SC42050 Literature Assignment

Moving Horizon Estimation

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Nowadays robots are more and more autonomous; one interesting problem for them is how to localize themselves based on their knowledge of the environment. Currently the research community is considering and studying Moving Horizon Estimators (MHEs), to handle some of these issues; MHEs are, in some sense, the dual problem of Model Predictive Control, in which we fix the observation window. After reading (Haseltine and Rawlings, 2005), try to answer the following questions:

1. The paper applies the MHE to a chemical example; suppose you have a wheeled robot, whose dynamical model is nonlinear, such as

   $$\dot{x} = f(x, u)$$

   where x is the position of the robot and u is the control input. Suppose you only have access to very poor measurements, both from odometry and from range sensors (this implies other nonlinearities). Formulate the robot estimation problem in the framework of MHE for the full-information estimate.

2. (a) Why, in practice, is it necessary an arrival cost? Make a short literature survey on examples of arrival cost. What are the advantages and drawbacks?
   (b) Formulate the robot estimation problem for MHE with the arrival cost.

3. (a) When MHE should perform better than the Extended Kalman Filter? (For more information on Extended Kalman Filter see, for example, (Thrun et al., 2005))
   (b) Could MHE help to relax the measurement sampling frequency?

4. One of the future direction of research in MHE is to use Particle Filters to improve some of its features and overcome some drawbacks. Where in the MHE scheme could Particle filters be applied? In your opinion do you believe this will lead to new interesting results? (For more information on Particle Filters see, for example, (Thrun et al., 2005))

References

Haseltine, E. L. and Rawlings, J. B. (2005). Critical evaluation of extended Kalman filtering and moving-horizon estimation. *Industrial & Engineering Chemistry Research*, 44(8):2451–2460.

Thrun, S., Burgard, W., and Fox, D. (2005). *Probabilistic Robotics*. MIT Press.