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ULTRA-WIDEBAND ESTIMATION OF SPEED OF A FLUCTUATING TARGET WHEN SOUNDING BY DISCONNECTED PULSES*

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With regard for anomalous errors, asymptotic expressions are derived for characteristics of maximum likelihood estimates of speed of slowly and fast fluctuating targets. The loss in the estimation accuracy caused by fast fluctuation of targets is considered.

In recent years a new line in the theory and technology of radioelectronic systems is application of pulses of nano- and picosecond duration as sounding signals [1–3]. Short-pulse signals and their sequences represent a special case of ultra-wideband signals (UWBS) [1–2]. Actual UWBS often have very sharp edges, permitting to approximate them by disconnected functions of time [1–5]. In [4] we investigated the ultra-wideband estimation of range of a fluctuating target when sounding by disconnected pulses. Now we consider the ultra-wideband estimation of speed of a fluctuating target in the case of sounding by a sequence of disconnected pulses.

Let the target be moving with a radial speed

$$V_0 \in [-V_{\max}/2; V_{\max}/2], V_{\max} << c, \tag{1}$$

where c is the propagation speed of the signal. Assume at first that the target is slowly fluctuating [6], so that the signal scattered by the target [5]

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

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

$$\int_{-\infty}^{\infty} f(x)\,dx = 0, \quad \max f(x) = 1, \quad \int_{-\infty}^{\infty} f^2(x)\,dx = 1. \tag{3}$$

Denote as

$$\Psi(y) = \int_{-\infty}^{\infty} f(x) f(x - y)\,dx \tag{4}$$

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