steel tubing. One end has a slightly larger knurled collar affixed while the other end is tapered/pointed and threaded. When the two portions are assembled, the all thread/rod portion feeds through the tubing and is threaded into the expanding hex head fitting. The tapered point allows it to be driven into the through hole of the hex fitting. While holding the smaller collar on the shaft, the user turns the larger collar, and as the threads feed into the fitting, the hex head expands and grips the SHCS, thus providing a safe way to install and remove fasteners. The clamping force retaining the SHCS varies depending on how far the tapered end is inserted into the tool head.

Initial tests of the prototype tool, designed for a 5 mm or # 10SHCS have resulted in up to 8 lb (≈35.6 N) of pull force to dislodge the SHCS from the tool. The tool is designed with a lead-in angle from the diameter of the tubing to a diameter the same as the fastener head, to prevent the fastener head from catching on any obstructions encountered that could dislodge the fastener during retrieval.

This work was done by John Bishop of QinetiQ for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16109-1

Diagonal-Axes Stage for Pointing an Optical Communications Transceiver

Potential applications include steering aircraft-mounted cameras for ground imaging.

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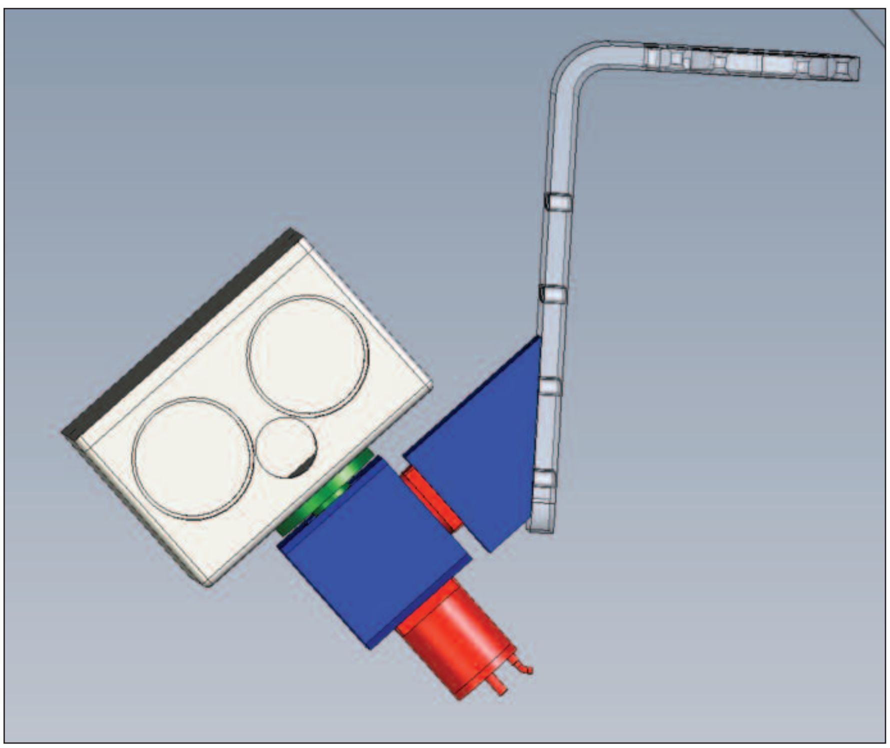
Traditional azimuth-elevation ("az-el") stages are used to point a variety of devices ranging from large optical telescopes to tank guns. Such a stage typically has an "elevation" stage having a horizontal axis mounted on an "azimuth" stage with a vertical axis. Both stages are often motorized.

Optical communications transceivers often require two-axis motorized control, as when the communications link is between a ground station and an aircraft or satellite. In such applications, the traditional azimuth-elevation stage has two important drawbacks: a "gimbal lock" exclusion zone at zenith and susceptibility to pointing errors caused by backlash. Az-el stages in which the azimuth stage cannot rotate a full 360° have the additional drawback of an azimuth exclusion zone.

The diagonal-axes stage described here mitigates or eliminates all of these problems. Instead of one vertical axis and one horizontal axis, a diagonal-axes stage has two horizontal axes, both oriented at 45° to the trajectory of the target. For example, a ground station located on the equator tracking a satellite with an equatorial orbit would have one axis parallel to northeast and southwest, and the other axis parallel to northwest and southeast.



A design based on the **Diagonal-Axes Stage** principle. Motors are shown in red, wedge and intermotor block are shown in blue, and the payload hub is green. The box at left with three circular apertures is an example of an optical payload; the L-bracket at left is a mounting bracket supporting the stage. Direction of travel is right-to-left.

The diagonal-axes stage is considerably less vulnerable to backlash. If it is correctly oriented, its axes rotate in only one direction during an overhead pass by a satellite. As a result, the effects of backlash may be inherently eliminated. If the gravity-induced torque on either axis changes during the pass, then backlash may become important during the part of the pass where the gravity torque, instead of opposing the motion of the stage, pushes the stage in the direction of motion. This can result in the loss of gear-to-gear contact in one or more stages of the gear reduction mechanism. In this case, a preload spring used to eliminate backlash need only be sufficiently strong to overcome the gravity torque, i.e. it need not overcome friction in the gear train.

The diagonal-axes stage is not backlash-free for arbitrary target trajectories such as an aircraft might execute. If properly oriented for any particular satellite, however, it is backlash-free for all passes of that satellite, which will trace out parallel paths on the sky, and for all passes of any other satellite that are perpendicular to the first. It will also be backlash-free for some fraction of other satellite trajectories.

This work was done by Martin W. Regehr and Vachik Garkanian of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47427