



Figure 6: Simulation results of the vehicle state estimator

tection and rollover detection simultaneously. In further works we will extend the results by considering more complex vehicle model in order to increase the observer robustness. We also expect to validate our approach in experimental studies using software simulator and experimental vehicle.

References

- [1] Bevely, D.M. Ryu, J. Gerdes, J.C. "Integrating INS Sensors With GPS Measurements for Continuous Estimation of Vehicle Sideslip, Roll, and Tire Cornering Stiffness". *ITS, IEEE Transactions on* vol.7, pp. 483-493, 2006.
- [2] H. Dahmani, M. Chadli, A. Rabhi and A.El Hajjaji Road angle considerations for detection of impending vehicle rollover, *IFAC AAC 2010*, 12-14 July 2010, Munich, Germany.
- [3] A. Nishio, et. al. "Development of Vehicle Stability Control System Based on Vehicle Sideslip Angle Estimation". *SAE Paper* No. 2001-01-0137.
- [4] J. Farrelly and P. Wellstead "Estimation of Vehicle Lateral Velocity". *IEEE Conference on Control Applications* 1996, p.552-557.
- [5] J. Farrelly and P. Wellstead "Slip-Angle Estimation for Vehicle Stability Control". *Veh. Sys. Dyn.* 1999, v.32, no.4, p.375-388.
- [6] M. Hou and P.C. Muller. "Observer design for descriptor systems". *IEEE Transaction in Au-*

Figure 7: The road geometry estimation

- tomatic Control* vol. 44, pp. 164-169, 1999.
- [7] M. Chadli, A. Akhenak, J. Ragot, and D. Maquin. "State and Unknown Input Estimation for Discrete Time Multiple Model". *Journal of the Franklin Institute*, Vol. 346, No. 6, pp. 593-610, 2009.
- [8] D. Koenig. "Unknown input proportional multiple-integral observer design for linear descriptor systems: Application for state and fault estimation". *IEEE Trans. Automat. Contr.* vol 50, pp. 212-217, 2005.
- [9] Z. Gao, D. W. C. Ho. "Proportional multiple-integral observer design for descriptor systems with measurement output disturbances". *IEE Proc.-Control Theory Appl.* vol 151, 3, 2004.
- [10] S. Mammam, S. Glaser, M. Netto "Vehicle Lateral Dynamics Estimation using Unknown Input Proportional-Integral Observers". *Proceedings of the 2006 American Control Conference* Minneapolis, Minnesota, USA, June 14-16, 2006.
- [11] J. Ryu and J. Christian Gerdes. "Estimation of Vehicle Roll and Road Bank Angle". *In Proc. of the 2004 American Control Conference*, Boston, Massachusetts June 30. July 2.2004.
- [12] T. Takagi and M. Sugeno. "Fuzzy identification of systems and its applications to modeling and control". *IEEE Transactions on Systems, Man, and Cybernetics* vol.15, pp. 116-132, 1985.
- [13] K. Tanaka, T. Ikeda, and H. Wang, Fuzzy regulators and fuzzy observers, Relaxed stability conditions and lmi-based designs, *IEEE TFS*, vol. 6, no. 2, pp. 250-265, 1998.
- [14] S. Kidane, L. Alexander, R. Rajamani, P. Starr and M. Donath. "Road Bank Angle Considerations in Modeling and Tilt Stability Controller Design for Narrow Commuter Vehicles". *In Proc. of the 2006 ACC*, Minneapolis, Minnesota, USA, June 14-16, 2006
- [15] H. Dahmani, M. Chadli, A. Rabhi and A.El Hajjaji Fuzzy uncertain observer with unknown inputs for Lane departure detection, *American Control Conference ACC 2010* June 30 - July 2, 2010 Maryland, USA.