IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Ms. SHAMBHAVI A S
Defence Research and Development Organization (DRDO), India

Mr. Prabhanjan Manjunath
Manipal Institute of Technology, India
Mr. Amaranath Siddaraddi
Nitte Meenakshi Institute of Technology, India
Dr. SRIKANTH H V
Nitte Meenakshi Institute Of Technology., India
Dr. Prahalad N Tengli
Nitte Meenakshi Institute of Technology, India
Mr. Sanath Kumar Naik L
CSIR-National Aerospace Laboratories (CSIR-NAL), India
Mr. Rohan Shinde
Manipal Institute of Technology, India
Mr. Vivekananda N
Nitte Meenakshi Institute of Technology, India
Mr. TEJAS NARESH REDDY
AgniKul Cosmos, India
Ms. Shreya S
Student, India
Mr. Amit S Herkal
Nitte Meenakshi Institute of Technology, India

INNOVATIVE STRATEGIES FOR MARTIAN EXPLORATION: AERODYNAMIC ANALYSIS OF SWARM UAVS FOR ENHANCED REMOTE SENSING

Abstract

Exploring Mars and gathering crucial scientific data within its remote and harsh environment presents formidable challenges. Remote sensing emerges as a pivotal technique in this pursuit, enabling data collection from Mars without direct physical interaction. Unmanned Aerial Vehicles (UAVs) appear promising for remote sensing on Mars, yet their deployment faces substantial hurdles, including restricted range, environmental risks, and rugged terrain. To confront these obstacles, a groundbreaking strategy was proposed which uses swarm UAVs for remote sensing operations on Mars named AVSAROM (Aerial Vehicle Swarm and Reconnaissance of Mars). This paper presents a meticulous exploration of the aerodynamic intricacies and operational dynamics of a AVSAROM tailored for Martian exploration. The primary UAV, characterized by a wingspan of 1500 mm, a length of 500 mm, and a propeller diameter of 400 mm, is accompanied by four secondary UAVs featuring a compact cube airframe measuring 60 by 60 mm, equipped with double rotors of 700 mm diameter each. The operational sequence of this AVSAROM system is engineered for mission-critical efficiency, encompassing distinct phases such as a precision take-off stage with secondary UAVs attached, a phase dedicated to travel for the attainment of horizontal velocity, the strategic detachment of secondary UAVs, a coasting phase integrated with remote sensing capabilities, and a controlled landing, followed by the precise reattachment of secondary UAVs. This study delves deep into the aerodynamic characteristics of the secondary UAVs, offering a nuanced analysis of their behaviour during pivotal phases such as detachment and reattachment. Critical mission phases undergo meticulous scrutiny, focusing on the gas-structure interaction during flight. Notably, the design of the attachment rod emerges as a focal point, prompting an in-depth exploration encompassing rigorous modifications and comparative assessments aimed at optimising aerodynamic performance. In future research, the trajectory is set towards refining and enhancing the capabilities of the AVSAROM system. This includes the development of waypoint navigation strategies, formulating algorithms to facilitate seamless attachment and detachment of secondary UAVs, and the exploration of terrain mapping simulations. These advancements, rooted in a scientific understanding of aerodynamic principles, not only bolster the robustness of swarm UAVs for Martian exploration but also chart a course for sophisticated data acquisition and exploration missions in extraterrestrial environments. This paper serves as a foundational contribution to the evolving landscape of UAV technology crucial for advancing scientific endeavours in Martian exploration.