Paper ID: 95740
oral
student

32nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Space Science Missions (2)

Author: Ms. Jessica Sillus
The Ohio State University, United States

Mr. Ian Harris
The Ohio State University, United States
Dr. John M. Horack
The Ohio State University College of Engineering, United States
Ms. Annabelle Zerby
The Ohio State University, United States
Mrs. Stephanie Small
The Ohio State University, United States
Ms. Svitlana Pryymachuk
The Ohio State University, United States
Mr. Max Heil
The Ohio State University, United States

CUBESAT MISSION DESIGN TO MEASURE LOCALIZED MAGNETIC FIELDS ON MARTIAN SURFACE UTILIZING ARTIFICIAL INTELLIGENCE AND ATMOSPHERE BREATHING ELECTRIC PROPULSION

Abstract

Understanding Mars' magnetic field is vital for identifying potentially habitable locations. Unlike Earth, Mars lacks a global magnetic field, exposing its surface to harmful radiation. However, localized magnetic anomalies which are likely due to remnants of a once active global magnetic field, exist near craters and volcanoes, potentially providing small regions of radiation protection suitable for future human habitation. Previous missions, including the Mars Global Surveyor (1996), gathered low-resolution magnetic data due to outdated instruments. Ingenuity (2021–2024) later recorded significantly stronger magnetic fields in a localized region, highlighting the need for higher-resolution data. The objective of this project was to design a 12U CubeSat mission equipped with modern magnetometers to obtain high-resolution magnetic field data by focusing on areas with craters. By orbiting at low altitudes utilizing atmosphere breathing electric propulsion (ABEP) and implementing Artificial Intelligence (AI) to process and transmit data around areas of interest, the mission aimed to produce detailed magnetic field maps to inform scientific research and human exploration efforts. ANSYS Systems Tool Kit was used to determine orbital parameters, including launch and arrival dates, with a ground track between –60 degrees and 60 degrees longitude, where Mars Global Surveyor detected strong magnetic fields. SolidWorks was used to design the satellite and verify compliance with CubeSat deployer standards through fit and vibration analyses. A Convolutional Neural Network (CNN), developed using Keras and TensorFlow, enables the CubeSat to identify craters in real time with its camera and on-board computer, reducing data transmission needs and prioritizing areas of interest. ABEP was implemented to use the Martian atmosphere as propellant for an electric propulsion system to overcome the low-altitude-associated drag. Thermal Desktop simulations ensured effective thermal management throughout the mission, validating components stay within operational temperatures. The Systems Tool Kit simulations confirmed a feasible transfer from a sun-synchronous Earth orbit to Mars, with successful orbital insertion and tracking. Structural

simulations in SolidWorks demonstrated that the satellite's deformation under vibrational loads remained within Nanoracks CubeSat Deployer tolerances. AI testing verified the system's ability to accurately identify craters compared to other geological features. This mission integrates heritage designs with modernized instrumentation, sustainable propulsion, and advanced AI to collect critical magnetic field data. The results validate the feasibility of interplanetary CubeSat missions and demonstrate ABEP's potential for sustained low-altitude Mars operations, contributing to the search for habitable regions.