Radioelectronics and Communications Systems
Vol. 48, No. 10, pp. 1–5, 2005

Izvestiya VUZ. Radioelektronika
Vol. 48, No. 10, pp. 3–10, 2005
UDC 621.396.96

THE MILLIMETER-RANGE SYSTEMS OF RADIO VISION. PART 2 — COMPARISON AND INTEGRATION WITH OPTICAL CHANNELS, RESULTS OF EXPERIMENTS

A. N. Zubkov

Lvov Research Radio-Engineering Institute, Ukraine

The paper gives comparison of information capacity of the millimeter-range radar channel with that of optical channels. Both types of channels, used for observation of ground targets, can be integrated in a single electrodynamic structure. Results of experimental investigations of informative criteria of ground targets in the millimeter range are included.

Comparative analysis of informative ability of the channels for shaping the radar and optical images. Of practical interest is comparison of ability to extract the information about structural features of objects when watching them by two competitive observation aids — a radar channel operating in the millimeter range (MMR) and an optical one (infrared in particular). The difficulties of such comparison are associated, first of all, with different principles of shaping of optical images (OI) and radar images (RI). In optical channels the structural features of objects in the "pictorial" plane manifest themselves due to high angular resolving capacity. In radar channels, because of physical impossibility to obtain angular resolution, comparable with optics, at limited dimensions of antenna aperture, we are forced to use other information criteria related to structural attributes of the object under observation. Consider a case when this criterion represents a range "portrait". This portrait or, in other words, the picture along some distance, is obtained when the object is sounded [1] by a signal, whose resolving capacity is much less than the averaged physical dimensions of the objects at different angles of vision [2].

Introduce several restrictions, which are acceptable in practical situations: the object under observation is located at the maximum range still permitting to discern it by optical means, which gives no way of using its color contrast on the noise background; effectiveness of decision-making from the shaped OI and RI does not depend on psycho- and physiological abilities of human operator, which is typical of automatic monitoring systems.

The amount of information contained in n independent samples, each permitting m levels, can be expressed as

$$I(n,m) = n \log_2 m. \tag{1}$$

In the case of radar image, the m value is proportional to $\sqrt{P_s}$, where P_s is the echo power, obtainable from the major equation of radiolocation; $n = L_D/\Delta D$, where L_D is the linear dimension of the object in the range direction, and ΔD is the radar resolving capacity in range.

For the radar channel, expression (1) takes the form

$$I_\rho(n_\rho, m_\rho) = \frac{L_D}{\Delta D} \log_2 (k D_\rho^{-2}) \tag{2}$$

where k is the coefficient unambiguously defined by parameters of the radar system and of the radio path; and D_ρ is object's range. Similarly, for the optical channel,

REFERENCES

1. A. N. Zubkov, Izv. VUZ. Radioelektronika, Vol. 48, No. 9, pp. 3–16, 2005.

2. A. N. Zubkov, R. V. Obukhanitch, N. F. Karushkin, I. N. Prudius, and L. M. Smerklo, Prikladnaya Radioelektronika, Vol. 1, No. 1, pp. 77–81, 2002.

3. A. V. Shileiko, V. F. Kochnev, and F. F. Khimushkin, Introduction into Information Theory of Systems [in Russian, ed. by A. V. Shileiko], Radio i Svyaz', Moscow, 1985.

4. A. N. Zubkov, N. S. Akinshin, and B. V. Suchinin, The polarized selection of non-Doppler land objects using millimeter radio wave range, MSMW-98 Symposium Proceedings, Kharkov, pp. 371–373, 15–17 September 1998.

5. A. M. Zubkov, I. N. Prudius, and L. M. Smerklo, A technique for remote monitoring of the earth's surface and an integrated system for its implementation [in Ukrainian], Patent No. 70868-A of Ukraine, Application No. 20031213144 as of 30 December 2003, Published 15 October 2004, Bulletin No. 10.

6. S. Kornblit, Microwave Optics — Optical Principles in Microwave Antenna Design Applications [Russian translation, ed. by O. P. Frolov], Svyaz', Moscow, 1980.

7. A. N. Zubkov, S. I. Koba, N. S. Dobryanskii et al., An experimental 94-GHz radar for maintenance of airborne self-guidance systems [in Russian], Proceedings of 14th Crimean International conference "Microwave Devices and Telecommunication Technologies", pp. 764–766, 2004, Sevastopol, Ukraine.

29 April 2005