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AN ALGORITHM OF DATA REPRESENTATION IN A PULSE-DOPPLER RADAR SYSTEMS

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A new algorithm is suggested for organization of data in systems for processing three-dimensional images of surfaces as applied to an airborne pulse-Doppler radar system.

Application of airborne pulse-Doppler radar systems for processing three-dimensional radar images of the terrain surface [1], as distinct from systems using scanning by the beam of antenna's radiation pattern (ARP), allows a considerable reduction in the resolution elements in terms of angle of site θ and azimuth φ at a certain mutual location of the vector $\vec{V}$ of motion speed of the radar-bearing aircraft and of the direction vector $\vec{S}$ of the antenna line of sight. The use of such a system improves the accuracy of subsequent data processing, but adds to the complexity of the data formation model.

From the viewpoint of geometry, the presence of narrow-band Doppler filters corresponds to cutting of the ARP cone-shaped surface by a set of conic surfaces of several constant levels of the Doppler speed. These surfaces, along with a section by spherical surfaces of constant level, form smaller resolution elements in the shape of intricate spatial geometric figures (domains D) of various size, each having different orientation in space. Under these conditions, it is necessary to develop special algorithms for data representation and for control of sounding with regard to mutual location of the vectors $\vec{V}$ and $\vec{S}$. Here we propose an algorithm for data organization based on approximation of conic and spherical surfaces by cylindrical and plane ones, consistent within the resolution elements. The algorithm includes the following operations:

1. For a given velocity V establish the correspondence between the range of Doppler frequencies $[f_{\min}, f_{\max}]$ and the range $[\alpha_{\min}, \alpha_{\max}]$ of angles α of deviation of the vector $\vec{S}$ from $\vec{V}$ with regard to the relation $\Delta V \sim \Delta f$, $\Delta V = 2V \cdot \sin\alpha \cdot \sin\Delta\alpha$, where ΔV and Δf are, respectively, the resolutions in velocity and frequency, and $\Delta\alpha$ is resolution in terms of the angle α. This dependence is nonlinear.

2. For each nth resolution element (RE) in terms of angles φ and θ, set in spherical coordinates in the form of the angle-measuring domain $D_n = (\varphi, \theta)_n = (\varphi_0, \theta_0), (\Delta\varphi, \Delta\theta)$, with its center (φ_0, θ_0) and dimensions $(\Delta\varphi, \Delta\theta)$, determine the Doppler angle corresponding to the RE center, by the formula

$$\cos\alpha_0 = \cos\varphi_0 \cdot \cos\theta_0 \Rightarrow \cos\alpha_0 \Rightarrow \alpha_0 \Rightarrow \arccos(\cos\varphi_0 \cdot \cos\theta_0).$$

3. Find the range $[\alpha_{\min}, \alpha_{\max}]_n$ of magnitudes of the Doppler angle α corresponding to the given RE, where, in the case of circular (point) ARP, $\alpha_{\min} = \alpha_0 - \Delta\varphi/2$, $\alpha_{\max} = \alpha_0 + \Delta\varphi/2$, and establish the correspondence between $[\alpha_{\min}, \alpha_{\max}]_n$ and the band of Doppler frequencies $[f_{\min}, f_{\max}]_n$ so that each jth angular interval $[\alpha_j, \alpha_{j+1}] \subset [\alpha_{\min}, \alpha_{\max}]_n$ of a Doppler resolution element (DRE) $D_{n,j}$ contained in D_n, is mapped by the frequency band $[f_j, f_{j+1}] \subset [f_{\min}, f_{\max}]_n$ of the Doppler filter. For a fan-shaped ARP, a different rule is used.

REFERENCES

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