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Author: Dr. Kelvin Layton
University of South Australia, Australia, kelvin.layton@unisa.edu.au

Mr. Azam Mehboob
University of South Australia, Australia, azam.mehboob@mymail.unisa.edu.au
Prof. William Cowley
South Australia University, Australia, bill.cowley@unisa.edu.au
Dr. Gottfried Lechner
University of South Australia, Australia, gottfried.lechner@unisa.edu.au

COMPENSATION FOR TRANSMITTER DISTORTIONS IN HIGH-SPEED SATELLITE DOWNLINKS

Abstract

High-speed downlinks are required to cope with the improved imaging resolution of future earth-observation satellites. A promising approach is to increase the bandwidth and use spectrally-efficient modulation although this induces distortion at the transmitter, which leads to signal degradation. For example, the power amplifier has a nonlinear characteristic when operating in the desired region near saturation. This work examines techniques to compensate for these distortions onboard the satellite, allowing for error-free transmission at high data rates. In particular, a novel scheme is presented to separately compensate for linear and nonlinear distortions caused by the output filter and power amplifier of the satellite transmitter.

The components of the compensation system form a Wiener model consisting of a linear filter and a memoryless polynomial. The filter has a length of 10 symbols and the polynomial has an order of 9. The two components are trained separately with regularized least squares to improve the stability of the compensation system. Following encouraging simulation results, a hardware testbed was developed using high-speed DAC and ADC boards to validate the algorithms. The hardware was integrated with the software framework for "hardware-in-the-loop" testing, which was initially performed with a nonlinear solid-state amplifier. Extensive simulations are currently being performed for more realistic configurations including distortions from a travelling-wave tube amplifier and X-band channel filter.

Simulation results suggest the proposed system reduces the total degradation by up to 3dB for a 64 amplitude and phase-shift keying (64-APSK) modulation scheme, compared to a system without compensation. Furthermore, the algorithm is more efficient than existing state-of-the-art methods in terms of computation. Initial hardware measurements obtained a 6dB improvement in Es/N0 and a data rate of 3Gbps. These results demonstrate the effectiveness of the proposed compensation.