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Brief Paper: Perceptual encryption algorithm for vector map based on geographical features

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Abstract
Recently years, vector map data is used in many applications and on/off-line services widely. The cost of production of vector map data is very expensive but it is stolen or copied easily by pirates without permission from the original providers. Therefore, provider desires vector map data should be encrypted before storing and transmitting to ensure the access control and prevent the illegal copying of vector map. In this paper, we proposed a perceptual encryption method for vector map based on geographical features. The geometric objects of vector map data are extracted to compute features as bounding boxes and distance vectors. After that, we encrypted those features and use them to compute and obtain encrypted vector map data. Experimental results have verified that the entire vector map is changed after encryption process. The proposed method is very effective for a large of dataset, responsive to requirements of security.

Keywords: Vector map data, geographical features, geometric object and cryptography

1. Introduction
The vector map is based collection of Geographic Information System (GIS) data about earth at various levels of detail. Vector map is created and developed by the merging system of cartography, statistical analysis, and database technology based on vector model [1, 2]. Due to vector map data is so high value in many applications that any company can buy it, make illegal copies and distribute or sell them easily many times without taking any permission from the original GIS data provider. Moreover, some applications of vector map require security, and must be kept away from unauthorized users. So vector map data should be encrypted before storing and transmitting to prevent illegal duplication and distribution of it.

The vector map data is stored in layers. Each layer consists of content data and attributed data. The content data is the geographical objects be represented by geometric objects as point, polyline and polygon. The attributed data is storage information and display information as header and text. Due to the attribute data does not determine the shape of object, we only need to extract content data for perceptual encryption.

For meeting above requirements, we present a perceptual encryption scheme for vector map in this paper. The main content of proposed scheme is to extract geometric objects from vector map data to compute bounding boxes and distance vectors. Then, it encrypted bounding boxes and distance vectors by secrete key. Encrypted vector map data will be obtained from encrypted bounding boxes and distance vectors. The detailed algorithm is described in Section 2. Experimental results and the evaluation of proposed scheme will be shown in Section 3. Section 4 shows the conclusion.

2. The Proposed Algorithm
The proposed algorithm is shown detailed in Fig. 1. Polyline and polygon are encrypting targets and extracted from vector map to perform perceptual encryption. With each extracted object, we compute the bounding box and center of bounding box corresponding to that object to compute a set of distance vectors. Distance vector is the distance from center to vertices of object. After that, bounding box and distance vectors will be encrypted using secret key which is generated from user key by hashing function. Next, we compute the center of encrypted bounding box. Finally, encrypted object will be obtained from the center of encrypted bounding box and encrypted distance vectors.

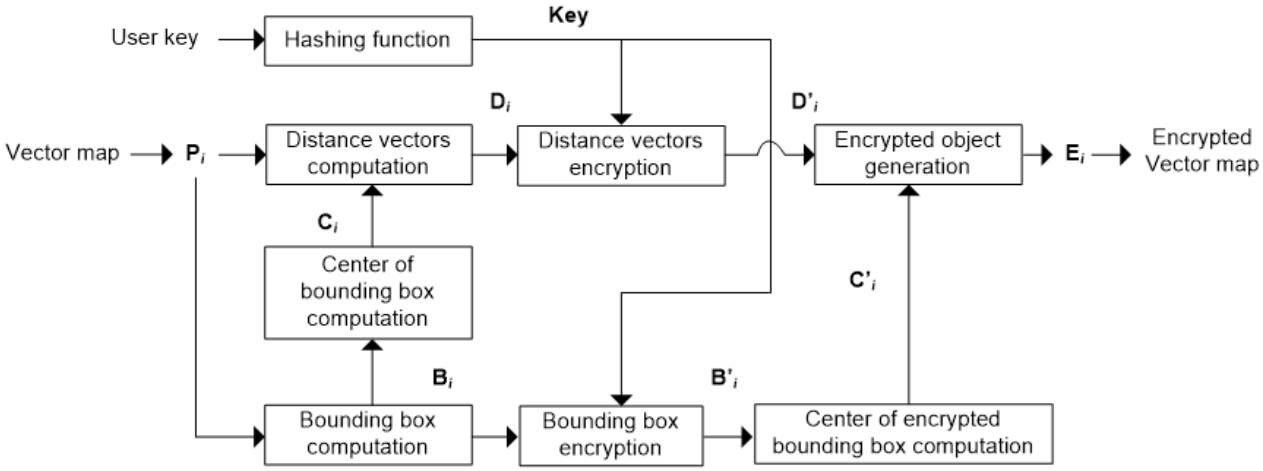
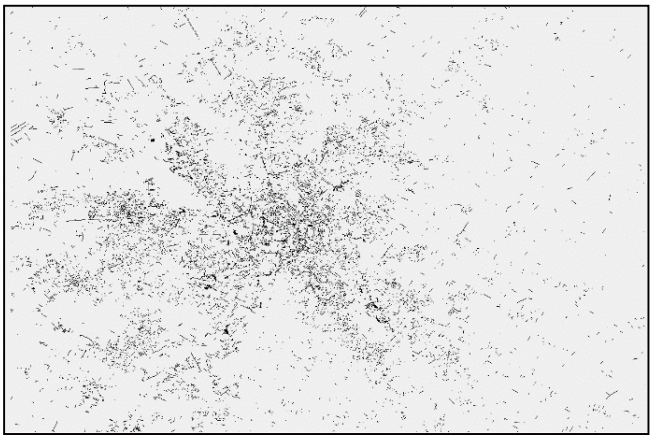


