Over the last three decades, ultrawideband (UWB) radars have been designed for military and civilian applications, such as ground-penetrating radar for detecting and imaging antipersonnel and antivehicular mines, sensing through canopies for opposing forces, identifying combatants and weapons in structures, and mitigating target-like structures induced by sea scatter for sea-based radars. In addition, numerous nonmilitary UWB radars have been designed and fielded for forestry, detecting underground utilities, automotive control, search-and-rescue operations, and humanitarian demining. Since 2004, UWB radar development has declined somewhat to a plateau, with most efforts concentrating on medical imaging, automotive control, sensing through structures for terrorists, and search and rescue operations. In contrast, UWB communication systems have come to the forefront on the wave of the telecommunications revolution.

The main reasons for using UWB radar are its competing capabilities of imaging objects due to its ultra-high resolution (higher frequencies) and penetrating media to detect shielded objects (lower frequencies). For example, a design of UWB radar is a tradeoff between resolution and penetration depth. Thus, the passband selection of the radar depends on the application, i.e., on the dimensions of the objects of interest. Although ultrahigh range resolution and deeper penetration are desirable, UWB radar has technological and electromagnetic-compatibility (EMC) issues.

The appeal of UWB communication is that voice and data transmissions with digital pulses permit low-power and relatively low-cost signals to carry information at very high rates over short distances. However, this application may also have concerns for EMC issues because a large number of UWB communication devices can significantly raise the noise floors of the receivers in sensing systems, thereby reducing their performance.

IN THIS SPECIAL ISSUE

This special issue addresses recent advances in UWB technology applications in medical systems, UWB phased arrays, and individual UWB antenna concepts.

MEDICAL SYSTEMS

In “Internet of Things-Enabled Hospital Wards,” Catherwood and McLaughlin consider how UWB technology can be used in medical environments, since this technology is reemerging as a high-data-rate solution for the Internet of Things (IoT). They empirically and statistically model body-to-body UWB IoT links between bed-bound patients and roaming medical personnel who are conducting their rounds. To create deployment data for future IoT-enabled hospital environments, their investigations involve statistical parameters that indicate link reliability and the probability of intersymbol interference for patients positioned in either of the two most common postures in a hospital and for nodes worn on a clinician’s waist or on a handheld device.

The second article, “Ultrawideband Technology for Medical In-Body Sensor Networks” by Garcia-Pardo et al., discusses the potential of UWB systems for in-body high-data-rate communications to collect and monitor important health-related parameters and to treat diseases. Although IEEE Standard for Wireless Body Area Networks (IEEE Standard 802.15.6) specifies...
in-body communications in the band for the Medical Implant Communication Service (MICS), high-data-rate communications are not feasible in the MICS band since the allocated bandwidth is so narrow. Consequently, UWB systems have emerged as a potential solution for in-body high-data-rate communications because they are much smaller and require less power. The authors provide an overall perspective on the current state of the art and limitations for analyzing in-body propagation and the future perspectives for UWB in-body channel analyses.

UWB PHASED ARRAYS

“Benchmarking Ultrawideband Phased Antenna Arrays” by Kinzel and Logan presents an embedded-element design and measurement data for a UWB flared-notch (Vivaldi) array. They built an all-metal dual-polarized phased array as a benchmarking reference to assess the effective technology readiness level for other planar phased-array apertures in the 2–21-GHz frequency regime. This 256-port array has a 7-mm lattice spacing and is precision-machined to ensure consistent agreement between the measured performance results and the predictions from simulated full-wave models. These attributes make the array desirable for benchmarking any new array hardware and for validating the computational modeling tools.

In “Ultrawideband Frequency-Diverse Array Antennas,” Wang introduces a frequency-diverse array (FDA) that generates range-, angle-, and time-dependent transmit beampatterns, a departure from the angle-dependent-only transmit beampatterns of traditional phased arrays. The FDA approach enables autoscanning transmit beampattern characteristics by having a small frequency increment across the array elements. The article introduces the FDA approach in the context of UWB applications for radar and communications. The FDA range-dependent and autoscanning beampattern characteristics are analyzed for continuous-wave and pulsed signals, and the characteristics for narrow-band and UWB signals are compared. Potential applications are discussed, along with the associated technical challenges, especially from the antenna and propagation aspects, such as transmit beamforming and optimal array design.

INDIVIDUAL UWB ANTENNA CONCEPTS

Sharma et al. explore conceptual design strategies of composite antennas for UWB applications in their article “Composite Antenna for Ultrawide Bandwidth Applications.” Their concept combines an unbalanced dumbbell-shaped cylindrical dielectric resonator antenna (CDRA) and a tilted annularly shaped printed line (TAPL), which is used as a radiator and excitation mechanism for the CDRA. A UWB bandwidth is achieved by combining the different modal patterns of the TAPL and the CDRA. The time- and frequency-domain simulations suggest feasibility for UWB applications. To authenticate the simulated outcomes, the authors fabricated and tested a prototype of the TAPL-CDRA radiator.

In “A Dual Reconfigurable Printed Antenna,” Saha et al. demonstrate the design concept and hardware implementation of a dual-reconfigurable printed antenna. A printed monopole antenna, fed by a single coplanar waveguide (CPW), provides the capability to reconfigure the antenna between UWB-notched and narrow-band responses, depending on the status of the switches and the positions of the split-ring resonators in the CPW feed region of the antenna. Measured results for both reconfigurable cases provide good agreement with the simulated results and theoretical estimations.

UWB systems have emerged as a potential solution for in-body high-data-rate communications because they are much smaller and require less power.

The proposed antenna can be used as a reconfigurable communication antenna module in a cognitive radio system.

In the seventh and final article, “A Compact Ultrawideband Reflector Antenna,” Ha et al. develop a compact UWB paraboloidal reflector on a finite ground plane with a mechanically steerable end-fire beam. To facilitate scanning, a fixed omnidirectional monocone feed is used, and an omnidirectional mode is enabled by a recessed reflector. The reflector design is based on a multidimensional parametric study to achieve a reduced size and reasonable performance in the frequency and time domains. Time-domain and power-domain analyses show that the high-power wide-band transient pulse is well reproduced.

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