

DIGITAL WATERMARKING FOR GRID DEM DATA USING SURJECTIVE FUNCTION

Chih-Cheng Cheng¹, Pai-Hui Hsu²

¹*Department of Civil Engineering, National Taiwan University,
No.1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan, d98521018@ntu.edu.tw*

²*Department of Civil Engineering, National Taiwan University,
No.1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan, hsuph@ntu.edu.tw*

Abstract: The Digital Elevation Model (DEM) is an important geospatial framework data which is commonly used in various applications such as national land-use planning, disaster prevention, environment monitoring, and engineering reconstruction, etc. Some applications require the DEM data with high resolution and high precision, however such kind of data is always classified as a national security information. The consequence is that the DEM data sharing should be considered more conscientious and careful in content and copyright protection. The purpose of this study is to develop an effective digital watermarking method for grid DEM data and make the trade-off between data sharing and copyright protection. Digital watermarking is the process of embedding visible or invisible information into a digital signal which may be used to verify its authenticity or the identity of its owners. A digital watermark is called robust if it could be detectable completely even when the watermarked data is subject to purposive or unintentional data modifications (or attacks). In addition to the robustness of watermark, the quality of original DEM data after embedding the digital watermark also should not be reduced. In order to satisfy these two basic requirements simultaneously, the digital watermarking algorithm should be developed according to the characteristics of the DEM data and its applications. In this study, a novel digital watermarking algorithm based on the surjective function is developed for the DEM data, and the robustness of the embedded digital watermark and the impact on DEM data quality is evaluated and analyzed.

This paper firstly discussed the spatial characteristics and requirements of the DEM data quality, and then a digital watermarking algorithm is developed for DEM data using the surjective function. In mathematics, a surjection function is a function whose image is equal to its codomain. That is, a function f from a set X to a set Y is surjective if every element y in Y has a corresponding element x in set X given by $y = f(x)$. The properties of a surjection function ensure that the digital watermark can be embedded into the DEM data entirely. In addition, the contents of the digital watermark can be embedded into the DEM data more than once, and therefore the robustness of the digital watermark could be preserved when the DEM data is subjected to some geometric attacks such as clip, rotation or scaling. In this study, a real DEM data set is used to test the performance of the proposed digital watermarking algorithm. The robustness of the watermark and the influence of DEM data quality are also analyzed to improve the effectiveness of the proposed method.

Keyword : DEM 、 Digital Watermarking 、 Redundancy 、 Surjection