THE EFFECT OF RANDOM SPREAD OF THE PARAMETERS OF THE ELEMENTS
OF AN ANTENNA SYSTEM ON THE ACCURACY WITH WHICH THE COORDINATES
OF A POINT TARGET AND THEIR DERIVATIVES CAN BE ESTIMATED

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Izvestiya VUZ. Radioelektronika,
Vol. 31, No. 1, pp. 12-18, 1988

An estimate of the position of a point target moving in the Fresnel zone of a
multiposition antenna system is considered in the case of coherent space-time
processing of the received broadband signals. The effect of the amplitude and
phase characteristics of the receiving elements of the antenna system on the
accuracy with which the target coordinates and their derivatives are estimated
is analyzed.

We will consider the accuracy with which the coordinates of a target and their deriva­tives can be estimated when the target is moving in the Fresnel zone of a multiposi­tion antenna system in the case of coherent space-time processing of broadband signals, received under conditions when there is internal noise in the apparatus and multiplicative interference due to instability of the amplitude and phase characteristics of the receiving elements of the antenna system. We will use a system of coordinates \( (R, u, v) \), where \( R \) is the length of the radius-vector of the target; \( u = \sin \psi; \psi \) is the angular position of the target in a plane passing through the \( OX \) axis and the radius-vector; \( v = \sin \theta; \theta \) is the angular position of the target in a plane passing through the \( OY \) axis and the radius-vector. The receiving multiposition antenna system consists of a set of \( n \) receiving elements having uniform radiation patterns within the operating sectors of angular coordinates \( \psi, \theta \). The position of the \( i \)-th element in a Cartesian system of coordinates connected to the center of the antenna system is defined by the coordinates \( \{x_i, y_i, z_i\} \). The origin of the system of coordinates coincides with the origin of the system of coordinates \( \{R, u, v\} \).

The probing signal \( s(t) = \text{Re} \{ \hat{s}(t) \} = \text{Re} \{ U(t) \exp j\omega t \} \), where \( U(t) \) is the complex envelope of the signal, is radiated from the point \( \{x_r, y_r, z_r\} \) and is reradiated by the moving point target, which, at the instant \( t_0 \) when the radiation begins, is situated at the point \( M \) with coordinates \( \{R_0, u_0, v_0\} \). Henceforth, we will assume that the frequency deviation of the signal reflected from the target due to accelerated motion of the latter is much less than the inverse duration of the signal, and consequently, during the time when the target is irradiated the change in its coordinates with time can be assumed to be uniform \( \{ l_1, l_2, l_3 \} = \{ R, u, v \} \) \( \{ l_4, l_5, l_6 \} = \{ R_0, u_0, v_0 \} \) \( \{ l_7, l_8, l_9 \} = \{ 0, 0, 0 \} \) \[1\].

Assuming that the signal during reception is subjected to the action of additive internal noise of the apparatus and multiplicative interference due to spread in the parameters of the receiving elements of the multiposition antenna system, the vector of the received signals \[2\] can be written in the form

\[
\| x_i(t) \| = \| a_0 \mathbf{s}(t, l_0, \varphi_0) + \mathbf{n}_i(t) \|, \quad i = 1, \ldots, n,
\]

where \( \varphi_0 \) is a random initial phase uniformly distributed in the interval \([0, 2\pi]\), \( a_0 \) is the random amplitude of the signal received by the elements of the antenna system situated at the point \( \{ 0, 0, 0 \} \), having a Rayleigh distribution with a mean square amplitude \( \langle a_0^2 \rangle \), and \( \| \mathbf{n}_i(t) \| \) is the vector of the additive Gaussian noise with zero mean and correlation

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acteristics of the elements of the antenna array on the accuracy with which the location of a target situated both in the far zone and in the Fresnel zone of the antenna can be determined in the case of coherent space-time processing of the signals, and enable one to determine the requirements regarding the stability of the characteristics of the antenna elements.

REFERENCES

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Revised 27 October 1986