Portfolio Exam 2

Sensor Fusion – Kalman and Particle Filter

The deliverables for the following assignments are the commented source code of your implementations. Upload them via the eLearning platform. The code should be structured so that I can use it myself. So please include a readme file.

During the interview, you should be able to present/explain your solutions, visualize results graphically, and change parameters. You do not need to prepare slides.

Task P2.1

Realize an implementation of the Kalman Filter in a programming language of your choice for a simulation of the ball-throwing example from the lecture slides. The task of your Kalman Filter is to estimate the position and velocity vector of the ball only from the observed erroneous positions over time.

Your implementation shall be flexible in the sense that it can handle the following variations:

- Simulate the trajectory of a ball with the parameters *launch position* (especially the height above an imaginary ground), *launch speed* and *launch angle* of the ball.
- Simulate the observation of the ball position (x, y as shown in the slides). The estimated ball position shall be subject to uncertainty and it shall be possible to parameterize this uncertainty. In addition, the time span between two observations shall be variable and the observations shall be able to drop out completely over a certain period of time.
- The initial parameters of the Kalman Filter shall be adaptable.
- The normally distributed noise on transition and observation should be adjustable. This means that the covariance matrices $\boldsymbol{R}$ and $\boldsymbol{Q}$ shall be set as a parameter in the Kalman Filter.

Task P2.2

Realize an implementation of the Particle Filter in a programming language of your choice for a simulation of the ball-throwing example from the lecture slides. The task of your Particle Filter is to estimate the positions and velocity vectors of **two** balls flying simultaneously only from the observed erroneous positions over time.

Your implementation shall be flexible in the sense that it can handle variations similar to the ones from Task P2.1. In addition, you need to consider how to deal with more than one ball flying at the same time. How do you estimate two positions from the density? How do you define your state?

Note: There is more than one good approach here. Thus, there is no clear best solution approach in this task.