Exam questions

Discrete time Kalman filtering

1. Describe the difference between using a least-squares procedure and filtering of a problem with more observations than unknowns.

2. When all observations are filtered, is the vector of unknowns then identical to the vector coming from a least-squares procedure?

3. Describe the difference between the Kalman and the Bayes version of the filter. Why is the Bayes version preferable to the Kalman version?

4. A special case of updating happens when the system matrix F is the identity matrix I. Show that in this case the Kalman filter collapses to the formulas for recursive least-squares algorithm. [Help: the student is provided with the two sets of formulas.]

5. A Kalman filter is described by the coefficient matrices F and A as well as covariance matrices for the system and observation equations, Sigma_{epsilon,k} and Sigma_{e,k}. A third covariance matrix P couples the two sets of equations. It is called the covariance matrix for updating. What does the variances on the diagonal of P tell about the present condition of the filter process. Can very small entries in P lead to numerical instability?

6. The covariance matrices for the system and observation equations, Sigma_{epsilon,k} and Sigma_{e,k} are matrices that are given before the filtering can start. Describe how fine tuning of these two matrices can change the behavior of the filter result x and P.

7. Describe why Kalman filter techniques are so useful in modern times compared to least-squares methods. Mention examples where such filters are of crucial importance in real time applications. [Hint: machine control, flight navigation, attitude control of a satellite.]

8. Is it possible to design a Kalman filter where old observations get lesser weight than more recent ones?