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IMPROVEMENT OF SATELLITE TRACKING AT EARLY ORBIT PHASE OF A CLUSTER LAUNCHED NANOSATELLITES

Abstract

Nowadays, cubesats are becoming a more well-known standard for satellite missions around the world; many of these satellites have been and are being deployed in a regular basis. A unique characteristic of the cubesat launch is that the launch is essentially a piggy back launch. Typically, a set of cubesats is released in a cluster. This characteristic induces a challenge in the early orbit operation. Not long after the deployment of the satellites, orbital parameters in terms of two-line elements (TLEs) are assigned arbitrarily to these satellites for later object identification. These TLEs are not updated instantaneously, thus the prediction accuracy of the orbit is subject to errors. During the early orbit phase after the deployment, many of these satellites would share a similar orbit. Moreover, as the beacon or transmitter frequencies are typically in the amateur band. The frequencies between two satellites can be separated by a few or several KHz, making it difficult to differentiate one satellite from another. At this stage, transmissions of beacon signal can be the only reliable source of information from satellites/objects. Detecting and identifying the space object from a cluster becomes important in the mission operation. In the paper, an identification procedure is proposed and verified to classify satellites at the early orbit phase under which a cluster of satellites are closely located and beaconing in the same band. Using the rough TLE and the nominal frequency as the reference, the expected reception frequency is estimated through an orbit propagator. A wide-bandwidth radio signal recorder is employed to collect the received signal samples. A time-frequency processing algorithm is then developed to extract and analyze specific features of the satellite transmission data or beacon. Advantages of the proposed approach are the improvement of satellite orbit determination without relying on GPS information, and an early prediction of different satellites at the same time. In the paper, the software radio approach for data collection and processing will be described. Simulation results are then provided to assess the performance and limitation of the method. A field trial by processing collected data at the early orbit phase of a cluster of Cubesats is then reported to verify the proposed method. Some extensions of the system are then discussed including the use of ground station network for cooperative tracking.