Gyroscopes in Spaaaace!

Draper Laboratories Works Toward Safer Space Exploration

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Moving around in open space is a cautious endeavor. Without the luxury of gravity, the slightest push can send you twirling in circles or, worse, tumbling off into the unknown. Every motion must be thought out and deliberate, all the more so because our bodies take that luxury into account.

Because we've lived with gravity all our lives, every motion we make automatically adjusts for that extra bit of weight exerted on us. Space (and that weight's sudden absence), however, requires some adjustment. While tinkering on a satellite, you might find that your fine motor skills aren't quite as fine as they were on Earth as you reach to grab something and overshoot by a solid three inches.

So far, this hasn't been much of an issue. Most of humanity's work in space has been on the Moon, where gravity is at least still present, or around the International Space Station (ISS), where we can control the conditions astronauts operate under on the occasions they need to work outside the station and provide them with all manner of assistance, from handholds and tethers to robotic arms.

But NASA's upcoming efforts are increasingly taking place in the space between celestial bodies as opposed to on them. Their Asteroid Redirect Mission plans to move an asteroid into orbit around the Moon where astronauts will study it up close, while the long trip to Mars, whenever we take that leap, will see astronauts living in zero gravity for so long that their bodies will adjust to the lower gravity and begin to atrophy.

Now, astronauts aren't entirely helpless out in space. They have thrusters to get around in case of emergencies, but turning yourself into a human rocket is a brute force method of travel through space. Today's astronauts don't have a way of keeping themselves stationary while working short of bolting themselves down to something. Until we have something that lets astronauts remain stationary and oriented properly, operating in open space is a dicey proposition.

Luckily, Draper Laboratories is working to give space exploration a higher degree of precision with two new technologies: the Variable Vector Countermeasure Suit (or V2 Suit for short) and a jetpack. Both projects showcase the control moment gyroscope (CMG), which has been used in spacecraft and the ISS for a while now, but has never been compact enough for personal use.

CMGs utilize a spinning rotor and motorized gimbals that tilt the rotor. When the rotor is tilted, it, in turn, rotates the spacecraft or, alternatively, can resist rotation. In the V2 Suit, CMGs are used to simulate gravity, adding that extra bit of resistance that our bodies are used to. It won't be enough to give astronauts the exercise they need to resist muscle atrophy, but by simulating the gravity we're used to, it will make jobs requiring fine motor skills easier. In the jetpack, CMGs are being used to precisely rotate astronauts into position, adding some fine-tuned control where current propulsion systems are lacking. Both technologies will further help space explorers maintain their position and attitude (what way they're facing) while they work and move around.

Draper's main challenge will be to shrink the CMGs to a manageable size while making sure they don't consume too much energy and can be used long enough without falling into a "singular configuration" to be practically used.

A singular configuration occurs when the gyroscopes start counteracting each other or one has just rotated as far as it can. The former would create a net motion of zero, while the latter would effectively cut off an entire direction of motion. The problem is more pronounced for smaller CMGs since their size means they can't turn as far before they hit that singular configuration.

Draper's plan is to use a four-gyroscope system, with three to handle pitch, roll and yaw and a fourth gyroscope held in reserve that the jetpack's programming would use as needed to prevent the abovementioned problems from occurring.

The minds at Draper Labs still have considerable amounts of work ahead of them before their prototypes become standard-issue equipment, but they also have an equally considerable amount of time. NASA's Asteroid Redirect Mission won't be happening until the "mid-2020s," and a manned trip to Mars is still eternally just beyond the horizon. But whenever we finally get there, the astronauts we send may boldly go with a fancy new gyroscope jetpack on their backs. **PTE**

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