AUTOMATIC COMPILATION OF ROAD FIGURE FROM THE PLOTTING DATA

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ABSTRACT

The aspect of the automatic spatial data extraction is considered very difficult. This is commonly recognized in the field of image processing. Therefore, the main stream in the spatial data (vector) extraction so far has been done by human operators with application of an analytical plotter. However, the digital mapping performed by the analytical plotter requires much skill from the operators. The digital mapping itself takes a lot of time because of the manual extraction and compilation.

In this paper we studied the speed of the manual road data acquisition and the automatic compilation. Our method on the acquisition the road data is taken straight preferentially. At this stage, crossing is ignored, and the other side of a road edge is created by a parallel copy of the original line. Shave of crossing or small changes such as road widths are ignored at the first stage. Finally, the automatic compilation composed of line merging, expansion, contraction, connection and code change is done to the original plotted data.

According to our experiment, the total result of 93.2 % of 386 places, where compilation was necessary, involved all seven patterns and it has been successfully compiled. The processing time of the automatic road compilation including the failed place recovery is about 15 minutes. It is over 80% reduction of the processing time compared to the fully manual compilation (90 minutes).

1. INTRODUCTION

The aspect of the automatic spatial data extraction is considered very difficult. This is commonly recognized in the field of image processing. Therefore, the main stream of spatial data (vector) extraction is still done by human operators although many advanced studies are available for the automatic extraction of buildings, roads, road facilities, etc. Also the softcopy stereo plotter's capacity for the spatial data extraction is not larger than that of the analytical plotters.

On the other hand, according to the fields of practical application of GIS, it is spreading widely; sale of the spatial data is increasing. At the initial stage of GIS, production method of the spatial data was digitized on the basis of the existing maps. Nowadays, it is replaced by plotting with application of the analytical plotters since many customers are building up GIS or accumulating the spatial data, when a new map is required, even in the case when a paper map can be sufficient. Therefore, at present the main stream in the spatial data extraction is done by the analytical plotters.

The digital mapping based on the analytical plotter requires much skill from the operators. The digital mapping itself takes much time because of the manual extraction and compilation. Particularly, the compilation takes much time; because CAD dose has insufficient capacity for the map compilation. At present, the rectangle of buildings and drawing of straight lines is considered very easy. However, most of other figure compilation is considered very difficult to be used for automation. These are roads straightening, fine-drawn contour lines and relation between roads and buildings, or some other features. Since these subjects need to be resolved, some of the automatic compilation for plotting data is required. In this paper we studied the speed of manual acquisition of the road data and the automatic compilation.

2. DATA ACQUISITION

Figure 1 shows the result of plotting according to our method.

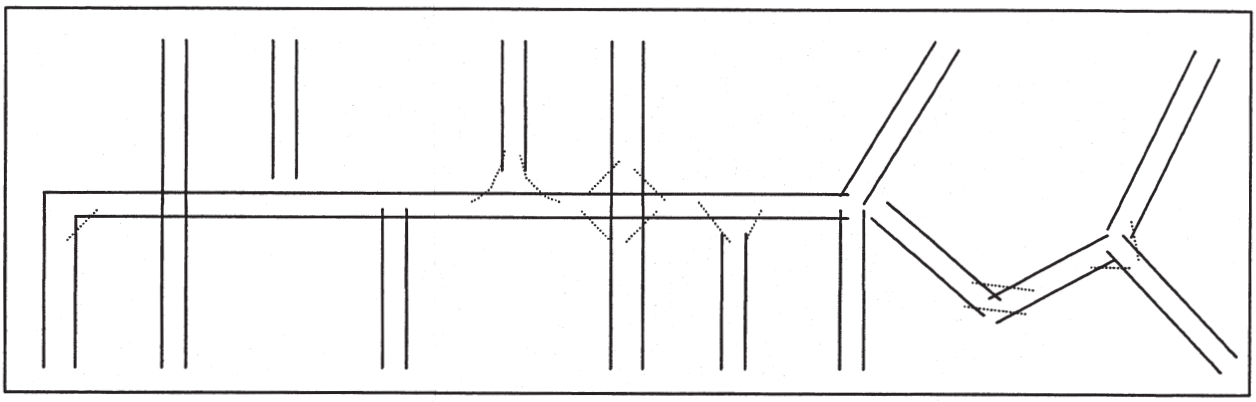


Fig. 1 data acquisition

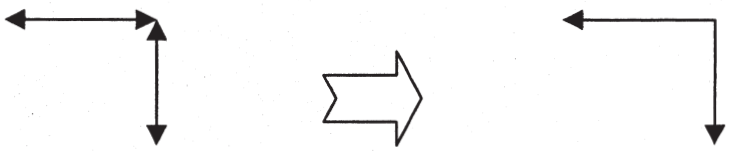
3. AUTOMATIC COMPILATION

Automatic compilation composed of line merging, expansion, contraction, connection and code changing are done to the original plotted data.

