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ERROR REDUCTION OF A LOW COST GPS RECEIVER FOR KINEMATIC APPLICATIONS BASED ON A NEW KALMAN FILTERING ALGORITHM

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Abstract. *Positioning for kinematic applications is of great importance in terms of accuracy and computational complexity. In this paper, we present an algorithm based on correlation between error components in three directions, i.e. Δx, Δy, Δz to decrease positioning error of a GPS receiver for kinematic applications. The main feature of proposed algorithm is that it modifies data at each instant and in each direction using data of two other directions at the same instant (i.e. some sort of online modification). This feature was acquired using an approach introduced to model state transition matrix using AR coefficients of two other directions. The algorithm was implemented on the output raw position data collected from a low cost GPS receiver. Experimental results showed a reduction of approximately 20% at every direction of the positioning errors.*
Keywords: GPS, Kalman filter, OEM GPS receiver, Positioning error

1. **Introduction.** Recursive estimation is of primary interest in navigation and tracking problems. The issue is to compute the kinematic state (the position and its derivative) of moving vehicles from noisy measurements through a number of sensors. The Kalman filter introduced in (Kalman 1960) and further studied in many textbooks such as (Anderson and Moore 1979) has been applied to a wide range of practical problems. One of these practical problems is accurate positioning of Global Positioning System (GPS), especially in kinematical applications. For example, it has been a continuing challenge to determine and fix the GPS carrier- phase ambiguities, e.g., see (Kubo et al. 2008). Moreover, the challenge is even greater for kinematical GPS applications. This problem has been resolved using a particular generalized procedure and Kalman filter in (Kim and Langley 2000). In the proposed tightly coupled Inertial/GPS navigation system for Unmanned Aerial Vehicle (UAV) applications in (George and Sukkarieh 2005), an indirect and error state extended Kalman filter is employed to estimate vehicle position, velocity, altitude and Inertial Measurement Unit (IMU) bias errors. Small UAVs and Micro Air Vehicles (MAVs) have payload and power constraints that prohibit heavy sensors and powerful processors. In (Kingstone and Beard 2004), a novel method for real-time application is presented using Extended Kalman filter and a distributed-in-time architecture to deal with these kinds of constraints in these applications. In (Takeuchi 2008), an approach for optimization of linear observations for the stationary Kalman filter based on a generalized water filling theorem is introduced. In (Yamaguchi and Tanaka 2006), Kalman filter has