Cartographic design considerations for automated graphic revision of 1:25,000-scale vector data

Nonoko TSUKADA, K.IRIE
Tokyo Map Research Co., Ltd.
1-45-2 Yotsuya Fuchu-shi Tokyo
183-0035 Japan
E-mail: ntsukada@t-map.co.jp

T.TERABAYASHI, T.KADOWAKI, K.NAKAMINAMI
Geographical Survey Institue, Ministry of Land, Infrastructure and Transport

M.MACHIDA, Y.TSURUOKA
Nihon Computer Graphic Co.,Ltd.

Abstract

This study examines the possibility to produce 1:25,000 topographic maps from vector data fully automatically, which meet the current specification and symbols. Automatic production of topographic maps requires formalizing cartographic knowledge of each symbols. After the production of visualized output, the result revealed the difficulty of reproduction of some symbols and relationships of features. Based on the examination, the suggestion of consideration of the design of the symbols for automated production will be given in a conclusion.

1. Introduction

1:25,000- scale topographic maps, the largest scale map series with nationwide coverage in Japan, have been provided as paper maps as well as raster image data. Along with the advent of computer-assisted cartography, production and topographic map revision are currently done through the raster revision process called, Vector Raster Cad_Map Revison(VRC_MR) system, to produce raster graphic map data. Today the growing use of geographic information systems demands fundamental spatial database covering whole area of Japan. The Geographic Survey Institute of Japan(GSI) has started to develop digital topographic database in vector format from 1:25,000-scale raster image data, in addition to the existing vector data such as administrative boundaries and shore lines. At the same time as the requirements for digital map information have grown, the demand for visualized map information in paper form and various media still continues. These demands require the new revision plan which includes the development of vector database, the use of existing hardware and software for production, to maximize the automation of production procedures wherever possible, to minimize the interactive editing, to create symbols that meet established 1:25,000-scale map series standards, and to produce publication-quality output. The revision plan consists of two tasks, to plan vector data structure and to redesign symbols. This study is a first step of the whole revision plan, which focuses the possibility to produce current symbols with prototype vector data without interactive editing. The results of examination are to be the subject of future research for design of vector data structure and to redesign of redesign of cartographic symbols of 1:25,000-scale map series from vector data.

2. **Symbolization of features on topographic maps**

Automated cartographic symbolization of features on intermediate scale topographic maps is not easy task. Table 1. summarizes anticipated difficult operation at automate reproduction of symbols of features with vector data.

Table 1. Main problem in cartographic symbols of 1:25,000-scale topographic maps

Characteristics of symbols	Examples of symbols	Problem for symbolization
dot, halftone, stipple, filling	river, cemetery, urban area	needs to set symbol area first
variable size and form	cliff, rock, tower, tunnel	needs geometric data for size and form, complex symbolization
overlays other symbol	snow shield, dam	needs supplement data for topology
intersection	class roads	needs supplement data

Based on recognized problem described above, this study tries to reproduce 1:25,000-scale topographic map automatically with prototype vector data from two map sheets. Especially, this study examines :

- generate edge of roads from centerline data
- represent special pattern of line data, such as railroads and fence
- represent special pattern of area data, such as buildings
- represent symbolization of cliff

Although all features in prototype data are tried to be symbolized to meet current symbol specification, temporary simplified symbols are used for representation of some of relief features which are considered very difficult to be symbolized. The system used for this study is NIGMAS by Nihon Computer Graphic Co., Ltd. Table.2 below shows a summary of prototype data.

Table 2. Summary of prototype data

Map sheet	Tuchiura	Hitachifujisawa
Year of production	1999	
Data format	Based on Digital mapping format(DM)	
Number of kind of cartographic symbols in a map sheet among 126 symbols of 1:25000 scale topographic map	79	61

3. Operation of data representation

Flow of symbolization is as follows; conversion of data format from DM data to NIGMAS system, data conversion of each feature to layer and line type; generation of symbols of cliff, generation of annotation and point symbols; generation of line symbols; generation of symbolization of other data. Fig. 1 below shows the image of generation of cliff, which has a grouped line data.

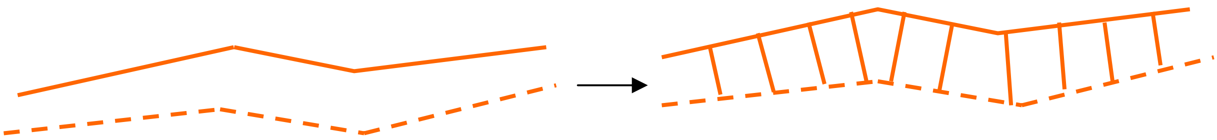
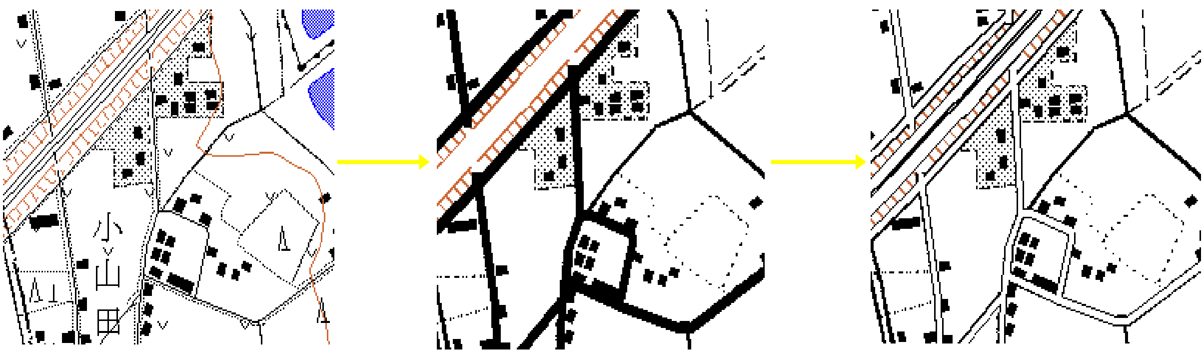


Fig.1 Image of generation of symbols of cliff

Fig. 2 below illustrates steps of generation of edge roads from centerline. Furthermore, intersections of roads are also represented by this method.



