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DIFFERENTIAL GPS ATTITUDE DETERMINATION CONCEPT FOR CUBESATS AND DRONES

Abstract

The use of GPS signals is not limited to positioning service: by taking advantage of the phase differential measurements of the GPS carrier signal (DGPS), used normally to augment the position accuracy, it is possible to determine the attitude of a platform. This concept has been exploited for both space- and ground-based application such as satellites, airplanes and boats. This study aims to explore the feasibility of a miniaturized DGPS attitude determination sensor, suited for miniature satellites, such as CubeSats, and drones. This sensor can be used both as an attitude and position sensor, while providing also a time reference (GPS time). It is particularly suited for this kind of applications because of its light weight and low hardware complexity: it is foreseen to miniaturize the whole sensor electronics to fit in a standard CubeSat board. The proposed attitude determination sensor is formed by a number of receiving GPS antennas, each one measuring the phase of the GPS carrier at the same time. The phase difference between each antenna is proportional to the angle between the vector connecting two antennas (known as baseline) and the direction of the incoming GPS signal. Having multiple baselines allows to estimate the attitude of the platform with respect to an inertial frame of reference. Unlike current DGPS attitude sensors, the distance between the antennas will be under the wavelength of the L1 GPS signal carrier (19.05 cm): this allows the use of a simpler, faster and more reliable attitude estimation algorithm, at the cost of a reduced accuracy of the attitude estimation. In effect, reducing the baseline length worsen the influence of differential phase measurement errors on the attitude determination. This is the main point of the study: to establish a set of minimum requirements, in terms of geometry and antenna performances, in order maximize the attitude estimation accuracy. A tradeoff will be performed between different antennas configuration and types, taking into account the limitations imposed by miniaturized COTS hardware. Some preliminary numerical analysis shows an attitude accuracy around 1deg 3σ with 1mm RMS noise on the phase difference measure, using four patch antennas in a flat square configuration with 8cm side length (CubeSat configuration).