S3S Nanosatellite Star: Sensor Designed For Navigation

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When you're sending a satellite the size of a shoebox into orbit, it's safe to say that space is at a premium. Fortunately, a Ryerson researcher has devised a small-sized technology that is making a big impact onboard miniature satellites.

John Enright, an aerospace engineering professor, is principal investigator of Ryerson's Space Avionics and Instrumentation Laboratory (SAIL). There, he develops attitude sensors for spacecraft, and his latest invention – the S3S nanosatellite star tracker – has really taken off. Brought to the market by Sinclair Interplanetary, an Ontario-based supplier of spacecraft hardware, software, training and expertise, the S3S has already generated more than $700,000 in sales.

Attitude sensors, simply put, tell a satellite what it's looking at. A star tracker is a special type of attitude sensor that photographs stars and determines the satellite's heading from the distinct patterns of stars in the image. Accuracy is key; just one fuzzy picture or misidentified star could potentially send a satellite in the wrong direction.

“Star trackers have been used for quite a while,” Enright says. “They are highly accurate, but they demand a lot of mass, volume and power – all of which is in short supply onboard a small satellite.”

As a result, small satellites have had to make do with less accurate types of sensors. The S3S, however, offers the ideal solution. No bigger than a deck of cards and weighing only 90 grams, this star tracker is currently the smallest unit of its kind available on the market. It was expressly made to provide precise orientation information to small satellites, which offer significant cost-savings over their larger counterparts. In fact, the inventors hope that the S3S will enable new and innovative space missions that previously would have required a large spacecraft, and a large mission budget to match.

The S3S was developed by Enright, along with SAIL PhD candidates Tom Dzamba and Geoff McVittie, Cordell Gr ant of the Space Flight Laboratory of the University of Toronto Institute for Aerospace Studies, and Doug Sinclair of Sinclair Interplanetary. Enright’s team developed most of the onboard procedures that are used to see and match up stars, and ultimately estimate a satellite’s orientation. The group also developed techniques to focus and calibrate the sensors during the manufacturing process.

> *To assess the S3S’s accuracy, the researchers used computer-generated images in the lab that mimic stars.*

From there, field testing was done using real stars in the skies over North Toronto and California (“it was warmer and less cloudy,” Enright says). Also, numerous tests, including those involving motion, vibration and radiation, were used to verify that the S3S could survive the rigours of launch, and the space environment encountered in orbit. In the end, it was determined that the S3S could withstand three to five years in space, more than double the average design lifetime of most miniature satellites.

Today, as orders for the S3S continue to be fulfilled, Enright says his team is still an active participant in the production process. “Our lab continues to be involved in studying how to improve the sensors’ performance and general capabilities.”

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