

tate the separation drum. The electrostatic separator uses a high-voltage power module that generates an electrostatic field with very low power consumption. Small vibrators and smooth surfaces placed at appropriate angles are used to avoid particle hang-up.

This system is amenable to testing and operation in vacuum, and the operating parameters and hardware configurations can also be adjusted for testing and evaluation in reduced gravity.

This work was done by Mark Berggren of Pioneer Astronautics for Glenn Research Cen-

ter. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18515-1.

Advanced Aerobots for Scientific Exploration

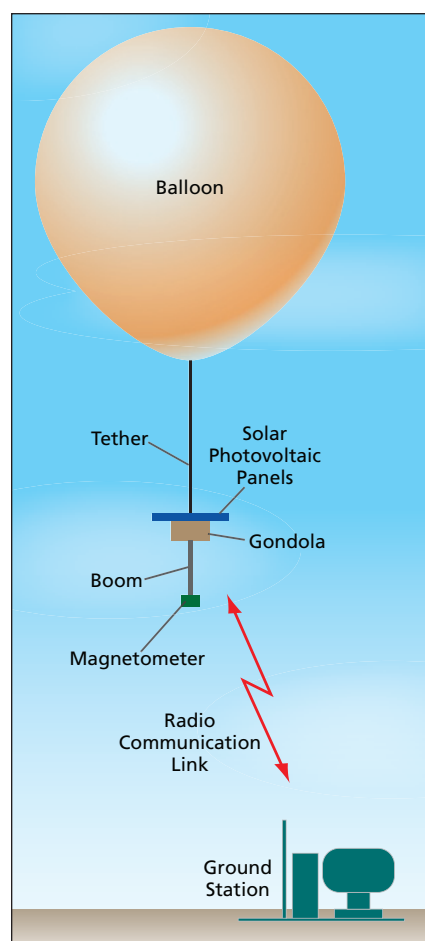
Relative to prior such aerobots, these are much less massive.

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The Picosat and Uninhabited Aerial Vehicle Systems Engineering (PAUSE) project is developing balloon-borne instrumentation systems as aerobots for scientific exploration of remote planets and for diverse terrestrial purposes that can include scientific exploration, mapping, and military surveillance. The underlying concept of balloon-borne gondolas housing outer-space-qualified scientific instruments and associated data-processing and radio-communication equipment is not new. Instead, the novelty lies in numerous design details that, taken together, make a PAUSE aerobot smaller, less expensive, and less massive, relative to prior aerobots developed for similar purposes: Whereas the gondola (including the instrumentation system housed in it) of a typical prior aerobot has a mass of hundreds of kilograms, the mass of the gondola (with instrumentation system) of a PAUSE aerobot is a few kilograms.

The figure schematically depicts a recent PAUSE aerobot designed and built for terrestrial demonstration and testing in the development of a Mars-exploration aerobot. This aerobot includes a gondola with instrumentation system having a total mass <5 kg, the exact mass depending on which of two alternative configurations is chosen. The gondola is suspended from a 12-m-diameter helium balloon, rated at a helium gauge pressure of 5 mb (500 Pa), that is capable of supporting a load of as much as 15 kg for as long as 24 hours.

One of the instruments is a magnetometer. To isolate the magnetometer sensor head from magnetic fields generated by other equipment, the magnetometer sensor head is mounted at the outer end of 0.8-m-long fiberglass boom that extends from the gondola. Also



This **Aerobot** is a prototype of planetary-exploration and terrestrial aerobots having masses of only a few kilograms.

mounted on the boom are an external-temperature sensor and a downward-looking electronic camera containing a complementary metal oxide/semiconductor (CMOS) image sensor.

The gondola houses the magnetometer boards; two other CMOS imagers (one aimed upward, the other aimed

horizontally); a spread-spectrum radio transceiver operating at a nominal carrier frequency of 900 MHz; a flash electronic memory having a capacity of 1GB; a single-board computer; a pressure sensor; lithium primary batteries in one configuration or solar photovoltaic panels (on top of the gondola) and lithium-ion rechargeable batteries in the other configuration; a battery-current sensor; a serial multiplexer; voltage converters; a Global Positioning System (GPS) receiver; and an inertial measurement unit (IMU) that consists of accelerometers, gyroscopes, and magnetometers for all three coordinate axes.

The single-board computer takes temperature, pressure, IMU, battery current and voltage, and GPS readings at time intervals of one second. The magnetometer data are read at a repetition rate of 4 Hz, and an average of four successive readings is recorded every second. The cameras are set to automatically acquire images at intervals of five minutes, but they can also be commanded to acquire images at any time. The data (including digitized images) are both stored in the flash memory and transmitted via the radio transceiver to a ground station. The data transmissions are programmed to take place at set intervals; in addition, data transmissions can also be commanded at any time from the ground station. The instrumentation system has an average power demand <4 W, with occasional jumps to 7 W during transmission of data.

This work was done by Alberto Behar, Carol A. Raymond, Jaret B. Matthews, Fabien Nicaise, and Jack A. Jones of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42737