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Author: Prof. Klaus Schilling
University Wuerzburg, Germany

ADVANCED ROBOTIC AUTOMATION TECHNOLOGIES FOR MULTI-SATELLITE SYSTEM PRODUCTION

Abstract

Current realization demands for growing numbers of spacecraft in the context of pico-satellites (about 250 per year) and of mega-constellations (about 15 per week) require the transition from traditional manufacturing to more advanced automated production methods. Similar to terrestrial mass production, additive manufacturing techniques (3D-printing) and robotics promise significant efficiency increases for larger quantities of satellites. While human-robotic manipulator interaction is assisting integration, transport robots connect different integration and test steps in the production process, in order to satisfy the high quality assurance requirements.

This contribution is based on the experiences acquired from the "industry 4.0"-demonstrator plant at the Zentrum für Telematik, where networked, highly automatized production methods are investigated. One specific application example addresses here the implementation of small satellites. A modular, flexible satellite bus design was developed to support the subsequent use of automated integration. Similar to computer and electronics industry, the approach employs a baseplate providing all power and data lines. Standardized electrical interfaces (promoted by UNISEC Europe) enable integration of boards from different suppliers and with different performance capabilities. The classical satellite subsystems (OBDH, AOCS, power distribution, batteries) are typically placed on a standard board. More complex metallic structure items are provided by 3D-printers in one piece, reducing weaknesses in connections and minimizing the amount of integration steps. The interleafing step-by-step integration and test procedures are supported by autonomously guided vehicles (AGVs) to transport the satellite according to its integration status to the related test equipment. Depending on the test results the automation system decides about next integration activities to be pursued. In more complex decision making scenarios human interaction is required. This way, variations of a standard satellite can be produced at large quantities respecting the typical high quality standards in spacecraft realization.

The subsequent step leverages from the single satellite to the constellation and formation level. It requires performance tests for the satellite cooperation capabilities. In particular the inter-satellite communication link and the control system interactions are to be tested for typical scenarios. The multi-satellite test facility in Würzburg is foreseen for related performance tests and will be described in more detail.