Radioelectronics and Communications Systems
Vol. 49, No. 1, pp. 33–41, 2006

Izvestiya VUZ. Radioelektronika
Vol. 49, No. 1, pp. 47–59, 2006
UDC 621.396.969.181.4

J-CORRELATION RANGE FINDER BASED ON THE METHOD OF MINIMUM

A. G. Sorochan

Research Institute of Complex Automation, Donetsk, Ukraine

The paper considers a range measuring system based on the *J*-correlation method of signal processing and discloses the main features of its operation. The potential accuracy of range measurement, sensitivity, and resolving capacity are evaluated. The possibility for determination of Doppler's shift of frequency is demonstrated.

The use of *J*-correlation processing of signals makes it possible to design high-frequency time delay measurers [1–3]. In this connection, there arises a necessity in analysis of possibility for applying this method of processing in the range-measuring systems. The purpose of this work is to analyze and disclose the main features of the range finder using the *J*-correlation method of signal processing.

The block diagram of the *J*-correlation range finder is presented in Fig. 1, where An1 and An2 are the transmitting and receiving antennas, respectively, G — generator, CDL — calibrated controllable delay line, MIX — mixer, X1–X3 — the first, second, and third multiplier, DL — delay line, LPF — low-pass filter, NBF — narrow-band filter; LFG — low-frequency generator, and DPU — digital processing unit.

Analysis of the device, assessment of its potential accuracy and sensitivity will be performed under the condition that the received input is activated by a reflection signal only from the first object of reflection.

The modulator at the frequency W_s forms the FM-signal modulated in frequency by a harmonic oscillation with its frequency Ω and modulation index β, i.e.,

$$U(t) = U\cos\left[W_s t + \beta\sin(\Omega t + \varphi)\right] \quad (1)$$

where U and φ are the signal amplitude and initial phase.

One of the frequencies comprising signal (1) is radiated into space after amplification. The signal reflected from the object, with the respective space-time delay τ, comes to the input of the receiver, in which the signal arriving at the HF-amplifier output and containing both the signal and noise components, can be represented as

$$S(t) = U_s(t-\tau) + U_n(t) = U_{sn}\cos\left[W_s(t-\tau) + W_D t + \beta\sin\left(\Omega(t-\tau)+\varphi\right)\right] + U_n(t) \quad (2)$$

where U_s is signal amplitude; $U_n(t) = A(t)\cos\left[W_s t + \Phi(t)\right]$ is a normal stationary noise process in the frequency band $\Delta\Omega$ with the middle frequency $W_s > \Delta\Omega$; $A(t)$ is the envelope; and $\Phi(t)$ is the instantaneous phase, uniformly distributed on the interval 0–2π.

The correlation function of the noise process is described by equation $R_n(z) = \sigma_n^2\rho(z)$, in which σ_n^2 is the process variance, $\rho(z) = \sin(\Delta\Omega Z)/\Delta\Omega Z$ is the correlation factor, and W_D is the Doppler shift frequency (for a moving object).

The second part of signal (1), after delaying in the CDL by the time interval θ and conversion in the mixer MIX, has the form

REFERENCES

1. A. G. Sorochan, S. M. Liginov, and V. I. Litvinenko, A technique of measurement of time delay of a modulated signal passing over several propagation channels, and a device for its implementation [in Ukrainian], Patent of Ukraine No. 42816 (Application No. 97073670 as of 9 July 1997), Published in: Official Bulletin of Ukraine. Industrial Ownership, No. 10, 15 November 2001.
2. A. G. Sorochan, Izv. VUZ. Radioelektronika, Vol. 44, No. 11, pp. 57–65, 2001.
3. A. G. Sorochan, Izv. VUZ. Radioelektronika, Vol. 46, No. 12, pp. 62–66, 2003.

19 June 2002