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THE TARDIS EXPERIMENT: AN INNOVATIVE VOR-BASED SYSTEM FOR HAPS BACKUP POSITIONING AND ATTITUDE DETERMINATION

Abstract

TARDIS (Tracking and Attitude Radio-based Determination In Stratosphere) is a stratospheric experiment that exploits the VHF Omnidirectional Range (VOR) signal to perform an in-flight attitude and position determination. This project has been conceived by a group of students of Aerospace Engineering from Sapienza University of Rome and selected for the Rocket and Balloon Experiments for University Students (REXUS/BEXUS) Programme cycle 12. The programme is managed by the Swedish Space Agency (SNSA) and the German Space Agency (DLR) in collaboration with the European Space Agency (ESA). The experiment will be launched from Esrange Space Centre in Kiruna (Sweden) in October 2019. VOR is a radio-navigation systems based on high power transmitting stations at ground and on passive airborne receivers. The navigational information decoded by the receivers is defined as "radial" and it represents the bearing angle of the receiver with respect to the ground station position. The balloon

position is obtained by the integration of two radials. An attitude estimation can be done through the signal power received by antennas with different reception patterns. TARDIS aims at mounting four antennas to monitor both position and attitude in-flight. The power received by each antenna will be analysed and compared with the data collected during antennas tests. This process will give the signal source direction. The latter, integrated with the balloon position, will determine the attitude. Ground tests will be made to characterise the antennas and to build up a database of values that are associated to a single angle. The investigation could demonstrate the applicability of a passive system, based on a mature ground-based radio-frequency infrastructure, for the implementation as back-up position and attitude determination for the future stratospheric vehicles. High Altitude Platform Stations (HAPS), planned to autonomously operate for months, could implement such a system for improving the reliability of their navigation systems. This paper deals with the development and production of a passive navigation system based on the VOR infrastructure. Firstly, a brief description of the VOR principle of operations will be given. Secondly, the experiment design will be presented, with particular regards to the designed antennas configuration. Then, data collection and analysis processes will be explained. Finally, the testing and implementation phases, with particular regard to the antennas characterization, will be given.