

# **DEVELOPMENT OF A LOW-COST ANTI-TILTING ROVER FOR PLANETARY EXPLORATION**

Program Element – Innovative Technologies and Concepts  
Application Thrusts – Planetary Exploration  
Technology Themes – On-Orbit and Planetary Robotics

A Proposal Submitted To  
**Canadian Space Agency**

By  
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## **Technical Objectives**

The objectives of the project are to develop concepts and the associated enabling technologies to use simple and low-cost robotic devices for future planetary exploration missions. A two-wheeled robot rover is proposed here to serve the needs of future low-cost space missions involving the exploration in rough terrain environments. The motivation of this research is to apply inexpensive and ready-to-deliver technologies to space exploration and investigate the potential roles of simple robotic devices in fulfilling the mission tasks of the planetary exploration program in the next ten years. The technical objectives of the proposed project are thus to

- 1) establish the concept of using a simple two-wheeled rover, which contains only three main bodies – two hemispherical wheels and a central body, in future planetary exploration missions to reduce the program cost and enhance operation reliability
- 2) derive mathematical models of the proposed rover to perform kinematics/dynamics analysis and explore the full potential of the rover in accomplishing scientific tasks in future planetary exploration missions
- 3) develop a robust control scheme of the two-wheeled rover for rough-terrain traversing
- 4) prove the concept and demonstrate the rover capabilities via computer simulation, and
- 5) mature the readiness of the technology to the targeted (Technology Readiness Level) TRL level

Upon successful completion of the project, we expect to accomplish:

- 1) A good understanding of the properties and capabilities of the proposed rover in connection with future space applications
- 2) A mathematical model and a robust control algorithm
- 3) Computer simulations of the rover performing typical tasks on rough terrain

The current TRL of the proposed project is identified as 1, while the TRL targeted at the end of the project is 3.

## **Technological Innovation**

The main innovations of the project are:

- 1) Compared with the existing rovers that usually have four to six wheels, the proposed rover has a much simpler architecture, which makes it easy to build, maintain and operate, thereby leading to a lower mission cost.
- 2) The proposed rover does not need complicated control algorithms. It can have different modes, which gives it advantages in performing certain tasks, such as climbing steep slopes in a special manner and allows it to recover from tip-over accidents quickly and swiftly
- 3) The proposed rover can be regarded as a basic "element" in the rover family---It can be used as a "building block" of rovers with more than two wheels. Moreover, two or more of the proposed rovers can work together as a "robotic work crew" to perform coordinated tasks involving heavy and bigger-sized payloads.
- 4) The proposed rover can be used to perform special tasks, such as surveying of the Martian surface based on its trajectory history. Higher resolution results can be achieved using the rover, as compared with satellite imaging.