Exercise and Homework Round 1

These exercises (except for the last) will be gone through on **Friday, September 13, 12:15–14:00** in the exercise session. The last exercise is a homework which you should return via MyCourses by **Friday, September 20 at 12:00**.

Exercise 1. (Drone positioning problem I)

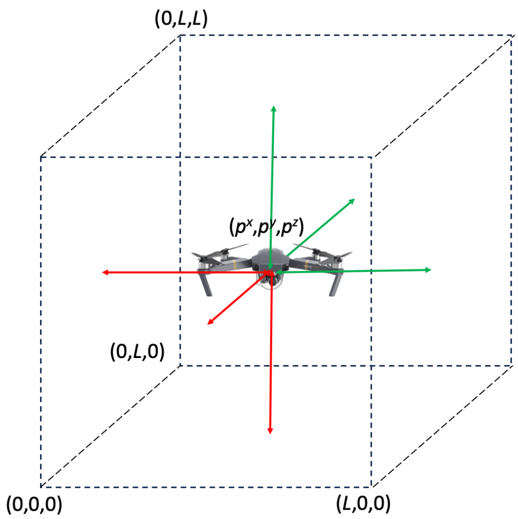

Figure 1: Drone positioning problem I.

Suppose that we wish to determine a drone position in a closed three dimensional box (p^x, p^y, p^z) as shown in Figure 1. In this scenario, suppose that the drone is equipped with sensors that measure the distance between the drone and the surrounding walls. The measurements from these sensors are given by

$$
\begin{aligned}
y_1 &= p^x + r_1, \\
y_2 &= p^y + r_2, \\
y_3 &= p^z + r_3, \\
y_4 &= L - p^x + r_4, \\
y_5 &= L - p^y + r_5, \\
y_6 &= L - p^z + r_6,
\end{aligned}
\tag{1}
$$

where r_i for $i = 1, \ldots, 6$ are independent zero-mean random noises with variance σ^2.

(a) Rewrite the measurement model above in a vector notation with the following form:
$$\mathbf{y} = \mathbf{G}\,\mathbf{x} + \mathbf{b} + \mathbf{r}.$$

(b) Which are the minimal subsets of measurements that can be used to find the position of the drone?

(c) If you have all the measurements, what would be a sensible strategy to compute the position in order to minimize the effect of noise?

Exercise 2. (Drone positioning problem II)

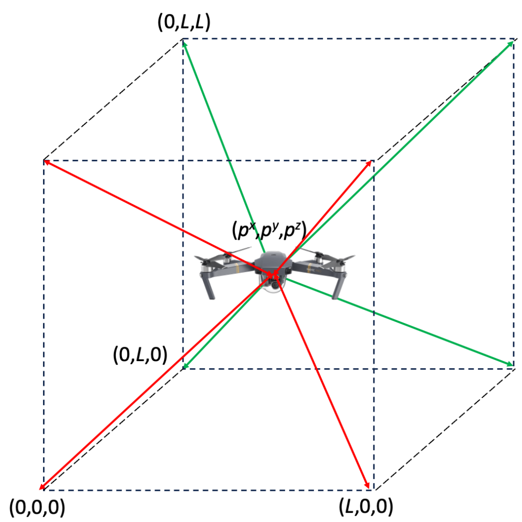

Figure 2: Drone positioning problem II.

Assume that instead of distances to the walls, we measure distances to the corners (all 8 of them) as shown in Figure 2.

(a) Write down the model in form of Equation (1).

(b) Rewrite the model in a vector notation with the following form:

$$\mathbf{y} = \mathbf{g}(\mathbf{x}) + \mathbf{r}.$$

(c) Which are the minimal subsets of measurements enough to find the position now?

Exercise 3. (Dynamic model)

Derive 3D version of the dynamic model in Equations (1.17) and (1.18) of the course book. What is the corresponding $\mathbf{F}$ now?

Homework 1 (DL Friday, September 20 at 12:00)

Assume that instead of distances to the corners as in Figure 2, we measure azimuth and elevation angles to each of the corners. Write the resulting model in form

$$\mathbf{y} = \mathbf{g}(\mathbf{x}) + \mathbf{r}.$$