Hybrid of Support Vector Machines and Kalman Filter for GPS/INS Integration

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INTRODUCTION

One of the advantages of GPS/INS integration is that the integrated solution can provide continuous navigation capability even during GPS outages. However, bridging the GPS outages is still a challenge when MEMS inertial sensors are used. Methods being currently explored by the research community include applying vehicle dynamics constraints, optimal smoother, and neural network (NN) algorithms. In a NN-based integrated system, a Kalman filter estimates position, velocity and attitude errors as well as the inertial sensor errors, to give precise navigation solution while GPS signals are available. At the same time, a neural network is trained to map the vehicle dynamics with corresponding Kalman filter states, to correct INS measurements when GPS measurements are unavailable. To achieve good performance, it is critical to select suitable quality and number of samples for the neural network. This is sometimes too rigorous a requirement which limits applications of NN-based methods in real world environments.

This paper explores the use of support vector machine (SVM) for GPS/INS integration. The SVM is established based on the structural risk minimisation principle instead of the minimised empirical error principle that is commonly implemented in neural networks. The SVM can avoid local minimisation and over-fitting problems in a neural network, and therefore potentially can achieve a higher level of global performance. This paper explores the application of the SVM to aid the GPS/INS integrated system, especially during GPS outages. It discusses the principle of the SVM and the Kalman filter (KF) hybrid method, and describes the design of the multi-output SVM (MO-SVM). Field test data is processed to evaluate the performance of the proposed method. The result is also compared with the NN-aided GPS/INS solution.

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