Location Estimation and Uncertainty Analysis for Mobile Robots

Autonomous Robot Vehicles, I. J. Cox and G. T. Wilfong, Eds., p. 90, New York: Springer-Verlag.
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1. What is the major contribution of the paper?

2. In the introduction the author talk about different uncertainties, which are caused from the error in the dead reckoning estimates, in the robot's position estimate. What does it means to the robot's position estimate that the error grows and after a while becomes very large? What does it means for the use of dead reckoning (or more precise in this particular case, odometry) in mobile robot positioning? (3)

3. The vehicle, described in the paper, is a differential driven vehicle with the rotational centre between the two driving wheels. How is the incremental displacement (ΔD, $\Delta\theta$) estimated (calculated) between any two samples of the encoder values? Is this calculation linear or non-linear? (3)

4. How is the estimate of the robot's position $(X, Y, \theta)^T$ updated after that the encoder values are sampled? What assumptions are taken under such an update? Is this update linear or non-linear? (3)

5. What is the purpose of the correction term, which is seen for the first time in Equation 3.3? When is it necessary to use such a correction term? Should it always give you a better position estimate or does it only makes your model more complex? (3)

6. Derive the co-variance matrix for the incremental displacement, i.e. derive cov[ΔD, $\Delta\theta$]. What does it means to the derived co-variance matrix if we assume the same uncertainty in both of the wheels? What would happen to the co-variance matrix if we assumed the error of the left wheel to be two times bigger than the same for the right wheel? (4)

7. What does the covariance matrix derived in Section 6 actually tells us? Do the math for the second approach, i.e. the one that uses the Taylor series to approximate the adjustment factor, and derive the co-variance matrix for the robot's position. (5)