Center line data

Drawing black thick line with accordance of specification

Drawing white line on black line to create edge of road

Fig.2 Image of generation of edge of roads from centerline data

4. Results

The examination involved presentation of each symbol in prototype data including roads and railroads with pattern, and relief features which are considered challenging to be symbolized automatically.

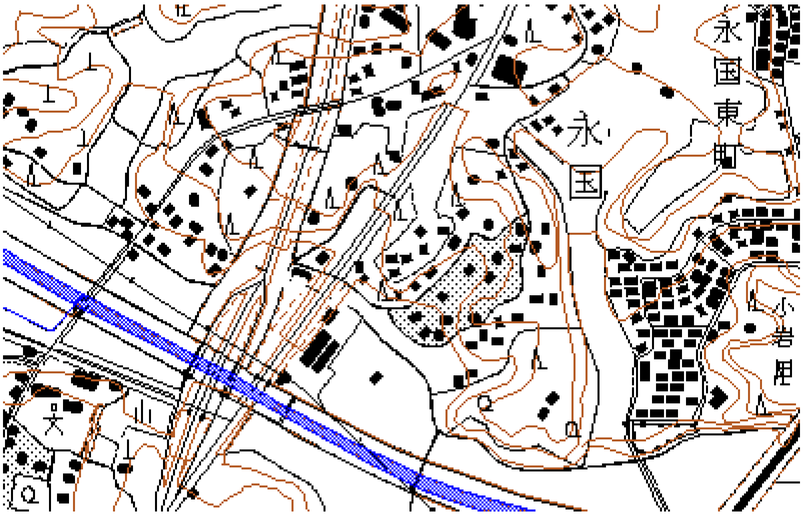


Fig.3　Data before line features symbolized

Fig.3 shows prototype vector data of study area with name placement, point symbols such as buildings and vegetation plant.

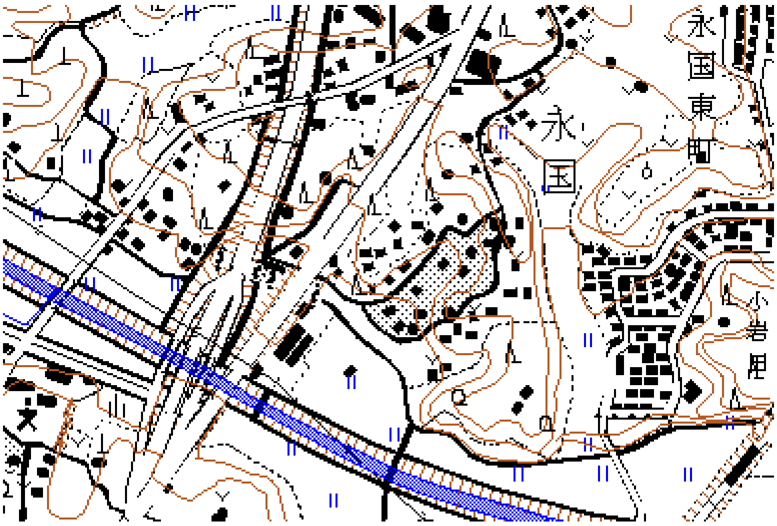


Fig. 4　Data after symbolization of line features

Fig.4 left is result of symbolization of line features as well as relief features.

5. Discussion and Prospects

The result of examination of each feature is summarized as below.

Degree of difficulty	Number of Symbols	Process of operations	Feature	Reason
Easy	50 (approximately)	Simple conversion to symbol	Point symbols variety of buildings miscellaneous culture features	Conversion to symbol with size
Moderate	1	Additional operation enabled symbolization	Symbolized road	
Hard	30 (approximately)	Incomplete symbolization	Area patterns(sand area, large wash, gravel area, Relief features(cliffs, rocks, depth) railway bridge road under construction Single-line river Boundary with pattern	insufficient data - orientation - width - length Illegible - pattern
No operation	4	No treatment raw vector data	Features to be presented to scale (double-line road, station)	

Table 3. Summary of result of operation and degree of difficulty depending on feature

There are approximately 80 features available in the examined prototype data, whereas there are about 130 features and symbols for current 1:25,000-scale topographic maps.

Examination of symbolization of each features shown on topographic maps of study area seemed some success since almost features examined are able to be symbolized automatically to some extent. As anticipated earlier, point symbols such as symbols of buildings and miscellaneous features which consists of more than half symbols examined, are symbolized with current algorithms without specific additional work. Yet, the examination revealed problems in presentation of patterns, orientation, and size of symbols of some features, such as railway bridge, road under construction, and a sluice. These result of symbolization of such features above may cause misinterpretation of features. Thus, this elucidated problem in some features should be solved either redesigning of symbols or data structure of topographic maps in order to produce 1/25,000 scale topographic maps automatically.

6. Conclusion

The examination suggests the possibility of reproduction of 1:25,000 topographic map automatically from prototype vector data, to some extent. On the other hand, there also have been found difficulty in reproduction of some symbols due to the insufficient geometric or topological information of data. Furthermore, the examination indicates the problem in presentation of relationships among features in addition to the problem of reproduction of individual symbol. Next steps for automated reproduction will be: to redesign symbols which have been identified as difficult to be reproduced and/or to add supplemental data to prototype of vector data for visualization of symbols.

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