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DYNAMICAL MODELS FOR AUTOMOBILE MOVEMENTS

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Abstract. *The Real-Time Kinematic (RTK) Global Positioning System (GPS) with Kalman filtering estimates the position and velocity of automobiles and so on by using dynamical models. If the dynamical model is not appropriate for automobile movements, the accuracy of the predicted position and velocity decreases. In this case, when the methods statistically test whether cycle slips (i.e., sudden jumps in the carrier phase observation by an integer number of cycles) occur, using the difference between observation and prediction, the inadequate dynamical models cause the mis-detections of cycle slips. To prevent these mis-detections, we proposed a dynamical model in which the jerk is assumed to be a first-order Markov process (jerk model), but we did not demonstrate that this jerk model fit the automobile movements. It was therefore necessary to show that the time series data in different time intervals fit the same jerk model i.e., that the jerk model is a stationary autoregressive model. This paper proposes the method that decides whether the autoregressive model is stationary. The stationarity of the jerk model is analyzed by using observation data collected with a car. Moreover, the cycle slip detection performance of the jerk model is compared with that of another model, and it is shown that the performance of the jerk model is improved.*
Keywords: Dynamical model, Stationary decision, Autoregressive model, Jerk, Kinematic GPS, Cycle slip detection

1. **Introduction.** The information system using Global Positioning System (GPS) of the United States is widely used for navigating cars, boats and airplanes as well as determining the location of portable terminals, cellular phones and so on. These location and navigation fields use single point positioning, in which the receiver tracks the C/A (coarse and access) codes from GPS satellites, measures the distances from the satellites to the receiver, and calculates the position of the receiver. On the other hand, in the construction field, the so-called "intelligent construction system" [1-3] is being introduced. In this system, Global Navigation Satellite Systems (GNSS) receivers using GPS and GLONASS (the Russian GNSS) signals are installed in construction equipment, which operates according to the GNSS-measured positions and design data. This system reduces the work load for putting three-dimensional signs on a construction site. Because construction work requires position to be determined to within several centimeters, the intelligent construction system uses kinematic positioning, in which highly accurate positions are measured by using the carrier phase [4] of GNSS signals.

In kinematic positioning, the phase lock of the carrier tracking can be lost when the carrier signal is interrupted or the signal to noise (SN) ratio decreases suddenly, and this