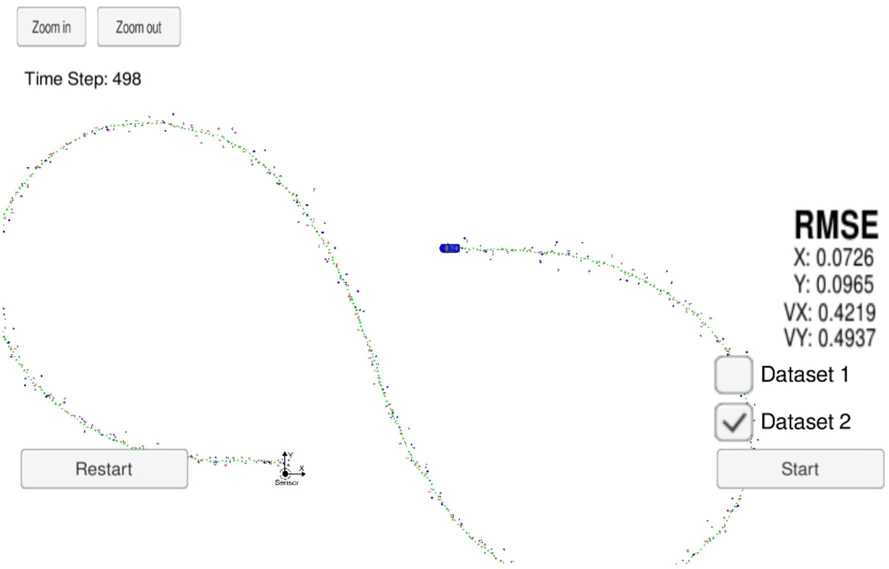
Extended Kalman Filter

Objective

Use sensor data from LIDAR and RADAR for object sensor fusion and tracking. Each estimation (depicted with a green triangle) is compared with the ground truth trajectory, and the error is displayed in RMSE format.





Code and Files

1. Project Dependencies and Environment

- cmake >= 3.5
- make >= 4.1
    - Linux: make is installed by default on most Linux distros

- Mac: install Xcode command line tools to get make
    - Windows: Click here for installation instructions
- gcc/g++ >= 5.4
    - Linux: gcc / g++ is installed by default on most Linux distros
    - Mac: same deal as make - [install Xcode command line tools]((https://developer.apple.com/xcode/features/)
    - Windows: recommend using MinGW
- Eigen library

2. My project files

(Note: the hyperlinks **only** works if you are on the homepage of this GitHub reop, and if you are viewing it in "github.io" you can be redirected by clicking the **View the Project on GitHub** on the top)

- CMakeLists.txt is the cmake file.
- Docs folder contains documents which describe the data.
- src folder contains the source code.
- Readme_EKF – describes the overall deliverable
- install-ubuntu.sh – installation script with the necessary libraries

3. Code Style

- Google's C++ style guide.

4. How to run the code (on Linux)

1. Make a build directory: mkdir build && cd build
2. Compile: cmake .. && make
3. Run it by entering ./ExtendedKF
4. Run the simulator ./term2_sim.x86_64
5. Select desired Graphics
6. Select EKF and UKF project
7. Press Start

5. Accuracy

Minimum required [.11, .11, 0.52, 0.52]
Obtained [.09, .08, .45, .44] on dataset 1
Obtained [.07, .09, .42, .49] on dataset 2

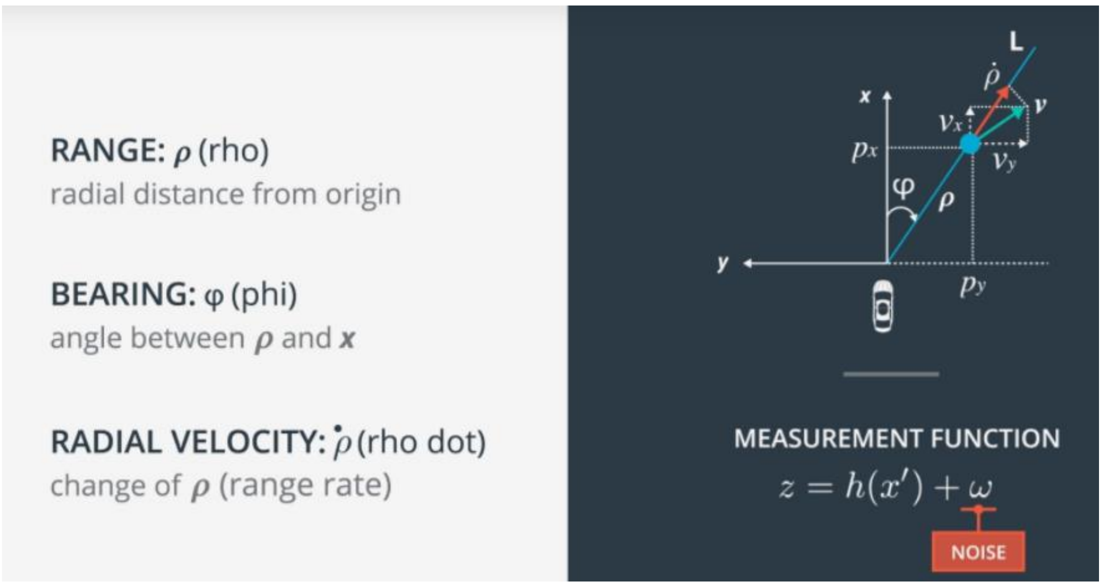
I have also tested the accuracy of the EKF when only one sensor reading was available on the second dataset. I have obtained the following RMSE errors:
Only LIDAR RMSE [.16, .15, .6, .49]
Only RADAR RMSE [.24, .33, .6, .81]

