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AIAA INTERNATIONAL BALLOON TECHNOLOGY CONFERENCE

(subject to JPL approval)

The Development of a Planetary Aerobot Testbed (PAT)

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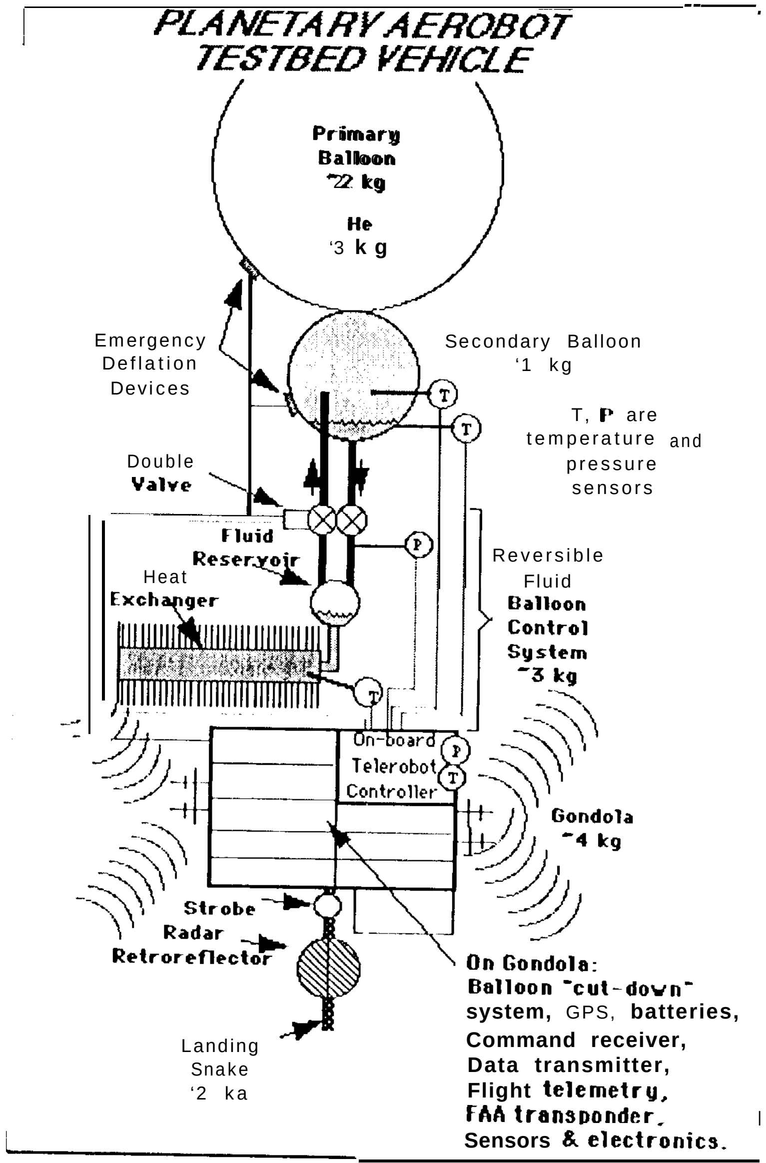
The exploration of the solar system is now centered around mobile surface exploration. Many proposed missions for surface and atmospheric research often allow only one chance to retrieve data in a single, predetermined spot. Autonomous robotic balloons, known as aerobots, provide an unobstructed, predictable means of visiting (and revisiting) many location< along a planet's surface over an extended period of time. Through the use of prevailing wind patterns and altitude control systems, an aerobot has the ability to predict and learn how to reach a target location. It is self-learning and self-sustaining. An aerobot will have more than one opportunity to perform a maneuver needed to view geological features, take environmental readings, or reach a designated landing site. Both global (e.g. wind patterns) and precise (e.g. ground sample analysis) research can be conducted over an entire planet An aerobot also provides the opportunity to analyze an area multiple times and recover from previous trajectory problems. Aerobots are defined and characterized by having one or more of the following chracteristics: 1) autonomous determination of position and velocity; 2) cyclic altitude path about a mean altitude; 3) control of altitude and flight path; and 4) control of landing at a designated surface location.

This paper discusses the design and deployment of the Planetary Aerobot Testbed (PAT), a flying testbed for aerobot technology. The primary purpose of PAT is to develop the telerobotic technologies necessary to fly Aerobots in the atmospheres of Mars, Venus, Titan, and the outer planets. In addition, PAT will also demonstrate new science techniques such as imaging from a moving balloon. The PAT vehicle will conduct a series of terrestrial technology demonstrations which will: 1) move gradually from manual teleoperated control of the robotic vehicle to fully autonomous altitude change and landings; 2) achieve increasingly long-range mobility from widely separated launch and landing sites (first predicted sites followed by designated sites).

