EKF landmark-based localization of a robot

EKF test results

Figure 1 shows the output results of the MATLAB code.

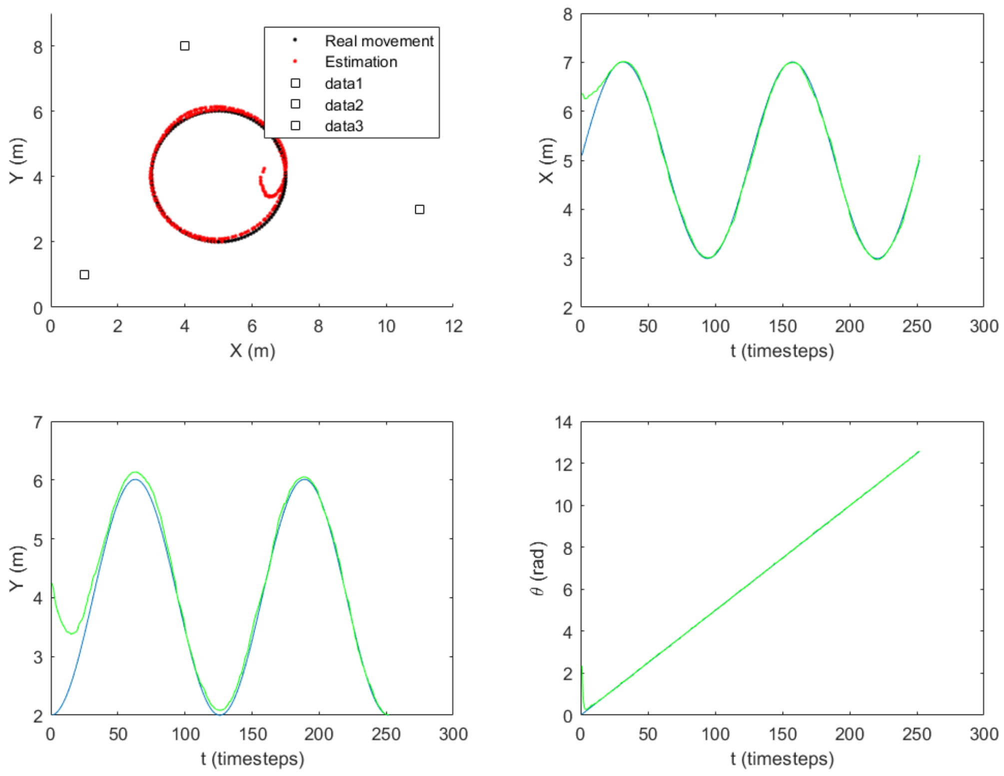

Figure 1: Output of the MATLAB code with starting point [6, 3, pi].The landmark-based EKF converges to solid estimations on the localization of the robot.

The plots of Y against the time shows that the initial error takes approximately 50 timesteps to disappear, which is 25 time units with $timestep = 0.5$ on line 4 of the MATLAB code.

Both plots X and θ show similar outcomes to plots Y, but with a faster convergence time (< 50 timesteps) and nearly indistinguishable differences between the estimate and the real state.

Using the assumption of a starting point at [6, 3, pi] as indicated in the assignment, the algorithm **can** converge, because the estimation plots and real plots coincide within a respectable error margin as seen in Figure 1.

Robustness test of EKF

As the results of the first tests of the EKF were very convincing (even despite the random noise being added at every new test iteration), I tried to test the robustness of the EKF by altering the initial estimates.

First, I started by altering the initial estimates slightly, by giving it a different orientation θ and moving the X and Y starting position within the circle. My initial hypothesis was that, when placed exactly in the middle of the circle, the EKF algorithm would not be able to converge because it would have a near infinite amount of options to choose from. This hypothesis was proven wrong, as every point I used as starting position within the circle converged at a relatively fast pace.

Secondly, I chose initial starting positions outside the circle. Again, I thought that this might break down the performance of the EKF and that it potentially would not be able to converge. Although the tested starting positions outside the circle still converged, it did take longer for the EKF to converge from a starting position at [10, 10, 0], see Figure 2.

