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Highly Integrated Distributed Systems (7)

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QUSAD – AN INTERACTIVE, SPACE MISSION ANALYSIS, DESIGN, AND SIMULATION TOOLKIT

Abstract

Due to standardisation and technological advancements in miniaturization CubeSats have become more and more popular and enable space accessibility for a broad community, allowing university students to gain hands-on experience in satellite and space mission design. A continuously increasing number of manufacturers offer hardware for CubeSats that is conform to the standard. The variety of components poses the challenge of finding an optimum component combination without exceeding the mission requirements and resources. An optimum design needs the possibility to choose from a large pool of components while using design analyses methods to evaluate the potential of the design. To keep a tool at hand that condenses the necessary knowledge of components, system, mission design, operations, and analysis functionality, the Institute of Space Systems at TU Braunschweig (IRAS) is developing an Interactive, Space Mission Analysis, Design, and Simulation Toolkit. The toolkit's core module is QuSAD (SQL-Based CubeSat Analyse and Design Tool). It consists of an SQL and a MATLAB segment. An SQL database with available Commercial off the Shelf (COTS) CubeSat components was developed, consisting of more than 230 components sorted by ADCS, EPS, OBDH, communication, propulsion, structure, payloads subsystems, and available kits. Additionally, a database for customized components either own developments or for educational purposes is implemented. The MATLAB segment provides a graphical user interface and an extendable modular structure that can connect and interact with the database, accommodate basic tools to assist the design process, analyse trade-off parameters, and evaluate design budgets. The user can interactively select his satellite mission using COTS components from the database and integrate them into a virtual satellite. Subsequently, the design can be analysed, saved and optimised using the Profile Viewer to assess mass, volume, cost, link, and power budgets. The software provides three main functionalities in the current state: database handling, CubeSat design, and profile view. Future development of the tool should extend the COTS database and existing modules, implement additional system models, and add or embed complex functionality of existing tools developed at the IRAS. Examples are orbit propagation, battery degradation trending, thermal analyses, mission planning according to Space Debris Mitigation (SDM) Guidelines, conjunction analyses, and 3D-Visualization. The paper will give an overview of the current state of existing technology and tools, describe the already implemented QuSAD features as core of the new developed tool, and map out a technology roadmap for new functionalities based on existing tools and research of the IRAS.