Weak GPS L1 Band Signal Tracking through Low cost Dual Polarization Antenna for Vehicular Communication

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Extended Abstract

Precise positioning with the help of global positioning system (GPS) receiver is in demand for a vehicle to vehicle communication (v2v). Particularly, under challenging environment and all-time availability for autonomous or Simi autonomous vehicle in the urban environment, vehicles are required to acquire their precise location information under dynamic and a very dense multipath urban environment. GPS receiver needs to acquire at least four satellites to estimate position. However, under highly dynamic multipath environment, the positions obtained by GPS receiver may get affected, complete loss of lock due to the insufficient number of acquired satellite. Since the multipath effect can attenuate not only GPS signal but also change the polarization of GPS signals from Right Hand Circular Polarization (RHCP) to Left Hand Circular Polarization (LHCP). Conventional GPS antenna is RHCP antenna, which rejects LHCP signals. However, LHCP signals can still be useful as studies such as sensing and altimetry [1, 2]. Study of aided weak signal tracking [3] proposes to implement frequency lock loop with FFT discriminator to tracking weak signal and deploy INS to handle high dynamic platform [4]. Nevertheless, under urban environment, visible satellite number is limited due to received LHCP signals. Conventional weak signal tracking methods are not effective to acquired weak signal due to change in polarization. Therefore, acquiring and tracking LHCP GPS signal in the multipath and dynamic environment, and increasing the locked satellite numbers, we propose to implement dual polarization patch antenna to collect LHCP signal as well as RHCP, with the assisted high order frequency lock loop aid phase lock loop since high order phase lock loop can track weak signal and frequency lock loop with Kalman filter significantly reduce the effect of high dynamic environment on frequency shift.

For evaluating this method, experiments conducted in a highly dynamic multipath environment which is likely a case of the vehicle to vehicle communication in the urban environment. The experimental site for our study is dense covered building covered area and narrow sky view. A dual polarization patch antenna connected to USRP (Universal Software Radio Peripheral) and NovAtel generic GPS receiver with an external atomic clock with 10 MHz reference frequency for synchronization used in data collection. Under such extreme environment commercial receiver can only acquire and track one satellite, PRN 9, our software-based GPS receiver with both RHCP and LHCP can acquire and track PRN 9 and PRN 7. Based on the results of data processing, new method is more efficient for weak signal acquisition and tracking under high dynamic multipath environment.

[1] M. Usman and D. W. Armitage, "Acquisition of reflected GPS signals for remote sensing applications," in *Advances in Space Technologies, 2008. ICAST 2008. 2nd International Conference on*, 2008, pp. 131-136.

[2] D. Manandhar, R. Shibasaki, and H. Torioto, "Prototype software-based receiver for remote sensing using reflected GPS signals," in *ION Proceedings, GNSS*, 2005.

[3] K. Yan, N. I. Ziedan, H. Zhang, W. Guo, X. Niu, and J. Liu, "Weak GPS signal tracking using FFT discriminator in open loop receiver," *GPS solutions,* vol. 20, pp. 225-237, 2016.

[4] K. Yan, T. Zhang, X. Niu, H. Zhang, P. Zhang, and J. Liu, "INS-aided tracking with FFT frequency discriminator for weak GPS signal under dynamic environments," *GPS Solutions,* pp. 1-10.