Optimal Estimation Theory and Its Applications

Instructor: Dr.-ing. Jian-Guo Wang Graduates: Steffen Lindenthal Ofeliya Popova Michael Leslar Matthew Cannata Wen Zhang (completed in 2007)

LSM (least square methods): Review (probability theory, static estimation, random processes, different adjustment methods), reliability theory, Posteriori variancecovariance component estimation; Linear Dynamic systems: Continuous & Discrete Linear systems and their solutions, Observability & Controllability, Shaping Filter, Covariance Propagation in discrete time; Optimal Linear Filtering: Recursive filters, Discrete & Continuous Kalman filter, Orthogonal Projection and Kalman filter, Sequential Least-Square Method and Kalman filter, the Extended Kalman filter, Reliability analysis, Introduction to Variance component Estimation; Optimal Linear Smoother: fundamentals, Fixed-Interval smoother, Fixed-Point Smoother, Fixed-lag smoother; Correlated System and Measurement Noise Processes, and Colored Noises; Implementation Methods and Practical Considerations; Advanced Topics in Kalman Filter (introduction): suboptimal filter, system identification, concepts of robust Kalman Filter, Test Statistics, Recognizability of constant sensor errors, Adaptive Kalman Filtering, Wavelet Kalman filtering, Sigma Point Kalman filtering; Applications: Kinematic single Point Positioning of GPS, Real-time Tracking: The  $\alpha$ - $\beta$ - $\gamma$  filter, The multi-sensor integration.

The lecture will combine the literature readings with discussions, presentations, reports, project assignments, and instructor's presentations as well.

## **Reference:**

- Baarda, W (1967): Statistical Concepts in Geodesy, New Series Publications on Geodesy, Vol. 2, No. 4, Netherlands Geodetic Commission, Rijkscommissie Voor Geodesie, Kanaalweg 4, Delft, Netherlands, 1967.
- Baarda, W (1968): A Testing Procedure for Use in Geodetic Networks, New Series Publications on Geodesy, Vol. 2, No. 5, Netherlands Geodetic Commission, Rijkscommissie Voor Geodesie, Kanaalweg 4, Delft, Netherlands, 1967.
- Brown, Robert Grover; Hwang, Patrick Y.C. (1997): Introduction to Random Signals and Applied Kalman filtering – with MATHLAB Exercises and Solutions, John Wiley & Son, ISBN 0-471-12839-2, New York, Chichester, Brisbane, Toronto, Singapore, Weinheim, 1997.
- **Caspary, W. (1987):** Concepts of Network and Deformation Analysis, Monograph 11, School of Surveying, The University of New South Wales, Australia, March 1987.

- **Chui, C.K.; Chen, G. (1998):** Kalman Filtering with Real-time applications, Springer Series in Information Sciences, Vol. 17, 3<sup>rd</sup> edition, ISBN 3-540-54013-X, Springer Verlag, New York, 1998
- Gelb, Arthur (1974): Applied Optimal Estimation, The M.I.T. Press, ISBN 0-262-20027-9, Cambridge, Massachusetts, and London, England, 1974.
- Grewal, Mohinder S.; Andrews, Angus P. (1993): Kalman filtering Theory and Practice, Prentice Hall Information and system sciences series, ISBN 0-13-211335-X, Englewood Cliffs, New Jersey, 1993.
- Kamen, E.W.; Su, J.K.(1999): Introduction to Optimal Estimation, springer-Verlag London Berlin Heidelberg, ISBN 1-85233-133-X, 1999.
- Salzmann, Martin (1993): Least Squares Filtering and Testing for Geodetic Navigation Applications, New Series – Publications on Geodesy, No. 37, Netherlands Geodetic Commission, Rijkscommissie Voor Geodesie, Kanaalweg 4, Delft, Netherlands, 1993.