PHOENIX is a 2U CubeSat that is developed by the National Cheng Kung University as a part of the QB50 project. The PHOENIX was deployed from ISS in May, 2017 and has been successfully communicated with ground station in Taiwan ever since. However, for some issues of PHOENIX, the tumbling rate has once been found to be very high to the extent that the rate sensor along the Y-body axis was saturated. This high-rate condition has been confirmed with received RF signal from PHOENIX and 3-axis magnetometers measurements.

The high tumbling rate phenomena lead to several challenges and issues needed to be resolved. First, B-dot control laws, depending on the time varying rate of change in the magnetic field, becomes unreliable because of the latency between the time and the magnetic field is sampled and when the torque is applied through the magnetorquer. Second, with the fast changing polarity in 3-axis magnetic measurements, Magnetometer Rate Estimator cannot determine the 3-axis angular rate correctly. Third, the saturation of Y-MEMS rate sensor makes it more difficult to judge the performance and feasibility of the control laws before decreasing rotational rates to a certain magnitude. To clearly understand the tumbling motions, information from the received telemetry data are important, like the time-varying power of RF signal, and the change of orientation of the measured magnetic field.

Tumbling motions can be separate into direction of rotation and magnitude of rotation. With the certain amount of successive magnetometer data, the direction of rotation can be determined approximately, which shows PHOENIX is in a predominant Y-spin with the higher angular rate in Y-body axis, which have the bigger moment of inertia. On the other hand, magnitude of rotation can be viewed as the frequency of change of magnitude in 3-axis magnetometers.

However, if there are some issues about calibration of 3-axis magnetometers, there is still other way to obtain information about tumbling motions and verify the result from Magnetometer Rate Estimator. RF signal for instance, by receiving successive RF signal, magnitude of rotation can also be regarded as frequency of change in power of signal. With ceaselessly rotation, the envelope of power signal will be a periodic curve resulting from antenna pattern. Time-frequency analysis can tell more related messages, such as bandwidth of RF signal, useful to filter signal, and frequency
shift during the communication, correlating with relative motions between cubesat and ground station. Furthermore, with power spectrum of RF signal, condition of received signal can be identified.

Preference for abstract consideration:

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