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Method for increasing the ratio signal-noise by connecting separate autonomous radars into a system

Modern realities necessitate us to look for quick and effective ways to improve the quality of radar detection of aerial objects with low radar visibility. Combining autonomous radars into a system will enable more complete use of the reflected signal energy and increase the signal-to-noise ratio.

Increasing requirements for the quality of radar information about the air situation forces not only to look for new technical solutions in the creation of various components of radars, which are the main information sources about the air situation in air defense systems, air traffic control, but also to direct efforts to the development and creation of non-traditional systems and means, which are multi-position radar systems, especially in conditions of critical shortage of time and resources necessary for the creation and development of fundamentally new models of equipment. The importance of such measures is indicated by the analysis of combat experience in the Russian-Ukrainian war, where the number of applications and the intensity of low-contrast air attack vehicles flights, including unmanned aerial vehicles (UAVs), increased significantly. Such air attack vehicles, as a rule, have small values of radar cross-section. High-potential radars with adaptive search are necessary for their effective detection.

The main idea of multi-position radar systems is to use the information contained in the spatial characteristics of the electromagnetic field more effectively (than in conventional monostatic radars). As is well known, when an aerial object is irradiated, a secondary scattering field is created in all directions in space (with the exception of shielded areas). Monostatic radars use information from only one small area of the field corresponding to the aperture (radiating or receiving surface of complex antennas) of the receiving antenna. In a multi-position radar systems, information can be obtained from several areas of the scattering field of an aerial object (or the radiation field of signal sources), which allows to increase the signal-to-noise ratio, immunity to interference and other important characteristics.

The development of multi-position radar systems corresponds to the general trend in technology - the integration of separate technical means into systems, due to the fact that cooperative functioning and interaction of elements, the main characteristics are significantly improved and new opportunities appear.

A global trend in the development of technology is the unification of individual devices into systems, in particular multi-position radar systems. The capabilities of conducting radar reconnaissance in such systems are better than in individual monostatic radars, and the energy potential is much higher. This advantage is achieved thanks to the use of matched processing of radar information. The paper proposes the use of surveillance radars as part of a system with different levels of coherence. Such a system can work more reliably than individual monostatic radars in difficult environmental conditions. Multiradar systems are more durable and can work in passive or semi-passive modes, determining the coordinates of objects that reflect electromagnetic waves.

Radar systems, depending on the method of combining the same radars, for this case, can use different methods of multi-position radar to determine the coordinates of UAVs. The signal-to-noise ratio of the resulting signal will also depend on the level of coherence in which the system operates, it can be a spatially coherent or incoherent system. For the case of a spatially coherent system, there are options when only one radar works for radiation, and the rest of the radar works only for reception, all radars work for radiation and for reception, while using the same signals in such a way that their in-phase summation occurs on the software with receiving at the input of receiving positions of only one echo signal. There may also be an intermediate option where N positions work for reception and M positions work for transmission, which may be due to tactical or technical reasons.

From the considered cases, the gain in the signal-to-noise ratio will obviously take place in all types of systems, but the largest – in a spatially coherent system, which uses the same signals in such a way that their in-phase summation occurs at the air object with the reception of only one echo at the input of the receiving positions signal. The optimal number of radars should be justified by economic feasibility.

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