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HARDWARE AND SOFTWARE REDUNDANCY CONCEPTS ON-BOARD OF SONATE-2

Abstract

SONATE-2 is a 6U-CubeSat, which main mission goal is the in-orbit demonstration of a newly developed AI processing platform. Experiments running on this platform include lightening detection, image segmentation and anomaly detection in images taken by the satellite. Thereby, on-board training of neural networks for AI based image processing applications will be demonstrated. Secondary mission objectives include the verification of AOCS components, tests of the ADCS's target-pointing capabilities and the operation of an amateur radio payload. The SONATE-2 satellite is planned to be launched into a SSO in Q1 2024.

In satellites, redundancy plays a key role due to the lack of hardware-based maintenance availability, but also because of the harsh space environment. Therefore, SONATE-2 consists of two fully redundant 5V and 12V busses which supply the satellite's subsystems and payloads with the required amount of power. Redundant subsystems are connected to one of the two power busses. In case of a power failure on one of the two busses, the redundant component supplied by the other bus is then still operational.

A key element of the design of SONATE-2 is hardware-based redundancy of the communication subsystem, the ADCS, the OBDH and the AI payload. Each of these subsystems is included multiple times on-board. SONATE-2's communication subsystem consists of two VHF-, two UHF- and two S-Band transceivers and antennas. The ADCS includes two processing computers and a total of four three-axis magnetometers, four three-axis gyroscopes, six reaction wheel, six magnetorquer and 12 sun sensors. On-board data handling tasks are executed by one of four available OBDH computers. The decision which OBDH is executing the telecommand processing and housekeeping tasks is determined by a software-based role arbitration. Furthermore, the AI-payload which consists of a Nvidia Jetson Xavier NX and four cameras is integrated in the satellite twice.

Each of these subsystems have further built-in software-based redundancy concepts, including fault detection, isolation, and recovery algorithms as well as redundant saved configurations. This paper gives a

brief overview of the SONATE-2 mission with the focus on the built-in hardware and software redundancy concepts of the satellite bus and the payloads on SONATE-2.