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THE MILLIMETER-RANGE SYSTEMS OF RADIO VISION. PART 1 — PRINCIPLES OF DESIGN

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The paper considers methods of engineering synthesis and principles of technical implementation of radiolocation channels responsible for search, selection, detection, and identification of complex-shaped ground targets in the millimeter range — to make these channels comparable with optical systems in their informativeness.

Criteria of information-and-energy optimization of radar channels used for observing the ground targets in the millimeter range of wavelengths. The informativeness (amount and quality of information) of any radar channel can be expressed via attainable resolving capacity of spatial coordinates and of Doppler's spectrum. Unfortunately, the radar systems of the meter, decimeter, and even centimeter segments of the radio-wave spectrum have substantial limitations in spatial resolution, particularly: high angular resolution can be attained only at the expense of large physical (or synthesized) dimensions of the antenna, which is often intolerable in practice; high resolution in range entails an increase in the relative width of the sounding signal spectrum $\Delta F/f_0$, where f_0 is the carrier frequency. In the low-frequency part of the radio range a considerable increase in ΔF leads to violation of the constraint $\Delta F/f_0 << 1$, although its observance is necessary for application of optimal methods of complex envelope processing, particularly, the correlation and filtering methods [1].

Application of devices working in the millimeter range (MMR) of wavelengths for resolving the tasks of radar observation over ground objects dwells on the intention of designers of new equipment to utilize as much as possible the advantages of this range (related to its intermediate position between the optical and traditional centimeter parts of the electromagnetic wave spectrum). From the optics this range inherited high informativeness, the possibility to attain high resolving capacity and accuracy of spatial coordinates' measurements, while from the centimeter range — the ability for all-weather and all day-and-night watch, even in the presence of dust and smoke [2]. However, prediction of effectiveness of radar observation channels and selection of their optimal parameters at early stages of synthesis of radar architecture requires accounting some specific MMR features. Of particular importance are (a) a pronounced dispersity of radio channel characteristics — due to availability of spectral zones of resonant absorption of radio waves in the above-ground atmospheric layers, and (b) substantial changes in the interference situation during radar observation of ground objects.

The latter feature stems from the fact that when we raise the spatial resolution of a radar system, the main part will be played by the interference whose spatial and spectral-energy characteristics differ weakly from the similar characteristics of the legitimate signal (the so-called target-like interference). The physical sources of this type of interference may represent reflections from local nonuniformities of the land surface, engineer constructions, etc. The traditional methods of improvement of noise immunity, for example, those based on moving-target selection techniques (MTS) [3], are of little or no use, especially for low-speed and immobile objects.

An important part of the engineering synthesis of radar structure is the choice of criterion of optimality permitting to assess efficiency of operation and select the best variant of system's architecture. Accordingly, we can formulate main

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