Control Systems for the Mars Pathfinder Mission[1]

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The Mars Pathfinder Project began in October 1993, along with the Near Earth Asteroid Rendezvous Program, as one of the first Discovery Program missions funded by NASA. The Mars Pathfinder Project is planned, designed, launched and operated by JPL Mars Pathfinder Project Team under the management of JPL Mars Exploration Project Office. The project is intended to be JPL's most visible demonstration of a successful better, faster, cheaper mission in accordance with NASA's new direction.

Mars Pathfinder will place a lander vehicle and rover on the Mars Surface and conduct significant technology and science experiments. The principle mission objective is to demonstrate a low cost cruise, entry, descent and landing system required to place a single payload on the Martian surface in a safe operational mode. Additional objectives include the deployment and operation of three science instruments and operation of the Microrover Flight Experiment. Mars Pathfinder will set the course for future Mars lander missions as part of a comprehensive NASA Mars exploration program.

Mission phases include Launch, Cruise, Entry and Descent, Landing and Surface Operations. In order to accomplish the mission, the spacecraft is comprised of three stages: cruise vehicle; entry capsule; and lander vehicle. The Cruise vehicle includes a Magellan-heritage Star Scanner, 5 digital Sun Sensors and 8 one pound Thrusters. Four Trajectory Correction Maneuvers are planned during the cruise phase. At Mars arrival, the cruise stage is jettisoned from the entry capsule. The entry capsule enters the Martian atmosphere directly from the Earth-Mars transfer orbit at a velocity of 7.6 km/s. The entry vehicle velocity is reduced through the sequential application of aerodynamic braking by a Viking heritage aeroshell and lander to absorb the remaining energy during touch-down on the Martian surface. Parachute deployment is triggered by detection of 15 Earth g's deceleration by a set of 3 accelerometers. Rocket firing occurs following parachute-assisted slowdown. The rockets are ignited at 50 meters above the surface. A small radar altimeter is used to trigger the rocket motor firing by measuring the altitude and deriving the velocity of the swinging vehicle.

After landing, the airbags are retracted onto the lander and three petals are deployed to right the lander. On the surface, an articulatable High Gain Antenna provides relatively high speed Earth communications. Surface attitude determination utilizes the science Imager for Mars Pathfinder camera to locate the sun, and the previously mentioned accelerometers for detection of the local vertical. On-board Inertial Vector Propagation provides the Earth's direction. The activities in this phase are primarily focused on establishing the full operational

configuration of the camera, High Gain Antenna and rover. The Imager for Mars Pathfinder camera will provide a high-resolution stereoscopic view of the Martian surface. All of these mission activities are controlled by the Mars Flight Computer, a commercially available Loral RSC-6000 risc computer capable of 22 mips, with 128 megabytes of high-density dynamic RAM and 4 megabytes of eeprom.

This paper describes the control systems employed by the Mars Pathfinder spacecraft during Cruise, Entry and Descent, Landing and Surface operations. Hardware as well as software algorithm design is discussed. The paper will also describe early test results.

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