Fig 1: Vector map perceptual encryption algorithm based on geographical features.

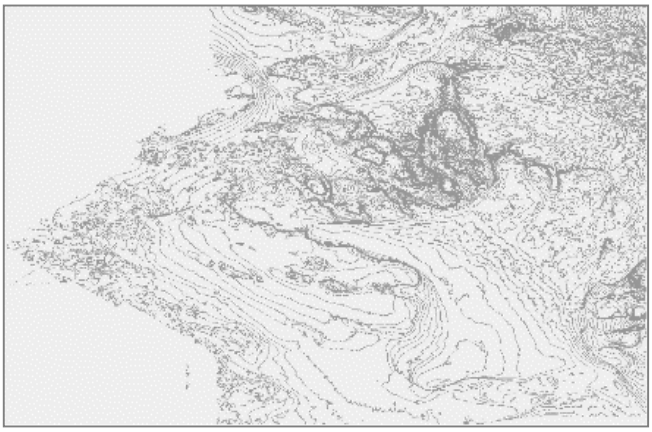
3. Experimental Results

We used vector maps with different scales in visualization experiences. The data format of vector map is shape-file (SHP) format [3], which is popular geographical vector data format. The proposed scheme is applied to polylines and polygons in vector map. In our experiments, we used SHA-512 algorithm [4] to hash user key, and used AES cipher to encrypt bounding boxes, distance vectors. AES algorithm is selected because it has high security than DES, XOR and others. In comparison with conventional works, the proposed scheme does not alter or expand the size of encrypted file, and it does not have loss data happen.

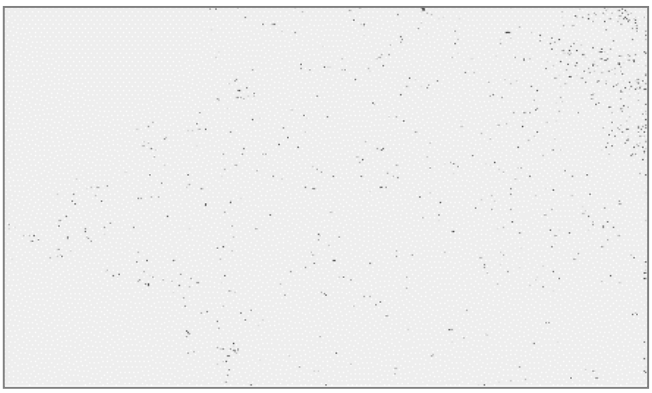
(a)



(b)



(c)



(d)

Fig 2: Experimental result with vector maps; (a) original Toulouse map and (b) encrypted Toulouse map; (c) original Massachusetts bay and (d) encrypted Massachusetts bay.

4. Conclusion

In this paper, we proposed a perceptual encryption scheme for vector map security. It is responsive to various formats of vector map data, reduces computation time and is high security. It can be applied to the security of map service on on/off-lines.

Acknowledgement

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