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Author: Mr. CHRISTIAN MENDOZA
Project Polaris - AREX, Bolivia, christian.mendoza2pw@gmail.com

Mr. Jerry Varghese
Purdue University, United States, varghese.jerryj@gmail.com
Mr. Andrés Jiménez Mora
Instituto Tecnológico de Costa Rica (TEC), Costa Rica, andjm1428@gmail.com
Mr. Gabriel Blanco Mora
Instituto Technologico de Costa Rica, Costa Rica, gaboblanco@estudiantec.cr

MULTIPLE INPUT MULTIPLE OUTPUT ADAPTIVE CONTROLLERS FOR A TITAN ROVER CONCEPT

Abstract

Project Polaris is an international student organization that seeks to design a buoyant rover capable of exploring Saturn's moon, Titan. The rover consists of a balloon and a payload, which contains scientific instruments. Titan has specific constraints such 1/7th Earth gravity, methane/nitrogen atmospheric composition, supersonic winds and other environmental adversities. The rover requires an adaptive control system that can deal with these conditions, and fulfill the mission requirements in such an environment. The Star Rover will maintain translational control using thrusters and altitude control using a balloon. Selection of the thrusters' configuration will be selected on fuel efficiency and complexity.

A mathematical model of the system that considers the equations of motion has partially been developed as a state space model currently with thirteen states. As such, the rover-wide controller will be a MIMO type (Multiple Inputs and Multiple Outputs). A dynamics control law will then be designed to control the rover under wind perturbations. An IMU (Inertial Measurement Unit) will determine translation and orientation as inputs for the MIMO controller.

In addition to vehicle dynamics, the MIMO controller will be responsible for triggering event sequences on the OBC (onboard computer), when certain input states are reached, i.e., task scheduling. These event sequences would include communication protocols and activating experiments, as a function of states such as elapsed time or altitude.

After verifying that the theoretical controller design satisfies the control requirements, physical testing will be implemented by using a mini-computer as the OBC. The performance of the controller will be evaluated in a mimicked environment by testing the behavior of the Star Rover in strong winds, a stable environment without disturbances, and even in the rain. This will allow the improvement of the controller, consideration of new variables in the mathematical systems model, and improvement of task scheduling.