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A non- navigational TIN-DDM automatic synthesis algorithm that takes into account the accurate determination of terrain features and full expression of topography

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Abstract:

Digital depth model (DDM) is the use of limited and discrete depth points to realize the digital expression of the undulations of the seabed terrain surface. According to the different organization methods of depth point data, it is divided into Regular Grid DDM (GRID-DDM) and Triangulated Irregular Network DDM (TIN-DDM). Compared with GRID-DDM, TIN-DDM has not undergone any data interpolation processing, and directly uses the measured depth as its model sampling point. Therefore, TIN-DDM has relatively prominent advantages in reflecting topographical changes. Based on TIN-DDM, the conclusions of seabed topography analysis are more accurate. Different from the traditional TIN-DDM that serves the needs of navigation applications, TIN-DDM (non-navigational TIN-DDM) that serves the analysis and expression of authentic terrain needs to focus on the accurate expression of the seabed terrain, that is to ensure the accuracy of the expression of seabed topographic features and the adequacy of the expression of seabed topography in the process of multi-scale expression (synthesis) of TIN-DDM.

Constrained by the traditional navigational TIN-DDM serving the safety and security thinking of ships, there are few researches on automatic synthesis algorithms specifically for non-navigational TIN-DDM application requirements. Inspired by the idea of the terrestrial TIN-DEM multi-scale expression algorithm, most of the existing non-nautical TIN-DDM automatic synthesis algorithms are improved by the terrestrial TIN-DEM multi-scale expression algorithm. However, it needs to be pointed out that unlike terrestrial TIN-DEM, which already contains complete land topographic control information (generally composed of typical topographic feature points) during data collection, the seabed topography measurement cannot directly obtain the seabed topographic feature points and the related seabed topography range, due to the particularity of the measurement methods. The existing automatic synthesis algorithm is difficult to realize the full mining of the deep-level terrain feature information in the non-navigational TIN-DDM, and the exploration of the correlation between the spatial scale and the terrain shape judgment conclusion is not deep enough. Therefore, this paper proposes a non-navigational TIN-DDM automatic synthesis algorithm that takes into account the accurate determination of terrain features and full expression of topography.

First, taking the local Delaunay influence domain as the range constraint of the sampling point terrain feature, analyzing the numerical change law of the critical rolling ball radius in the positive (negative) direction, establishing the TIN-DDM sampling point terrain type judgment criterion for micro-topography, and determining the topographic unevenness of sampling points within the range of local topographic features; Secondly, using the overall TIN-DDM as a reference for the range of topographic features of the sampling point, analyzing the numerical change law of the contact degree between the rolling ball and the TIN-DDM sampling point, establishing the criteria for determining the terrain type of the sampling point for macro-topography, and determining the skeleton and detailed terrain sampling points within the overall terrain feature range; On this basis, with the critical rolling ball radius as the associated link, based on the terrain unevenness of the TIN-DDM sampling points in the local area, analyzing the changing laws of topographic features caused by continuous longitudinal changes in the location of the sampling points, demonstrating the numerical correlation between the skeleton topographic sampling points and the critical rolling ball radius, and exploring the continuous state change trend of the topographic features of the sampling points from micro to macro, constructing TIN-DDM sampling point terrain feature quantitative evaluation index that takes into account the expression of seabed topography, and designing TIN-DDM automatic synthesis algorithm flow based on TIN-DDM sampling evaluation index; Finally, through experiments, the effectiveness of the algorithm in this paper is proved.

The data used in the experiment is the TIN-DDM depth data of a certain sea area in China, which contains 12774 sampling points in total, and the topography is complex and the degree of undulation is large Based on Surfer software to generate the terrain surface of the original seabed terrain and the isobath with a depth of 5 meters, as shown in Figure 1. Based on Surfer to generate the terrain surface and the contour map with a depth of 5 meters after the synthesis of each algorithm, as shown in Figure 2 and 3.

