Design of Broadband VHF/UHF Antenna with Multiple Directional Beams

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In the military, aviation and government band of 225–400 MHz, there are many important land and maritime, mobile and fixed communication systems. Specially, for a vehicle-mounted land mobile communication system, an antenna that can independently generate multiple directional beams can help with improving the system's throughput and reducing the interference with other users. However, due to the limited space on a ground vehicle, conventional directional antennas, such as log-periodic dipole arrays or horns, usually have excessively large dimensions. Electronically steerable parasitic array radiator (ESPAR) antennas are promising to avoid the large dimension issue. An ESPAR antenna is composed a single active antenna element, and a few passive parasitic elements terminated by a controllable impedance. By changing the termination impedance of the parasitic elements, ESPAR antenna can achieve different beam directions. However, ESPAR antennas usually suffer from narrow bandwidth. Another technique resolving the large dimension issue is the Huygens source antennas, which are fundamentally collocated electrical and magnetic dipoles. In fact, research on electrically-small Huygens source antennas has been extensively reported. However, owing to the electrically-small feature, the directionality and bandwidth performance are not as satisfied.

In this work, we present a broadband antenna with moderate form factor that can generate multiple directional beams. In our design, to achieve a better directionality, we extended the concept of Huygens source antennas by combining patterns that are more directional than the regular figure-eight-shaped and omni-directional patterns. Besides, antenna elements are modified to operate in a wide frequency band of 225–400 MHz. Following this method, a multi-beam antenna with eight beams is designed. The entire antenna has a dimension of $4\times4\times2$ feet, which can be easily installed on top of a car. Eight beams with low sidelobe level are achieved which can be connected to different channels of a multi-channel receiver and independently controlled, or the multi-beam antenna can be used in conjunction with a switching network and a single-channel receiver to perform beam switching. In the presentation, we will discuss the design details, and present simulation and measurement results of a scaled fabricated prototype.