Low-power attitude determination for magnetometry planetary missions

This work covers the subject of orientation or attitude in space and on the surface of a planet. Different attitude sensor technologies have been investigated with emphasis on very low power consumption and mass. In addition robust methods for attitude determination have been covered again with emphasis on the limited budget onboard very small satellites. A true low-power attitude sensor using the Anisotropic Magneto Resistor effect have been designed to late prototype state. Two prototypes of the AMR magnetometer have been built. One of the prototypes has an analog output and the second prototype has a digital output similar to that of the VFM fluxgate magnetometer.

Four different sensors have been tested and the most suitable sensor has been selected for the AMR magnetometer. The AMR magnetometer has been tested with respect to range, linearity, sensitivity, noise and bandwidth. A scalar calibration has been performed on both of the prototypes of the AMR magnetometer with very good overall result. Different attitude representations such as orthogonal matrices, Euler angles and quaternions are presented. Also methods for attitude determination of a sensor platform with more than one vector instrument are presented. To achieve the highest possible accuracy the process of intercalibration of the sensor platform is also covered. Intercalibration in this respect means the determination of the relative attitude between the vector instruments in question.

The magnetic survey of the region between the North Pole and northern Greenland was used as a case. The sensor platform for the magnetic survey consists of a vector magnetometer and a vector accelerometer. The two instruments were individually calibrated followed by intercalibration of the sensor platform.

The data collected during the airborne magnetic survey was used to determine the attitude of the sensor platform. With the attitude of the vector magnetometer known, maps of the magnetic anomalies were made with the vector information still intact. The maps of the magnetic anomalies using vector data showed a greater level of details than the maps obtained using only scalar data.

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