Novel Antenna Concepts for Future Spaceborne Earth Observation Missions

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This presentation summarizes some of the key contributions of the UCLA team in the projects undertaken in collaboration with JPL/NASA in the area of remote-sensing. The broad areas include antenna designs for Precipitation Radar (PR-2) mission, next generation of geosynchronous orbiting satellite antenna systems for remote sensing radar applications, a spaceborne mission for future SAR system at UHF/VHF to deliver data for estimation of soil moisture and deployable mesh reflectors for spaceborne active and passive systems for sea surface salinity and soil moisture study.

PR-2: One of NASA's Earth observation mission goals is to measure weather precipitation parameters. The proposed Precipitation Radar (PR-2) mission utilizes an offset, deployable membrane cylindrical reflector antenna that requires low sidelobes and wide angle beam-scanning in one direction. The proposed antenna is 5.3 m $\times$ 5.3 m operating at both *Ku* (13.6 GHz) and *Ka* (35 GHz) frequency bands. To demonstrate the technological feasibility of the concept, a half-scale model of 2.65 m was designed and evaluated including optimization of several parameters of the overall antenna system.

NIS: Current advances in monitoring hurricanes and convective storms throughout their life cycles necessitate the development of technologies for high resolution spacecraft antennas with an ultra-scanning capability. The goal is to characterize hurricane structure and center of circulation even in the presence of upper-level clouds, NEXRAD in Space (NIS). Since the parabolic reflectors have limitations for this application, an array compensated spherical reflector antenna is proposed for a geostationary radar antenna because of its inherent capability of scanning the beams to very large beamwidths. A 28-m spherical antenna system has been envisioned at 35 GHz. This system provides an antenna directivity of 77 dB, a beamwidth of 0.02^{o}, a sidelobe level of better than -30 dB, and a scan of up to ± 200 beamwidths results in a circular coverage area of 2540 km on the earth's surface. To overcome the performance degradation induced by spherical phase aberration, a planar array feed was used to correct the phase aberration of spherical reflector antenna. Also a 1.5-m breadboard model was designed and evaluated.

MOSS: To measure the soil moisture under substantial vegetation canopies and at useful soil depths, a Microwave Observatory of Subcanopy and Subsurface (MOSS) is proposed to be built in future. A Synthetic Aperture Radar at two operating frequencies of UHF/VHF is needed to separate the effects of vegetation and soil. The concept proposed is to synthesize two different antenna widths on the parabolic mesh reflector of 30m by subilluminating the reflector with a dual-frequency dual polarized stacked patch microstrip array feed. A low profile, reconfigurable, light weight experimental feed array (40.0cm by 13.4cm) with novel feeding architectures with dual-frequency and dual-polarization capabilities have been proposed as a feed for the parabola. The prototype was tested against a 3.65m diameter reflector at scaled frequency bands of 1.13GHz and 3.57GHz. Array configuration was analyzed using FDTD simulations and the array measurements were done at Spherical Near-Field Chamber at UCLA.

Radiometer & Radar Array: Future generation of soil moisture and surface salinity missions require an integrated active radar (1.26GHz) and passive radiometer (1.413GHz) frequencies with dual polarization capabilities. A low-profile, high efficiency sixteen element stacked patch microstrip array was designed, fabricated and tested for use in stand-alone aircraft based soil moisture study. The array was optimized for element spacing, excitation amplitude taper, cross-polarization and beam-efficiency using Particle-Swarm Optimization.