Pattern Improvement by the Use of Coincident Multiplicative Arrays

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This paper considers a uniformly spaced linear receiving array where element output voltages are split into two distinct parts which are then combined additively to form two coincident array output voltages $V_A(t)e^{j\omega t}$ and $V_B(t)e^{j\omega t}$. The two voltages are then multiplied, passed through a low pass filter and time- averaged to give the output product pattern $P_\circ(u) = \text{Re}\{A_\circ(u)B_\circ^*(u)\}$ Such a system has been used to obtain the principal solution (R.N. Bracewell and J.A. Roberts, Austral. J Phys.,7, 615-640, 1954)in radio astronomy (R.N.N.Utukuri and R.H.MacPhie, IEEE Trans. AP-15, 49-59, 1967). More recently, a thinned principal solution has been proposed (R.H.MacPhie, IEEE Trans, AP-51, to appear, 2003).

In this paper we first consider the case of two patterns of uniformly weighted coincident arrays which are shifted by $\pm\Delta\bar{u}/4$ where $\Delta\bar{u}$ is the beamwidth of the uniformly weighted array from the maximum to the first null. The resulting product pattern $P_\circ(u)$ has a narrower mainlobe and lower sidelobes than that of the power pattern of the uniformly weighted array. We next consider the product of the pattern $A_\circ(u)$ of a uniformly weighted array with the pattern $B_\circ(u)$ of an array with a linear amplitude taper. The product pattern $P_\circ(u)$ has the same beamwidth measured to the first null as the power pattern $|A_\circ(u)|^2$ of the conventional uniformly weighted array but has far sidelobes which are much lower.Other cases of pattern improvement with multiplicative coincident arrays will be given.

In summary, the multiplicative coincident array system has effectively twice the number of degrees of freedom as the conventional array with square-law detection since the patterns nulls of $A_\circ(u)$ and $B_\circ(u)$ can be chosen independently. This results in improved patterns with lower sidelobes and /or narrower mainlobes.