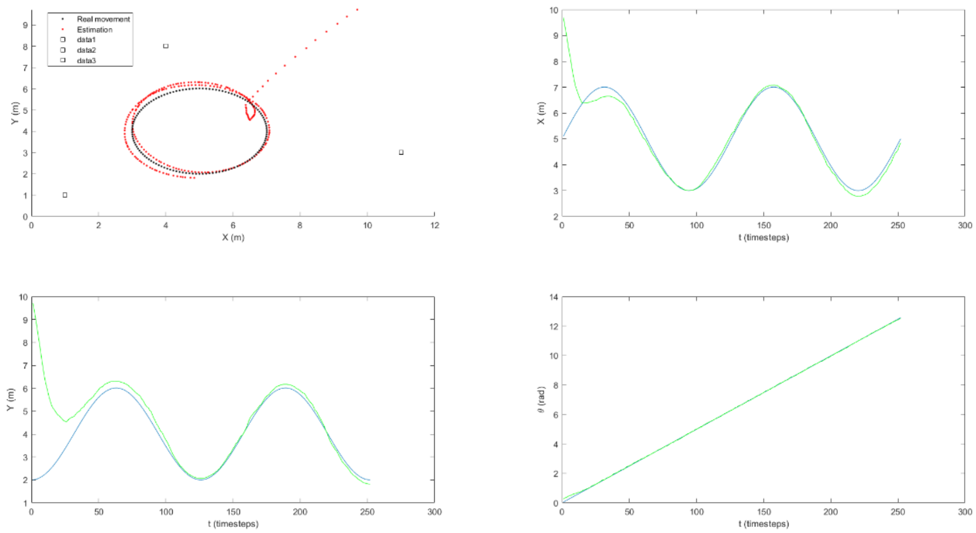

Figure 2: EKF with initial position [10, 10, 0] converged, but at a noticeable slower pace than a point closer to the circle.

Finally, the point [10, 10, pi] was tested, which is the same point as tested in Figure 2, but with a π rad difference in orientation. The results of the non-converging EKF can be found in Figure 3. It can be concluded that the orientation plays a big role in the convergence of the EKF for bad estimations of the initial position.

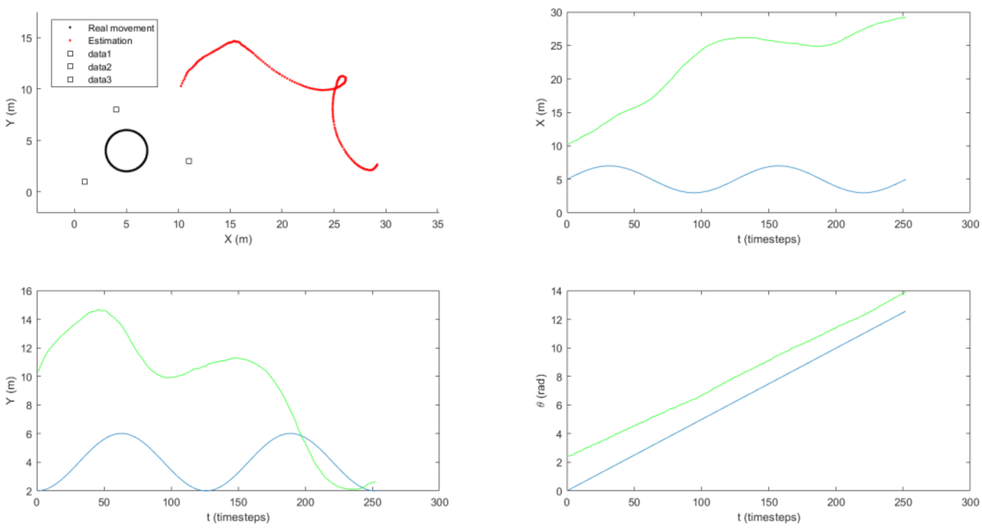

Figure 3: EKF with initial position [10, 10, π] is not able to converge, the longer it travels the more lost it is.