Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **16 (2009)** 749-762
 http://www.watam.org

ON GENERALIZED FILTERING METHODS FOR QUATERNION-BASED ORIENTATION ESTIMATION*

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Abstract: Under the assumption that the random interruptions in the observation process are sequence independent Bernoulli random variables, this paper generalizes the extended Kalman filtering (EKF), the Unscented Kalman filtering (UKF), the first-order Stirling's interpolation filtering (DD1), the second-order Stirling's interpolation filtering (DD2) and the Gaussian particle filtering (GPF). For a quaternion based orientation estimation problem, these generalized novel algorithms are referred to as GEKF, GUKF, GDD1, GDD2 and GGPF respectively in this paper. Using quaternion rather than Euler angles to represent rotation, an empirical study to compare the performance of GEKF, GUKF, GDD1, GDD2 and GGPF for orientation estimation is presented. The state vector includes rotation and angular velocity, and the orientation represented by quaternion is used as observed equation. From the simulation results we can prove that the GUKF is the best choice for quaternion-based orientation.

Keywords: Orientation estimation; Generalized extended Kalman filtering; Generalized Unscented Kalman filtering; Generalized first-order Stirling's interpolation filtering; Generalized second-order Stirling's interpolation filtering; Generalized Gaussian particle filtering.

1 Introduction

Accurate human orientation tracking is a critical component in virtual reality (VR) applications [1-5]. Having real time head and hand orientation information enables the computer to draw images in the correct perspective. Unfortunately, tracking systems which suffer from noise and distortions can cause incorrect viewing perspectives. To handle these imperfections, filtering is often applied to the tracked data so that a VR application can obtain more accurate estimation of the orientation.