Digitally Synthesized Phased-Array Antenna

Precision digital synthesis techniques for a phased-array antenna system

NASA’s Jet Propulsion Laboratory has developed a novel technique to control the phasing of a phased-array antenna to improve the signal-to-noise ratio (SNR) and reduce interference from jamming and multipath propagation in a cost-effective manner. Compared to single-antenna systems, phased-array antennas are ideal for use in GPS receivers, because adding the outputs of separate antenna elements improves SNR and reduces interference. Despite these advantages, conventional phased-array antenna systems are prohibitively expensive because received signals are phase shifted and then combined using analog circuitry. JPL’s phased-array antenna system uses digital synthesis techniques that eliminate the need for costly analog circuits and can be orders of magnitude more precise than the analog techniques used in conventional systems.

**BENEFITS**

- Inexpensive, flexible means of exploiting the advantages of phased-array antennas
- Digital synthesis of the phased array can be orders of magnitude more precise than an analog version involving analog phase-delay elements
- System can be used when satellite positions are unknown or antenna spacing is uneven
THE TECHNOLOGY

JPL’s phased-array antenna system comprises a phased-array antenna and a set of parallel digital signal processing channels containing analog-to-digital converters. During operation, the beam direction of the array is steered to a selected satellite by introducing a uniform difference between the phases of the outputs of adjacent antennas in the array. The phase-delay elements are digitally synthesized within each of the signal processing channels. Early, prompt, and late correlation functions for the selected satellite can be combined in phase from each of the antennas. All of the digital operations of these signal processing channels can be implemented in a single microprocessor, and a corrective feedback loop can be used to fine-tune the phase delay between adjacent antenna elements to maximize the arrayed signal.

This phased-array antenna system can be used in applications where the satellite positions are unknown. The satellite selection circuit can randomly slew the phase-angle difference through a continuum of values while monitoring the corrective feedback loop to maximize the correlation function. The system can also be used in applications where the spacing between the arrayed antennas is non-uniform or the antennas lie on a curved surface. Such variations can be accommodated by providing a proportionately different phase multiplication factor for each of the antennas.

APPLICATIONS

The technology has several potential applications:

- Communications systems - GPS, cellular telephone, military, and FM radio

PUBLICATIONS

Patent No: 6,828,935

The cross-correlation function of the spread spectrum pseudo-random code as a function of delay between the received satellite code and the code generated by the GPS receiver.

More Information

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