Class: Sistem Pengaturan Formasi dan Kolaborasi (EE185523)
Lecturer: Yurid E. Nugraha
Deadline: 2023/06/06

Assignment 5: Distributed Estimation and Input-Output Agreement

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1. (**Weight: 15%**) Read a paper *Diffusion Strategies for Distributed Kalman Filtering and Smoothing* by Federico S. Cattivelli and Ali H. Sayed. Explain in about 400 words the difference between distributed Kalman filter in this paper and the model discussed in the book.

2. (**30%**) Let $H_i, i = 1, 2, 3$, be the rows of the 3×3 identity matrix in the observation scheme $z_i = H_i x + v_i$ for a three-node sensor network, observing state $x \in \mathbb{R}^3$. It is assumed that the nodes form a path graph and that v_i is a zero-mean, unit variance, Gaussian noise. Choose the weighting matrix W and the step size Δ which satisfies the condition for stability. Experiment with the selection of the weights for a given value of Δ and their effect on the convergence properties of the distributed least square estimation discussed in the class.

3. (**30%**) Consider a network consisting of 4 agents where a single node acts as an input (and output) node and the remaining floating nodes are executing the agreement protocol. By using the protocol $\dot{x}_f(t) = -A_f x_f(t) - B_f u(t)$ and $y(t) = -B^\top x_f(t)$, and $u(t) = 5$, analyze what $\dot{x}_f(t)$ will be in

   (a) A path graph with V_i being one of the agent located at the end of the graph, and

   (b) A star graph G with V_i being the agent in the center.

4. (**25%**) Discuss what would happen if the input and output nodes V_i were in fact distinct nodes V_i and V_o, $V_i \setminus V_o = \emptyset$.