IAF SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative and Robotic Space Systems (6)

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TINA: SMALL TORQUE CONTROLLED ROBOTIC ARM FOR EXPLORATION AND SMALL SATELLITES

Abstract

In the last years, the introduction human sized robotic assistant arms, or co-bots, has modified the scope of applicability of robotic systems. The small size, limited strength and safe interaction possible with this new category of robots allows to use them in domain where the more traditional, and far more massive ancestors, were excluded. Unsurprisingly, space robotization is following a similar path and can benefit from small torque controlled robotic manipulators. For example, in order to interact with delicate spacecraft features or to serve as a payload manipulator on a lightweight rover. The cost and complexity of space missions implies that the system must be optimized according to the tasks and requirements. Therefore, TINA is not thought as an arm (Tina; This Is Not an Arm) but rather as a collection of torque controlled joints that can be connected according to the needs. Given its size and design, it is not meant to be used as an arm for deorbiting, which is achieved with a stronger class of robots, such as CEASAR [2].

The design of TINA is following the "qualifiable" philosophy of DEXHAND [1], that is, it is using industrial components that have similar performance as the space equivalent and following the ECSS guidelines closely. This philosophy ensures that the transition to a fully qualified design can be achieved with minimal envelop modifications. It also provides a nearly perfect model for the thermal and EMI modeling. Each joint is made of a brushless DC motor with a resolver, combined with a harmonic drive, a brake, a torque sensor and a link side resolver. They are controlled by a Soc that has a microcontroller

and a FPGA fabric. The field-oriented control of the motor is realized in the FPGA. The microcontroller functions are limited to simple management and logging functions. This architecture guarantees a hard real-time behavior as well as a great flexibility regarding the auxiliary functions. The communication between the joints and the OBC is using Spacewire with a 3kHz cycle time. The joints accept a single 18V to 50V supply or two separate logic and motor supply for a greater efficiency. This paper presents the mechanical design, electronics, communication architecture and software architecture of TINA.