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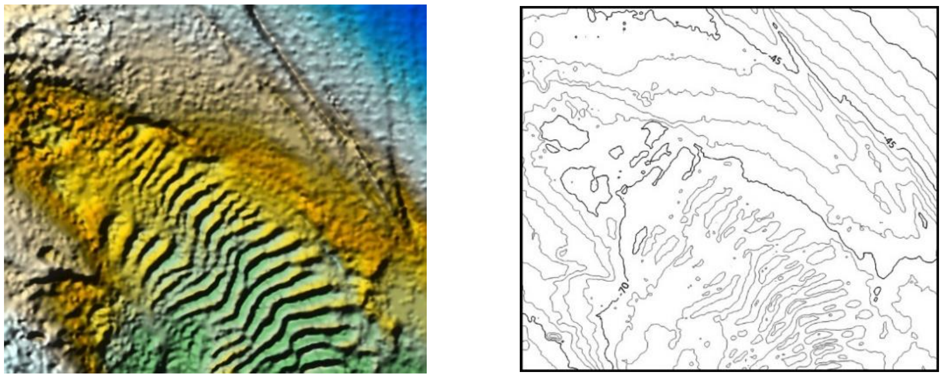

Figure 1. Topographic surface and 5-meter contour of the test sea area

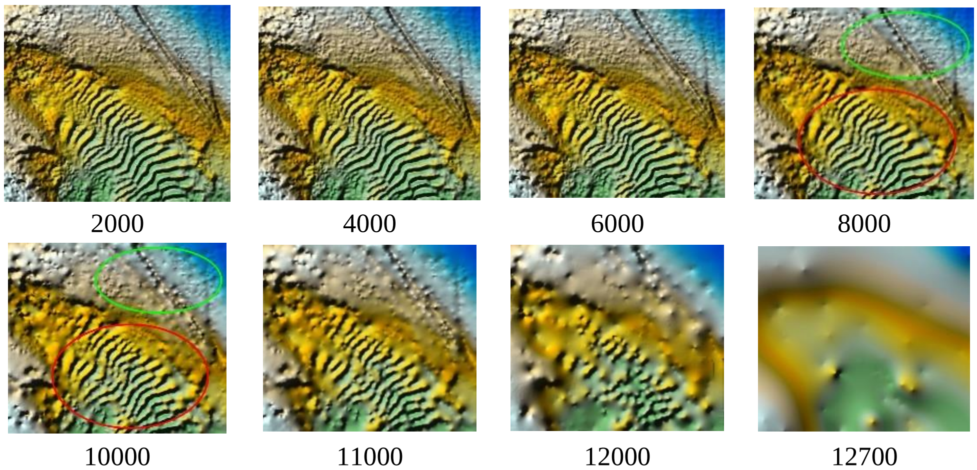

Figure 2. Terrain surface of synthesis result (Number represents the number of depth points to be deleted)

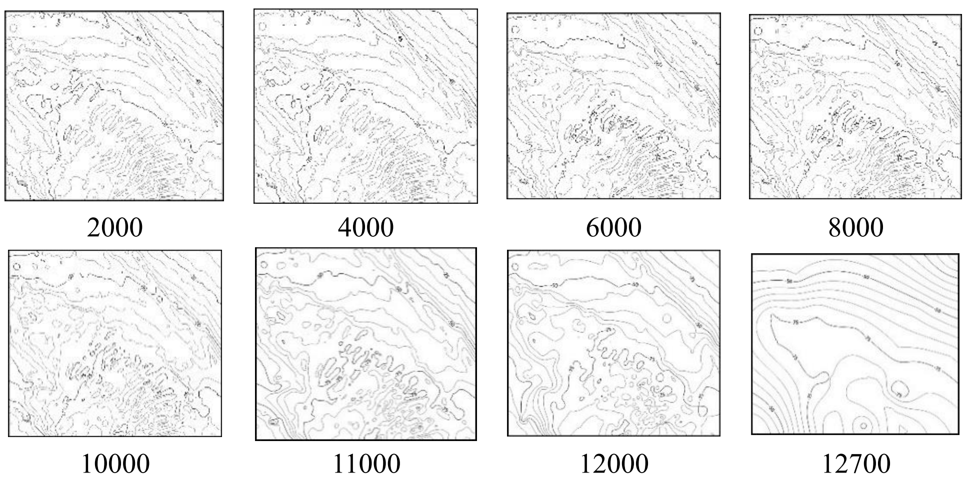

Figure3. 5-meter contour of synthesis result (Number represents the number of depth points to be deleted)

The experimental results show that the algorithm proposed in this paper is correct and effective. It has a good performance in the accuracy of the expression of the seabed topographic features and the adequacy of the expression of the seabed topographic form.

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