International Journal of Security and Privacy in Pervasive Computing
Volume 12 • Issue 1 • January-March 2020

Accuracy Enhancement of GPS for Tracking Multiple Drones Based on MCMC Particle Filter

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ABSTRACT

GPS information when received from multi-unmanned aerial vehicles (UAVs), also called drones, via a ground control station can be processed for detecting and tracking estimate target position. Tracking drones based on GPS has had some issues with missed received information or received information with an error that can lead to lost tracking. The proposed algorithm, Markov chain Monte Carlo based particle filter (MCMC-PF) can be used to overcome these issues of error in received information with keeping tracks and provides continuous tracking with a higher accuracy. This is suitable for real time applications that deal with GPS receiver devices with low efficiency during tracking. Simulation results demonstrate the effectiveness and better performance when compared to conventional algorithms of the Kalman filter (KF).

KEYWORDS

Data Association, Drones, GPS Receiver, Kalman Filter, Markov Chain Monte Carlo, Multi-Target Tracking, Particle Filter

1. INTRODUCTION

Unmanned aerial vehicles (UAV) or drone is a small aircraft without a pilot. This is now the most widely used in the military to provide a mission of photography/video graph. In recent years, the use of drones by civilians increased rapidly which provides many different applications for citizen such as transportation of important and emergency things. These different applications require for the drones to be tracked during the mission of transportation until reaching to the specified location and return to home (Horsman, 2016). The tracking system for the multiple drones need to GPS drone navigation system for detecting the estimated position of the drones and the tracking algorithm for processing the received information and keeping track. More advanced drones make use of GPS receivers for the navigation and control loop. The global positioning system (GPS) receiver is a satellite navigation system that uses a radio receiver to collect signals from orbiting satellites to determine position, speed, and time (Hamidu 2017; Lee, 2014). This navigation system is more accurate than over forms of navigation and provides position knowledge with error of a few meters. Advanced GPS systems can provide even better accuracies in error within a few centimeters. The collected information from GPS receiver broadcast its information automatically that will be received by ground control station

DOI: 10.4018/IJSPPC.2020010101

(GCS) upon the link of network wireless communication (Lukmana & Nurhadi, 2015). The GPS ground station gather the information from all flying drones which will be processed by the CPU attached to this station as shown in Figure 1. Some issues may be occurred during the receiving of GPS information from multiple moving drones such as losing information at instant time or receiving information with error (receiving information with unexpected position). Figure 2 demonstrates how the GSC operates to track multiple drones and overcome the issues of received information. Application program on PC with language of visual studio or any high-level language can be designed, implemented and run to process the received information with obtaining high efficiency tracking. Early, target tracking with different techniques based on algorithms of Kalman filter or particle filter were used (Ristic et al., 2004) to overcome the issues with low efficiency. According to obtaining the high accuracy of estimated position during tracking depends on the choosing technique, the proposed algorithm of Markov Chain Monte Carlo -based particle filter (MCMC-PF) will be used for tracking the estimated position instead of the conventional algorithm of Kalman filter (Khan et al., 2005). Using MCMC-PF improves the accuracy and overcome the issues of losing information, in additional to dealing with issue of maneuvering target. Due to the missed spaced and highly maneuvering target, this is the mainly our considered problem for estimation. Traditionally, this problem was tried to be solved using linearized filters, such as the Kalman filter (KF) (Ristic et al., 2004). When dealing with non-linear models in state equation and measurement relation and a non- Gaussian noise assumption, these estimation methods may lead to non-optimal solutions. The sequential Monte Carlo methods, or particle filters (Candy, 2009; Arulampalam et al., 2002), provide general solutions to many problems where linearization and Gaussian approximations are difficult specially in poor information. Recently MCMC-based particle filter (MCMC-PF) (Rabaste, 2010; Hu et al., 2004; Jing & Vadakkepat, 2010) has various applications that deal with poor information, difficult nonlinear and/or non-Gaussian problems for tracking missed spaced and false target drones. In MCMC-PF, the particles are sampled from the target posterior distribution via direct MCMC sampling method as described later, which

Figure 1. Ground control station for receiving information and tracking multiple drones via wireless communication link