

Abstract

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Real-time Cycle-slip Detection and Correction for Land Vehicle Navigation Using Inertial Aiding

Carrier phase measurements require resolution of integer ambiguities before precise positioning can be achieved. The GPS receiver can keep track of the integer number of cycles as long as the receiver maintains lock to the satellite signal. However, in reality, the GPS signal could be interrupted momentarily by some disturbing factors leading to a discontinuity of an integer number of cycles in the measured carrier phase. This interruption in the counting of cycles in the carrier phase measurements is known as a cycle slip. After a cycle slip, ambiguities need to be resolved again cycle slips need to be corrected to resume the precise positioning/navigation process. These cycle slips can, to some extent, be detected and fixed to avoid delay and computation complexity attributed to the process of integer ambiguity resolution. Capitalizing on the complementary characteristics of INS and GPS, INS is used to provide external information to detect and correct cycle slips. Lately, MEMS grade inertial sensors are being used for low cost navigation applications. Moreover, recent research is geared towards the use of fewer numbers of sensors avoiding their complex errors and reducing the cost. This paper introduces integration of GPS and reduced inertial sensor system (RISS) to address the problem of cycle slips. The performance of proposed method is examined on several real-life land vehicle trajectories which included various challenging driving scenarios including high and slow speeds, sudden accelerations and decelerations, sharp turns and steep slopes etc. Results demonstrate the effectiveness of the proposed algorithm in these severe conditions which cause intensive and variable-sized cycle slips. This research has a direct influence on navigation in challenging environments where frequent cycle slips occur and resolving integer ambiguities is not affordable because of time and computational constraints. An additional consequence of this research is the significant reduction in the cost of an integrated system due to the use of fewer MEMS inertial sensors.