CASA PHASED ARRAY RADAR SYSTEM DESCRIPTION, SIMULATION AND PRODUCTS

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The Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), an engineering research center sponsored by the National Science Foundation, is advancing the technology to enable future deployment of dense networks of low-power, short-range radars that overcome coverage gaps due to earth curvature and complex terrain [1]. Currently, the center has deployed a network of four small radars in a research network in Oklahoma. The radars in this test bed utilize X-Band mechanically-scanned antennas with magnetron transmitters, and coherent-on-receive receiver/data collection systems. The next step in the evolution of this technology is to realize these radars using solid-state electronics and electronically-scanned phased arrays. A driving consideration in the design is the ability to realize these systems commercially at costs in the $100k range [1].

In an effort to create the first prototype of the electronically scan phased array radar, CASA has developed a system architecture taking into consideration the important characteristics of the system, scalability and modularity. These are achieved by designing the system in such a way that the line-replaceable sections of the radar can be increased or decreased depending on the application and the sub-systems can be swapped out as new technology is produced. The system consists of the Phase-Tilt Antenna Structure, IF Digital Transceiver, Up/Down Conversion, and Host Computer subsystems.

The Phase-Tilt Antenna Structure Subsystem is made up of a dual-polarized linear phased-array of solid-state T/R modules. The phased array consists of 64 center-fed, dual-polarized, patch-array antenna columns arranged to scan electronically in the azimuth direction and mechanically in the vertical direction [2]. Each of the 64 columns employs a separate T/R module for phase, amplitude, and polarization diversity. The T/R modules are individually controlled via a field-programmable gate array (FPGA) controller, that distributes control signals, interfaces with the host computer, mechanical actuator, and IF digital transceiver. The transmitted signal is produced by an arbitrary waveform generator within the IF transceiver. The received RF signal from the T/R modules is combined in two analog stages, then down-converted, filtered, digitized and tagged with beam location information by the receiver within the IF transceiver and processed by the host computer. The host computer controls the system and contains the signal processor, the beam steering computer and the interface to CASA's Meteorological Command and Control (MC&C) computers, which determines the scheduling of the beam locations.

The predicted performance of the array is illustrated by means of a simulator applied to X-band tornado observations by the UMass X-Pol mobile dual-polarized Doppler radar. The simulator ingests the measured patterns of the phase-tilt antenna array and large volume data sets from the mobile radar in order to identify the inherent tolerances of the antenna subsystem to amplitude and phase quantization errors by introducing their effects to the measured patterns. Currently, the IF up/down converter and IF digital transceiver are being tested to characterize the subsystems and evaluate the waveform designs to be used in the future Phase-Tilt radar network.

References:

[1] D. McLaughlin and et. al. Distributed weather radar using x-band active arrays. Radar Conference, 2007 IEEE, pages 23–27, April 2007.

[2] J. Salazar, R. Medina, E. Knapp and D. J. McLaughlin. "Phase-Tilt Array Antennae Design for Dense Distributed Radar Network for Weather Sensing", Proceedings of IGARSS 2008, Boston, United States."

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