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A Wideband Switched Beam Antenna Array using Cavity-Backed Monopole Elements

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1 Extended Abstract

A wideband switched beam antenna array is presented that is capable of producing an omnidirectional pattern as well as multiple spatially distributed directional patterns. The proposed design consists of a uniform circular array (UCA) with compact cavity-backed monopole elements and is suitable for directional or omnidirectional transmitting/receiving as well as direction of arrival (DOA) estimation within the operational bandwidth of 1.8 GHz to 2.8 GHz. It has been shown that directional antenna elements can achieve more accurate DOA estimates over a larger bandwidth compared to isotropic elements [1]. A five directional element UCA is used in [2] to obtain multiple radiation patterns, but an omnidirectional mode is not demonstrated. Alternatively, a two-element design is used in [3] to achieve omnidirectional patterns at 1.3 GHz and 1.7 GHz with gain ripple in the H-plane less than ± 2.6 dB by geometrically arranging two quasi-yagi antennas such that there was no spacing between the element phase centres in the H-plane. For the proposed design, five cavity-backed monopole elements are used (UCA radius R = 15.5 cm) with each element directed outward at steps of 360°/5 = 72°, as shown in Fig. 1(a). The elements' width, height, and depth are 12.9 cm (0.77 λ_0), 6.5 cm (0.39 λ_0), and 3.6 cm (0.22 λ_0), respectively, where λ_0 is the wavelength of the lowest operational frequency (1.8 GHz). The radiating element within the antenna's tapered cavity consists of a triangular monopole with two sets of symmetrical shorting lines. Simulations showed the shorting strips and tapered cavity improved both the impedance bandwidth and boresight gain.

Full-wave electromagnetic simulations were performed using FEKO. The directional patterns are produced by exciting the desired antenna element port while the other four ports are terminated in 50 Ω, and the omnidirectional pattern is generated by exciting all five ports simultaneously in-phase. The simulated reflection coefficient result for each element in the array is shown in Fig. 1(b) and is less than -10 dB from 1.5 GHz to 2.8 GHz (60%). The proposed design achieves omnidirectional H-plane (*xy*-plane) radiation patterns with gain ripple less than ± 3 dB over the entire operational bandwidth. A minimum gain ripple of ± 1.5 dB is achieved at 2.6 GHz with a gain of 1.6 dBi. The normalized H-plane patterns at 1.9 GHz and 2.7 GHz are shown in Fig. 1(c). At 1.9 GHz, the peak gain in the directional and omnidirectional modes are 6.8 dBi and 2.7 dBi, respectively. At 2.7 GHz, the peak gain in the directional and omnidirectional modes are 7.9 dBi and 1.5 dBi, respectively.

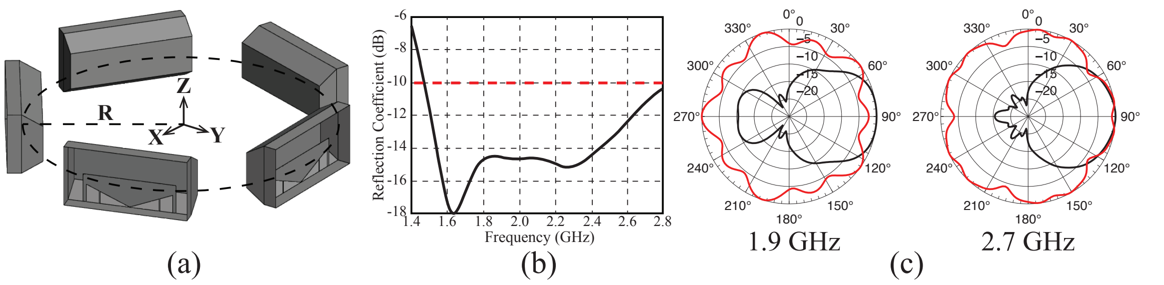

Figure 1. (a) Proposed array geometry. (b) Simulated array element reflection coefficient. (c) Simulated normalized radiation patterns: omnidirectional mode (red) and one of five potential directional modes (black).

References

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