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LANDING THE FIRST ISRAELI SPACECRAFT ON THE MOON

Abstract

Team SpaceIL participates in the Google Lunar X-prize (GLXP) race for building an autonomous vehicle to land on the moon and aims to do so by 2015. Designing a mission for landing on the moon is extremely challenging and requires the joint effort of various teams working on different aspects of the mission including mission computer, ground control station, attitude and orbit control, propulsion system, communication, etc. SpaceIL has recently undergone a full preliminary design review (PDR) for its systems and subsystems. Here we will provide outlines for the design of a mission aiming to land the smallest vehicle to ever land on the moon (140kg). We will discuss mission design issues stemming from our strict constraints and focus on the attitude and orbit control system (AOCS). The AOCS team is in charge of 4 logic states of the spacecraft: cruise, trajectory maneuvers, landing and hopping (achieving the 500 GLXP meter displacement requirement). The system is passive during cruise mode while spin stabilized and pointing the solar panels to the sun. Correction maneuvers, as well as the landing and hopping maneuvers are 3 axis stabilized and are initiated by a ground station command and automatically carried out by the spacecraft. The AOCS is composed of: 1. A novel sensory layer containing inertial measurement unit (IMU), star tracker (STR), RADAR for altitude measurements and several innovative optical sensors for providing 6-DOF state of the spacecraft based on image recognition (sensor was tested successfully in a rocket propelled experiment) and a novel sensor algorithm for hazard detection during the landing phase. 2. A unique Navigation system which fuses the input from the sensory layer and estimates the relevant spacecraft state in each of the mission phases. Unlike similar navigation systems, our system is capable of meshing data from different sensors configurations and switch from different configurations "on the fly" as sensors may malfunction during the mission. 3. Controller layer which receives the spacecraft state and process it through the guidance, navigation control and engines control loops to provide the proper engines commands. 4. Real time environmental simulation which models the system dynamics, engines force, sensors and errors. The simulation also generates real time imagery as it would be received from the spacecraft's cameras. The paper will focus on the most crucial mission of the AOCS which is the landing procedure and lay out its main phases.