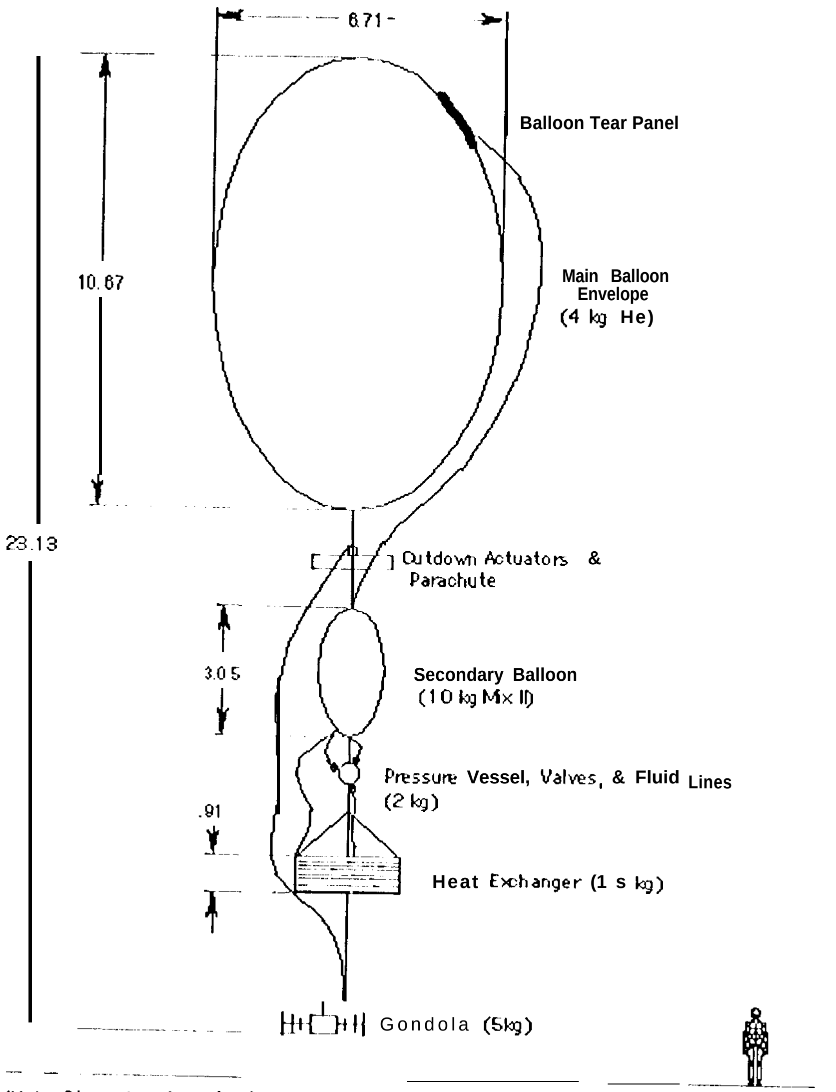
The PAT design consists of four primary functional systems (*see attached figures)*: the Buoyancy Control System (BCS), Radio Frequency Systems (RFS), Robotic Controller System (RCS), and PAT Operations System (POS). The BCS provides the lift and buoyancy control capability. It is composed of a main balloon (10 kg. of helium), a secondary balloon (reversible fluid), pressure vessel and valves, and a heat exchanger. in addition, recovery systems would include: a cutdown device, deflation device, and parachute. The RFS system, the aerobot telemetry subsystem, uses a line-of-sight radio to transmit on-board GPS readings, along with satellite data telephones for site-to-site (tracking, launch, and JPL) data transmission. The robotic controller will be composed of an Intel x86 architecture, running the VxWorks real-time operating system. It will perform a number of on-board functions, including valve control, power subsystem monitoring, and interpretation of uplink commands. Ground operations and visualization will be performed by the operations system, a predictive display and control workstation. "Ibis workstation ill collect and monitor all flight data, and use this data to predict and model the PAT trajectory.

The PAT gondola system is the housing structure for PAT instruments. To facilitate future instruments and navigation sensors, this simple instrument package is designed for rapid addition/removal of on-board sensors and efficient electrical integration. Initially, it would house a suite of navigation sensors, such as pressure, air speed, acceleration, rate gyro, imager, sun-sensor, and magnetic indicators. From these sensors, a number of estimators would be derived, including vertical motion, platform attitude, inertial translation, ground motion, and srrn-sensor. These navigation estimators would be used for autonomous slate determination and subsequent path prediction and planning. The science demonstration camera would also extend from the gondola housing structure. This camera would be used to demonstrate new technology options, including exposure required for high dynamic range, exposure required for high resolution, and effectiveness of swing/span timing. The total mass of the gondola and housed instruments is not to exceed 10 kg..

The earliest proposed launch date for the PAT vehicle would be November/December, 1996. This time line is heavily dependent don good/predictable weather at the designated launch site, as well as on-time completion of systems tests.


PLANETARY AEROBOT TESTBED VEHICLE
Primary Balloon ~2 kg
He ~3 kg
Emergency Deflation Devices
Secondary Balloon ~1 kg
T, P are temperature and pressure sensors
Double Valve
Fluid Reservoir
Heat Exchanger
Reversible Fluid Balloon Control System ~3 kg
On-board Telerobot Controller
Gondola ~4 kg
Strobe
Radar Retroreflector
Landing Snake ~2 kg
On Gondola: Balloon "cut-down" system, GPS, batteries, Command receiver, Data transmitter, Flight telemetry, FAA transponder, Sensors & electronics.

PAT Size for 16.S km max attitude, 6.0 kg payload, 9°A BCM



(Note : Dimensions in meters)