Quantization Effects in Digital Upconversion and Digital Beam Forming for TIGER Radar System

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Abstract

Digital multirate upconversion and beamforming are efficient techniques for FPGA implementation of a direct conversion TIGER transmitter. Digital implementation can be carried out using finite precision and infinite precision representation of the modulated signal. We consider finite precision representation, since it takes considerably less implementation resources compared with the infinite case. In multirate transmission systems, polyphase filters are used to generate the digital signals. Quantization of infinite precision samples into fixed point numbers perturbs the location of filter zeros from the unit circle. This perturbation causes non-linear effects in the stop band and reduces the dynamic range of the filter pass band. Quantization error increases with larger filter order since the highest order polynomial is mostly affected by the quantization. Similarly digital samples of phased signals are sensitive to finite precision. Finite precision reduces mainlobe level as well as sidelobe gain. For multiple beam generation, it degrades the transmitted beam and consequently fidelity of the target area.

Keywords

Field Programmable Gate Array (FPGA), Finite Impulse Response (FIR) filtering, Tasman International Geospace Environment Radar (TIGER), Digital Signal Processing (DSP).