

Automatic estimation of inertial navigation system errors for global positioning system outage recovery

ABSTRACT

This article presents an alternative approach of solving global positioning system (GPS) outages without requiring any prior information about the characteristics of the inertial navigation system (INS) and GPS sensors. INS can be used as a standalone system to bridge the outages during GPS signal loss. Kalman filter (KF) is widely used in INS and GPS integration to present a forceful navigation solution by overcoming the GPS outage problems. Unfortunately, KF is usually criticized for working under predefined models and for its observability problem of hidden state variables, sensor dependency, and linearization dependency. This approach utilizes a genetic neuro-fuzzy system (GANFIS) to predict the INS position and velocity errors during GPS signal blockages suitable for real-time application. The proposed model is able to deal with noise and disturbances in the GPS and INS output data in different dynamic environments compared to other traditional filtering algorithms such as the neural network and neuro fuzzy. Real field test results using the micro-electro-mechanical system grade inertial measurement unit with an integrated GPS shows a significant improvement obtained from the integrated GPS/INS system using the GANFIS module compared to traditional methods such as Kalman filtering, particularly during long GPS satellite signal blockage.

Keyword: Adaptive neuro-fuzzy inference system; Genetic neuro-fuzzy inference system; Global positioning system; Inertial navigation system; Intelligent navigator; Windowing method