An Overview of Latest Advancements in Displaced Phase Centre Antenna (DPCA) Techniques

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In certain applications, such as radars, remote sensing, and precise global positioning systems, the phase reference of the radio frequency (RF) system is of great importance as it affects the system accuracy, such that even small uncertainty could lead to big errors. In wireless communications, this phase reference is dominated by the antennas, the last components of the RF front-end parts, which radiate the Electromagnetic waves. Thus, knowledge of the antenna phase reference, well known as the phase centre, is vital in aforementioned applications. The phase centre location of an antenna is the effective source of radiation providing a uniform phase pattern at the far-field zone over a finite angular range in space, which is normally around the main beam. Therefore, any phase centre displacement will move the phase reference of the communication system. Particularly, in moving target indicator radars, where the antenna part is mounted on a moving platform, the forward motion of the moving platform changes the effective phase centre location of the operating antenna. This could result in errors as significant as missing low velocity objects. One of the techniques to overcome this problem is the displaced phase centre antenna (DPCA) processing technique [M. I. Skolnik, *Radar Handbook*, McGraw-Hill, 1990]. Traditionally, DPCA technique exploits two or more identical aperture antennas, which provide separate phase centre locations with identical secondary radiation patterns. This will, however, increase the hardware and complexity of the antenna systems.

In this paper, an electronically DPCA technique is reviewed through the use of a single adaptive aperture antenna. The emphasis is placed on parabolic reflector antennas, both symmetrical-cut and offset geometries, illuminated by over-moded primary feeds in order to adaptively change the aperture distribution. Both dual- and tri-mode waveguide primary feeds are investigated. It is shown that the phase centre location of the antenna can be electronically displaced over a single aperture by controlling the mode content factors as well as the mode alignments in the primary feed, while the associated secondary radiation patterns are axial at the far-field region. Such adaptive operation can be readily performed by signal processing algorithms. The proposed DPCA technique is a smart alternative to the mechanical DPCA, as it lessens the complexity and volume of the antenna system. All corresponding numerical and measured results will be presented and discussed in the conference.