A Method for Assigning Appropriate Elevation to Water Portion in the DEM Data

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***Abstract*— Digital elevation model (DEM) data comprise a uniform square mesh, and each element (i.e., a cell) of the mesh has an elevation value. In Japan, two types of DEM data, i.e., 5-m and 10-m meshes, are currently published by GIA Japan. However, both DEM data types have a serious problem relative to their water portion. This paper proposes a method to assign an appropriate elevation value to each cell of the water portion in 5-m mesh DEM data considering its classification (i.e., sea, lake, or river). The usefulness of the proposed method is confirmed by applying it to real-world DEM data.**

Keywords—DEM, Terrain, Water portion, Image processing

I. INTRODUCTION

Digital elevation model (DEM) data comprise a uniform square mesh, and elevation data are assigned to each element (i.e., a cell) of the mesh [1]. It is used for various topographic analyses, e.g., generating running water lines or evaluating disaster risk. However, due to nature of the measurement principle for constructing 5-m mesh DEM data, an effective elevation value is not assigned to the water portion in the DEM data. Specifically, -9999 is taken as the elevation value for all cells in the water portion. As a result, serious problems can occur if the original DEM data are used directly to reconstruct terrain surfaces, i.e., each water portion becomes a deep hole, and its surrounding edge rises like a sheer cliff (Fig. 1). In this paper, we propose a method to assign an appropriate elevation value to the water portion in DEM data by classifying the portion into three classes, i.e., seas, lakes, or rivers. In the proposed method, different algorithms are employed to assign elevation values for each class.

II. BASIC IDEAS

We focus on the 5-m mesh DEM data issued by Geospatial Information Authority of Japan, where a cell in the DEM data with an elevation value of -9999 is considered to be a cell in the water portion. For the three types of water portion, the elevation of the surface of a lake or sea is flat. In contrast, the elevation of a river gradually decreases as the river flows downstream. In the proposed method, different algorithms are employed to assign elevation in consideration of these elevation differences in the surface of the water portion. The classification of each water portion is performed as follows. Seas are specified manually, and lakes and rivers are classified automatically based on their rough shape in the DEM mesh.

III. OUTLINE OF THE PROPOSED METHOD

Figure 2 outlines the procedure of the proposed method. First, all cells in the input 5-m mesh DEM data are binarized into land and water portions. Then, a labeling process is performed to assign the same label to the connected cell in a water portion. Here, if the target data include a sea, the sea area is specified manually using a GUI. Simultaneously, the boundaries rivers and seas and rivers and lakes are specified manually. After the closing process is performed on each water portion (except for sea portions), the water portions are then classified as a river or a lake according to its degree of circularity [2]. Then, an appropriate elevation value is assigned to each cell in the water portion using different algorithms depending on the classification (i.e., sea, lake, or river). Specifically, the lowest elevation E_{low} is obtained as follows for each type, where an elevation below E_{low} is assigned to cells in the water portion as their elevation values: Here, a river is subdivided into multiple short sections, where, for each section, the minimum elevation value of cells located on both sides of the river in a given section is obtained as E_{low}. For a lake

Fig. 1. 3D terrain shape reconstructed with original DEM data

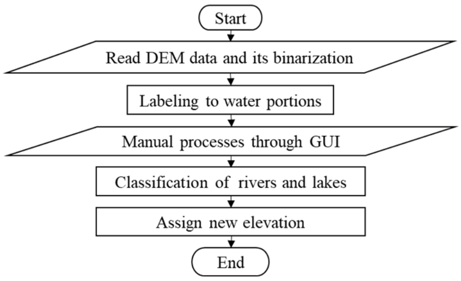

Fig. 2 Outline of the process

or sea, the minimum elevation value of cells on the shore is obtained as E_{low}.

IV. EXAMPLES AND DISCUSSION

The proposed method was applied to actual third-order DEM mesh data (5131-72-64) [1]. Figures 3(a) and 4(b) show the distribution of elevation visualized in 8-bit grayscale, where Fig. 3(a) used the original DEM data, and Fig. 3(b) used the data modified by the proposed method. Figure 3(c) shows a magnified view of the red rectangles A and B shown in Fig. 3 (b), and both images include water portions (black dots in Fig. 3(a)). By comparing portions A and B in Figs. 3(a) and 3(b), it is obvious that the proposed method assigned appropriate elevation values to cells in these water portions.

V. CONCLUSION

This paper has proposed a method to assign appropriate elevation value to water portions in DEM data by classifying each water portion as a river, sea, or lake and applying different algorithms to assign elevation to each type. The usefulness of the proposed method was confirmed by applying it to actual DEM data. In future, we plan to implement automatic segmentation of rivers and seas or lakes.

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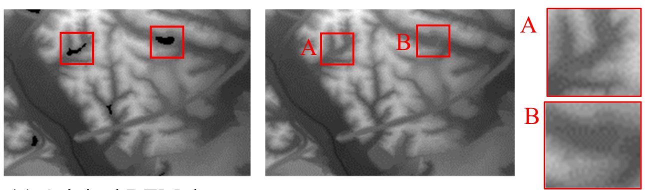

(a) Original DEM data (b) DEM data modifyed by proposed method (c) Magnified A and B in (b)

Fig. 3 Application result