There are seven patterns of automatic compilation. 1. The merging of lines that are connected already. 2. Merging lines that have not been connected yet. 3. The omitting roads crossing without shaves. 4. The omitting roads crossing with shaves. 5. The omitting T-figure roads crossing without shaves. 6. The merging of roads and assistant lines without cutting. 7. The merging roads and assistant lines with cutting.

3.1 Merging for Connected Lines

First process is merging of lines that are connected already. Two lines that connected the same coordinates merge in a line (fig.2).



3.2 Merging for Unconnected Lines

Second process is merging of lines that have not been connected yet. Edges of two lines are enough to near the distance and cross each other, the crossed point of the lines becomes a node and merges in a line (fig.3). Or the crossed point of expansion of two lines becomes a node and merges in a line (fig.4). Or the average point of two lines' edges becomes a node and merge in a line (fig.5).

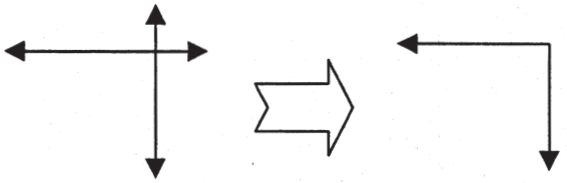


Fig. 2 Merge by crossed point

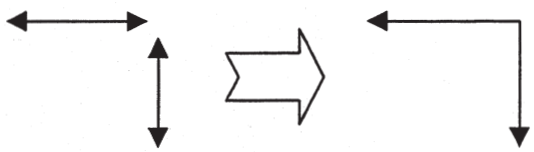
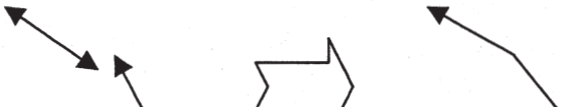


Fig. 3 Merge by expansion point



3.3 Omitting for Crossing without Shave

Third process is omitting road crossing that does not have shaves. Crossing points of road lines are searched, and divided by another lines. Then short lines according by input parameter are omitted; longer lines are merged in a line according to node connection (fig.6).

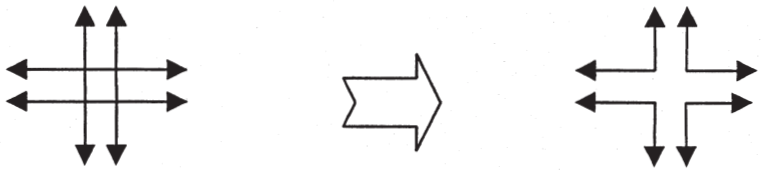


Fig. 5 Omitting crossing without shave

3.4 Omitting for Crossing with Shave

Fourth process is omitting roads crossing with shaves. Following the omitting of the road lines crossing in the third process, assistant lines are overlaid to the final result. Then crossing points of those lines are searched, and assistant lines are shortened until crossed points on road lines. The lines between crossed points are omitted, and the roads and assistant lines are merged in a line (fig.7).

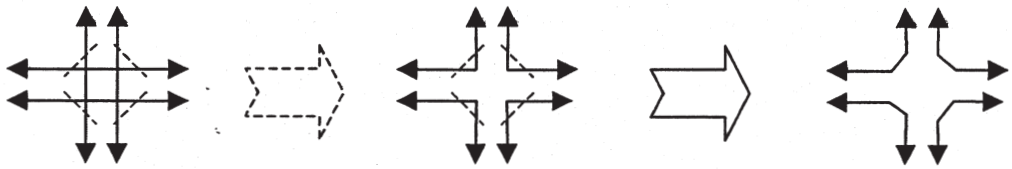


Fig. 6 Omitting crossing with shave

3.5 Omitting for T-figure Crossing without Shave

Fifth process is omitting T-figure roads crossing without shaves. The crossing points of edge lines or expanded edge lines and road lines are searched, and divided by another lines. Then short lines according to the input parameter are omitted; longer lines are merged in a line according to the node connection (fig.8, 9).

