Development of Biomorphic Flyers

Autonomous flight control and navigation in small size is offered for planetary and terrestrial exploration applications.

NASA’s Jet Propulsion Laboratory, Pasadena, California

Biomorphic flyers have recently been demonstrated that utilize the approach described earlier in “Bio-Inspired Engineering of Exploration Systems” (NPO-21142), NASA Tech Briefs, Vol. 27, No. 5 (May 2003), page 54, to distill the principles found in successful, nature-tested mechanisms of flight control. Two types of flyers are being built, corresponding to the imaging and successful, nature-tested mechanisms of exploration applications. The sensor is about 40 times lighter than a comparable inertial attitude reference system. Other significant features of the biomorphic flyer shown in the figure include its ability to fly at high angles of attack (~30°) and a deep wing chord which allows scaling to small size and low Reynolds’s number situations. Furthermore, the placement of the propulsion system near the center of gravity allows continued control authority at low speeds. These attributes make such biomorphic flyers uniquely suited to planetary and terrestrial exploration where small size and autonomous airborne operation are required.

This work was done by Sarita Thakoor of Caltech for NASA’s Jet Propulsion Laboratory and by Dean Soccol, G. Stange, Geno Ewyk, Matt Garratt, M. Srinivasan, and Javaan Chahl of Australian National University and Butler Hine and Steven Zornetzer of Ames Research Center for the NASA Intelligent Systems Program. Automated Precision, Inc. Further information is contained in a TSP (see page 1).

Second-Generation Six-Limbed Experimental Robot

This robot is designed to be more agile and dexterous than its predecessor.

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The figure shows the LEMUR II — the second generation of the Limbed Excursion Mechanical Utility Robot (LEMUR), which was described in “Six-Legged Experimental Robot” (NPO-20897), NASA Tech Briefs, Vol. 25, No. 12 (December 2001), page 58. The LEMUR II incorporates a number of improvements, including new features, that extend its capabilities beyond those of its predecessor, which is now denoted the LEMUR I.

To recapitulate: the LEMUR I was a six-limbed robot for demonstrating robotic capabilities for assembly, maintenance, and inspection. The LEMUR I was designed to be capable of walking autonomously along a truss structure toward a mechanical assembly at a prescribed location and to perform other operations. The LEMUR I was equipped with stereoscopic video cameras and image-data-processing circuitry for navigation and mechanical operations. It was also equipped with a wireless modem, through which it could be commanded remotely. Upon arrival at a mechanical assembly, the LEMUR I would perform
**Miniature Linear Actuator for Small Spacecraft**

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A report discusses the development of a kit of mechanisms intended for use aboard future spacecraft having masses between 10 and 100 kg. The report focuses mostly on two prototypes of one of the mechanisms: a miniature linear actuator based on a shape-memory-alloy (SMA) wire. In this actuator, as in SMA-wire actuators described previously in NASA Tech Briefs, a spring biases a moving part toward one limit of its stroke and is restrained or pulled toward the other limit of the stroke by an SMA wire, which assumes a slightly lesser or greater “remembered” length, depending on whether or not an electric current is applied to the wire to heat it above a transition temperature. Topics addressed in the report include the need to develop mechanisms like these, the general approach to be taken in designing SMA actuators, tests of the two prototypes of the miniature linear actuators, and improvements in the second prototype over the first prototype resulting in reduced mass and increased stroke. The report also presents recommendations for future development, briefly discusses problems of tolerances and working with small parts, states a need for better understanding of behaviors of SMAs, and presents conclusions.

*This work was done by Cliff E. Willey and Stuart W. Hill of Johns Hopkins University Applied Physics Laboratory for Goddard Space Flight Center. Further information is contained in a TSP (see page 1).*

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