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ULTRA-WIDEBAND SIMULTANEOUS ESTIMATION OF RANGE AND SPEED OF A FLUCTUATING TARGET

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The characteristics of maximum probable range and velocity estimates of a slowly or rapidly fluctuating target are found. The loss in estimation accuracy due to target's fluctuation is defined.

The possibility of application of ultrashort (subnanosecond) pulses and of their sequences in radio location has been considered in [1–5] and other literature. The short-pulse signals and their sequences represent a particular case of ultra-wideband signals (UWBS), whose application has its own features and permits to extend the radar capabilities. In [4] we defined characteristics of simultaneous ultra-wideband estimation of range and speed of a stable target, but many actual targets are fluctuating [6]. On the other hand, in [5] we found characteristics of ultra-wideband estimation of range of a fluctuating target. Now let us consider the characteristics of simultaneous ultra-wideband estimation of range and speed of a fluctuating target.

As in [4], the sounding sequence of UWBS can be written in the form

$$\tilde{s}_N(t) = \sum_{k=0}^{N-1} \tilde{s}[t-(k-\mu)\theta-\lambda] \tag{1}$$

where the function $\tilde{s}(\cdot)$ describes the shape of a single pulse, θ is its repetition period, and λ is time position of the sequence. The parameter μ defines the point of the sequence linked to its time position λ. Particularly, at $\mu = 0$ the λ value represents the position of the first pulse in the sequence, at $\mu = (N-1)/2$ — the time position of the middle of sequence (1), and at $\mu = (N-1)$ — time position of the last pulse. Assume that the sounding sequence (1) is scattered by a target moving at a range R_0 and with a radial speed V_0, and $|V_0| << c$, where c is the light speed.

Assume at first that the target is slowly fluctuating [6]. Then the target characteristics remain practically unchanged during irradiation by sequence (1), and the signal scattered by the target has the form

$$s_N(t, R_0, V_0, a_0) = \sum_{k=0}^{N-1} s[t-2R_0/c-(k-\mu)\theta(1+2V_0/c)] =$$

$$= a_0 \sum_{k=0}^{N-1} f\{[t-2R_0/c-(k-\mu)\theta(1+2V_0/c)]/\tau\}, \tag{2}$$

where $a_0 = \max s(t)$ is a priori unknown amplitude, and $t = \int_{-\infty}^{\infty} s^2(t)\mathrm{d}t/ \max s^2(t)$ is equivalent duration of a single pulse which, as in [1–5], does not exceed several fractions of a nanosecond. The function $f(\cdot)$ describes the shape of one pulse, meets the radiation condition [1], and is normalized so that

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