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MOBILE ROBOTS - Laboratory 1

Report 2 - Evaluating Covariances

Having independently set our *mahaThreshold equal to* $\sqrt{chi2inv(0.95,2)}$ the next step was to determine the initial covariance P_{init}, the one that kicks off the KF equations. This covariance represents the error on the initial state X = [x, y, θ]^T: physically, it is the error on the initial posture of the robot, when "put down" by the human operator on the floor. We assumed that, when put down, the operator can "miss" the target by roughly 1 cm, and "misorient" the robot by 10 degrees. In order to set these parameters, we considered a Gaussian distribution, and used the "rule of thumb" $3 * \sigma = max\,error$, by which each state variable has a 99.7% probability to be below the maximum error. Ultimately, we set the initial covariance:

$$P_{init} = \begin{bmatrix} \sigma_x^2 & 0 & 0 \\ 0 & \sigma_y^2 & 0 \\ 0 & 0 & \sigma_\theta^2 \end{bmatrix}$$

With:

$$\sigma_x = 4$$

$$\sigma_y = 4$$

$$\sigma_\theta = 4 * /180$$

The next step consists in evaluating *sigmaTuning*.

The standard deviation *sigmaTuning* is our tuning parameter, which takes into account the uncertainty on the rotational speeds of the wheels q_dot_l and q_dot_r. The two wheels are considered to be almost identical, therefore *sigmaTuning* represents the common standard deviation and it is the only parameter needed. Since it depends on many different factors, it has to be set by **trial and error**.

To choose this value, we tested all the various datafiles with various values of *sigmaTuning*. The values tested were:

- **0.5**
- **0.3**
- **0.2**
- **0.15**
- **0.1**
- **0.05**
- **0.03**
- **0.01**

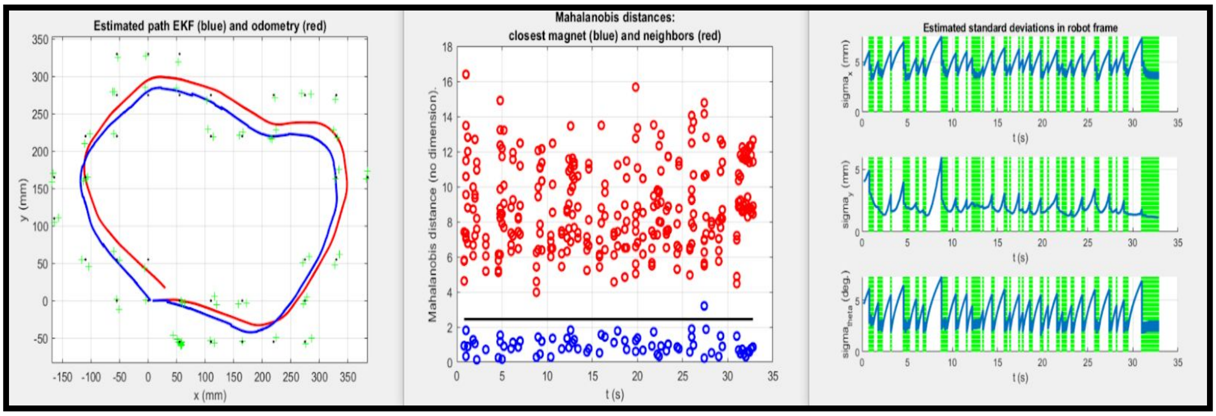

Figure 1 - Path, Mahalanobis Distances,
standard deviation of X w.r.t robot frame

Among all these values, the 0.15 parameter seemed the best tuning parameter for the datasets, as it seemed a good tradeoff between Final Odometry Errors, Magnets Rejected and Neighbor Magnets Under Threshold. This allows us to keep the Closets Magnets and the Neighbour Magnets distanced enough. Choosing a greater value of *sigmaTuning* would have resulted in having a greater number of neighbor magnets under threshold. On the opposite, by choosing a lower value we would have discarded many closest magnets (blue dots). This way we can reject all Neighbour Magnets and keep a great majority of our Closets Magnets for our measurements readings.