Low Cost, Electronically Steered Array Feed System for Ku Band Satellite Communication

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Ku band satellite communication antennas typically use a reflector with a horn-type feed. The horn feed has a fixed beam that must be pointed accurately to avoid antenna misalignment and polarization mismatch losses. To track moving satellites or compensate for motion of the mount platform, a mechanical steering system is required. These systems overcome some of the limitations of fixed beam antennas, but they are often expensive, bulky, and too slow to maintain a good link. Electronically steered array feeds overcome many of the fixed beam limitations and can improve the performance of the communication link. Steerable array feeds weight the signals from multiple closely spaced antenna elements with amplitudes and phases designed to steer the secondary reflector beam to a given location relative to the antenna boresight. The beam weights provide additional degrees of freedom that can be used to optimize the dish illumination pattern, maximize SNR, and alter the polarization of the antenna.

While phased arrays have been used for decades in many applications, current array technologies are too costly for use in consumer satellite communications terminals. We report on the development of a low cost, Ku band, electronically steered array feed that maximizes SNR and automatically maintains a communication link independent of movement with efficiency comparable to a conventional horn feed. The planar array mounts on a standard Ku band dish antenna. The feed consists of a two by four array of patch-type elements, with each pair of elements combined with a passive network, and the four pairs combined using variable gain amplifiers (VGAs) and a 4:1 combining network. A power detector provides measurements for both noise calibration and feedback control. Beam weights are selected to maximize SNR and track the satellite at different dish locations. As the dish moves, a PC-based control system uses calibration data and real-time power detector measurements to select the best beam weights and command the VGAs to steer the beam and maximize SNR.

Tests show that our current array feed system can automatically track a satellite maintaining a communication link while rotating the dish several degrees east and west of boresight. We are currently designing a four by four active array and migrating the control system to a microcontroller to reduce the size of the system, increase tracking speed, and lower the overall cost.