From the obtained RMSE data we observe that the radar measurements are noisier. The EKF is capable of utilizing both RADAR and LIDAR measurements to provide a more robust estimate and overall better results than each individual sensor.

6. Sensors and measurements

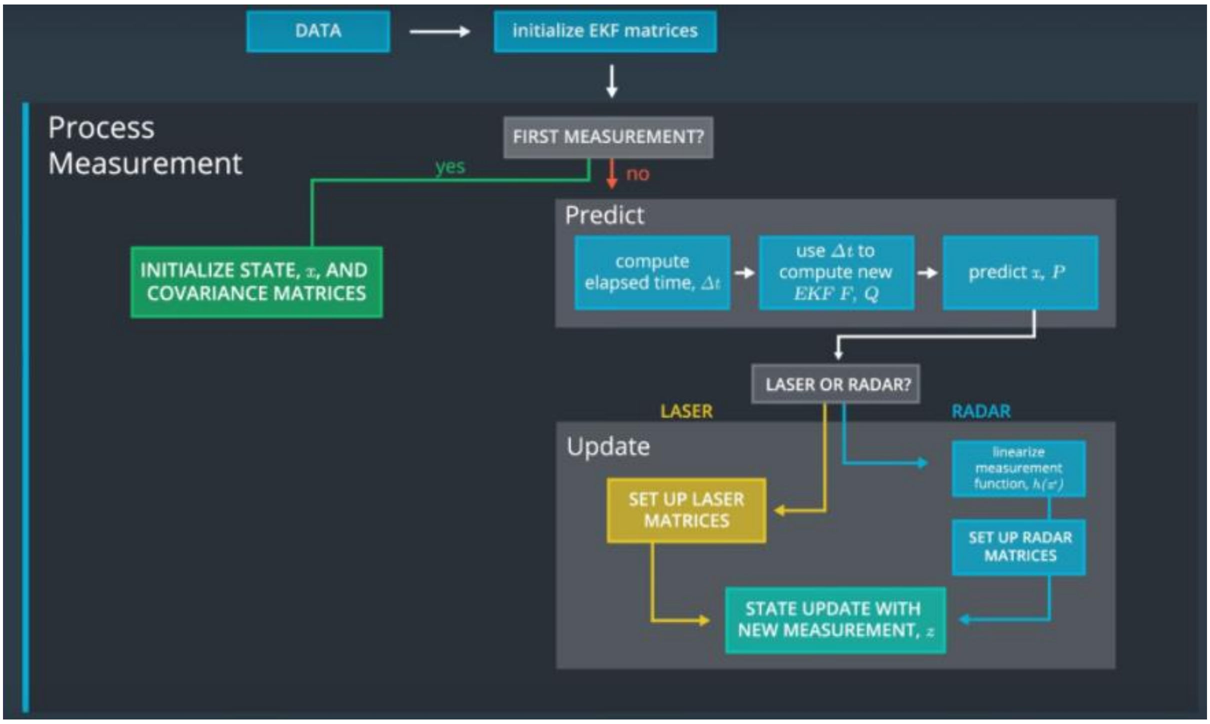
LIDAR sensors can detect static objects and are less sensitive to weather and illumination conditions, however they have a very high purchasing cost. The prices of LIDARs rises with the number of scanning layers. Some LIDAR sensors can offer as output point clouds or objects (depending on how they are set to give the output). Generally we get x,y,z information for each scanned point. For the case of the project the x and y coordinates are enough.

RADAR sensors are great at detecting moving objects made out of metal material, however they fail to detect items made of porous plastic or wood. Even more, RADARs usually have a narrow field of view, and to compensate for this issue they are usually used in arrays that slightly overlap in order to obtain larger fields of view. One of the biggest disadvantages of RADARs is that they omit objects in order, not to over-report. With the raw radar information we can determine the distance and speed of the road object.



7. Extended Kalman Filter

The implemented algorithm follows the general flow as taught in the lesson.



There is a slight modification, in the sense that I have included another function called UniversalUpdate, which performs the general update function, that is common to both KF and EKF, while the Update and UpdateEKF functions were implemented having only the specific error calculation for each scenario.