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On the Radiation Properties of Array of Skewed Stacked Dipoles

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Antenna arrays located on airplanes or other mobile platforms for satellite communication applications are typically required to support very large scan angles (close to end-fire). However, planar antenna arrays are typically characterized by scan loss. To increase the scan range conformal arrays and multi-panel configuration can be found in literature, but the height of the structures is still too large to be installed on airplanes without significant impact on the aircraft drag. To obtain wide-scan capability while still maintaining a low antenna profile, hybrid scanning mechanism are currently implemented (F. Tiezzi et al., EuCAP, 2010). The idea is to scan the beam electronically from broadside to a positive, as high as possible, angle and then to achieve the full coverage by mechanical rotation of the array along the azimuth.

In this work we present a study to determine the parameters affecting the power radiated in specific directions by antenna arrays with tilted elements. We developed an efficient Method of Moments (MoM) for the analysis of linear arrays with arbitrarily tilted dipole elements, in free space or in the presence of a backing reflector. By using this analysis method, we study the radiation characteristics of arrays of stacked dipoles over a ground plane, highlighting the variation of the patterns as a function of the inter-element distance and the angle of inclination of the element.

For half wavelength inter-element distance the array pattern is rather symmetric even for tilted elements, as expected from the Floquet theory (A.K. Bhattacharyya et al., IEEE TAP, 51, 1572-1581, 2003). However, when the elements are tilted by positive angles and for inter-element distance larger than half wavelength, a null and a reduction in directivity in the radiation pattern is achieved for negative scanning angles. Grating lobes in the visible region are weighted by element pattern. The minimum of the radiation pattern is not necessarily aligned with the dipole axis but, due to mutual coupling, it can move to different angles depending on the combination of inclination angle and distance. The array directivity is almost flat for positive angles up to very large scanning directions, and decreases rapidly at specific negative angles that change with the inter-element distance. Moreover, it is shown that, for large arrays (i.e. with more than 10 elements), the shape of the active element pattern does not change significantly as a function of the number of elements. At the conference considerations concerning the effects on the active element pattern of mutual coupling and of the onset of grating lobes for a given grid size/tilt angle will be presented. Moreover, a linear array design with selective pattern characteristics will be presented.