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A NEW CONCEPT OF SOFTWARE ARCHITECTURE FOR A FLEXIBLE ATTITUDE DETERMINATION AND CONTROL OF NANOSATELLITES

Abstract

Ongoing progress in the field of technology miniaturisation continuously extends the potential application area of nanosatellites, since newly developed bus components increase performance, especially in regards to attitude control. The wider range of possible applications results in diverging requirements from one mission to another. Besides the selection of a suitable set of sensors and actuators, the attitude determination and control software must be tailored to the particular mission, including its determination- and control methods, as well as its operational modes. Thus, adaptability is a key requirement for its software design.

This paper presents a new software architecture concept for attitude determination and control. It is currently being applied in the development of TU Berlin's nanosatellite bus TUBiX20, which will support two upcoming nanosatellite missions of the university; TechnoSat will be launched in 2016 and facilitates on-orbit verification of novel nanosatellite components, which require a pointing accuracy of several degrees. TUBIN will follow one year later and will carry an infrared imager that requires three-axis-stabilisation within arc minutes. The presented concept allows us to easily adapt the attitude determination and control system of TUBiX20 between these different accuracy requirements.

The fundamental principle of our concept is to apply different attitude determination and control strategies, independently from each other, in separate modules. Each module may use different sensors, models or algorithms, while all modules still have unified interfaces. The software runs several of these modules concurrently and is thereby able to switch dynamically between different attitude determination and control techniques, depending on the availability of sensors and actuators, and the currently required pointing accuracy. Furthermore, the functional redundancy allows for cross-checks of different results as a basis for FDIR mechanisms.

In the same manner, the concept allows for easy adaptation of system to a new mission. While in conventional software architectures, customisation is often reached by code modification. This bears the risk of introducing errors, and also increases the complexity of the code. The presented concept allows for the extension or removal of functionality according to need; thus, the complexity of the software remains at a minimum.

The paper demonstrates the capability of the developed concept as shown by TU Berlin's nanosatellites TechnoSat and TUBIN. Emphasis is placed on its flexibility towards adapting to diverging mission requirements, while also its benefits regarding modular testing highlighted.