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ASTROgyro

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Present state of the art attitude and orbit control systems (AOCS) in telecom satellites make use of autonomous star trackers (STR) and gyroscopes as separate sensors, with individual data processing located in the spacecraft central AOCS computer. In such a configuration, the star tracker has no direct access to the high bandwidth gyroscopic data. On the other hand, the gyroscope provides its pre-processed angle rate or rate-integrated information with low data rate solely to the central processing unit. There exists a well-known complementarity between the two types of sensors, but it is obvious that any hybridizing of sensor data is confined to execution in the s/c board computer.

The ASTROgyro (AGY) is a modular inertial reference sensor system, comprising two star trackers and two gyroscope units (each 3 axis) in a combined product. Both, star tracker and gyroscope take substantial benefit in their respective performance. Consequently, ASTROgyro improves the operational availability, robustness, and performance of rate and attitude measurements for the navigation tasks performed by the satellite AOCS system.

The ASTROgyro star tracker (AGS) is an evolution of the heritage ASTRO APS star tracker with more than 120 flight models under contract, 74 flight models delivered to customers and 28 units in orbit. Standalone, it has an accuracy better than < 1 arc-sec (1σ , xy-axis) and < 8 arc-sec (1σ z-axis). It was extended for an additional I/F to the gyroscope and for additional computational power to perform gyroscope data evaluation and data fusion.

For the ASTROgyro IRU (AGI) Coriolis Vibratory Gyroscopes were chosen because of its low complexity and high reliability. The gyroscope works up to a rate of 20 deg/sec with an Angle Random Walk < 0.01 deg/ $\sqrt{\text{hr}}$ (per axis) and a Noise Equivalent Angle < 0.4 arc-sec (1σ , per axis). The bias Instability (Allan deviation) of < 0.12 deg/hr (1σ , per axis) will be calibrated out on unit level by the support of the star tracker attitude data. Therefore, the gyroscope delivers its rate information with an update rate of 150Hz to the star tracker for calibration and data fusion.

The ASTROgyro system performs data fusion inside the star tracker processor and delivers drift-free 30Hz IRU data aided by 10 Hz STR attitude data. It achieves a Random Attitude Error of 1arcsecs (1σ all axis) and a Random Rate Error of 4 arcsec/sec (1σ , all axis). For star tracker blindings the gyro-assisted attitude bridging has an accuracy of better than 0.1 deg accuracy over a time period of 1000 sec. All data is delivered through the star tracker operational I/F to the AOCS system. This simplifies the accommodation on the S/C and enhances flexibility for different missions. For missions needing an IRU the complete ASTROgyro is used and for "gyro-less" missions only the AGS is used without changing H/W or S/W interface to the AOCS.