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INVESTIGATION OF A GROUND STATION SEGMENT FOR NANO-SATELLITES USING SDR APPROACH

Abstract

In NCKU's PACE Laboratory, there are currently two nano-satellite projects: PACE (Platform for Attitude Control Experiment) and TARO (Taiwanese Amateur Radio Orbital experiment). Both satellites use FSK modulation and operate with a conventional ground station to communicate with them (currently for laboratory purposes). This involves the use of an amateur radio transceiver and a TNC (Terminal Node Controller). This scheme works according to specifications, nevertheless considering research capabilities; it is limited to configurations the system can provide. For instance, operation over VHF or UHF amateur frequencies and use of FM or single side band mode. Thus, it makes the whole system limited to these configurations for future projects.

An ongoing scalable SDR (Software Defined Radio) solution is being developed, that is, to elaborate a reconfigurable environment to communicate with these small satellites using currently simple communication schemes such as FSK/OOK in the UHF/VHF band.

The proposed solution has two stages: the first one to comply with current communication requirements and the second one to provide additional research capabilities. The first stage involves two major improvements, one is logical and communication performance/compatibility related, and the other improvement is related to the acquisition of devices needed to match the requirements for satellite communication link budget. This stage is implemented using the SDR approach: using the USRP to generate RF signals, and GNU Radio to generate an interface to process the signals. Python object-oriented language is selected as the core development language because it directly links the processing blocks created in GNU Radio, and it also provide several non-high-resource-consuming research tools. The second stage corresponds to the future software research and upgrades to communicate with the small satellites. This will later involve development using other modulations and another frequency bands and possible new algorithms or processing, thus allowing a wider spectrum of possibilities.

In laboratory conditions, communication with the mentioned satellites has been achieved by making a program that calls the GNU Radio interface to transmit telecommands and to receive telemetry. Further development is promising as all modifications are software related. Nevertheless, proper power amplifiers and RF switches are yet to be selected to complete this first stage.

This scalable approach would not only outperform current ground station segment in NCKU laboratories, but it would also provide a research environment for future satellite projects.