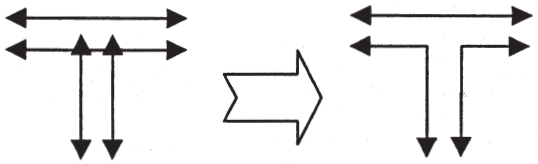


Fig. 7 Omitting for T-figure crossing without shave (crossing)

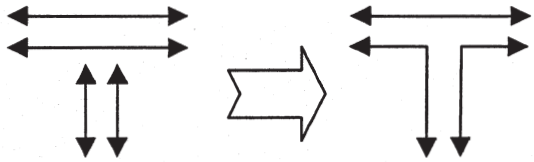


Fig. 8 Omitting for T-figure crossing without shave (expanding)

3.6 Merging by Assistants without Cutting.

Sixth process is merging of roads and assistant lines without cutting. The cross points of between road lines and assistant lines are searched, and the edges are shorted to the crossing (Fig.10, 11).

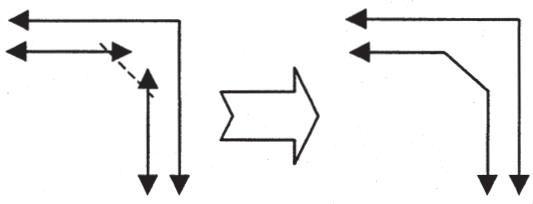


Fig. 9 Merging by assistants without cutting (corner)

Fig. 10 **Merging by assistants without cutting (width)**

3.7 Merging by Assistants with Cutting

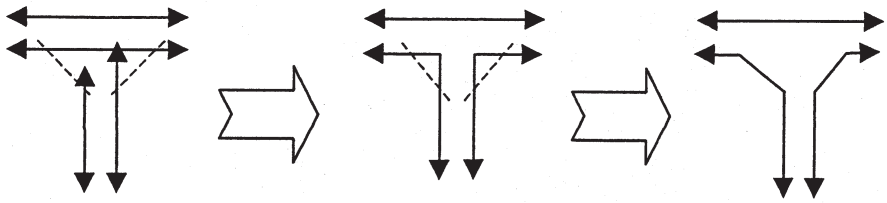


Fig. 11 Merging by assistants with cutting

4. EXPERIMENT

Figure 13 and 14 represent the outlines of the roads before and after automatic compilation. Figure 13 shows the result after the stereo plotting. Figure 14 is a result of the automatic compilation. The lines show roads, and break lines show assistant lines. All types of compilation used in our cases are represented on these figures.

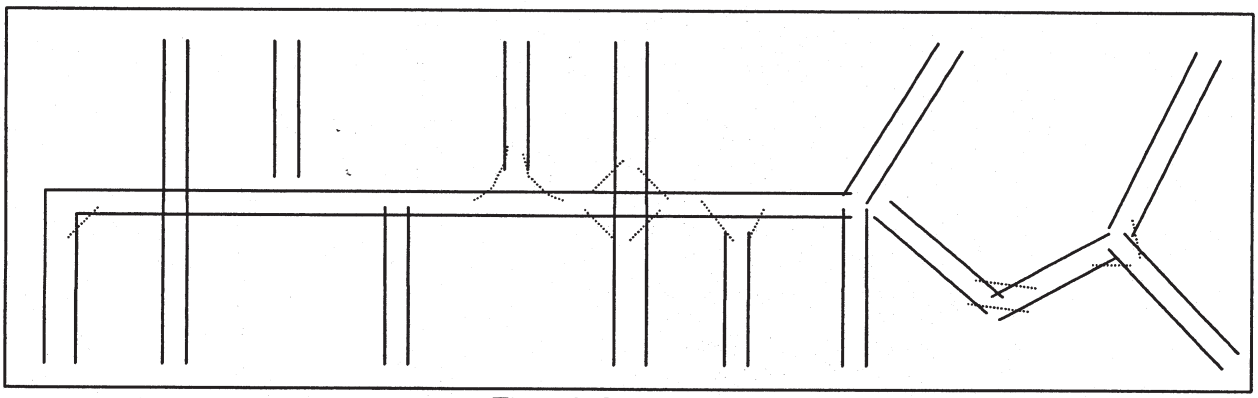


Fig. 12 before compilation

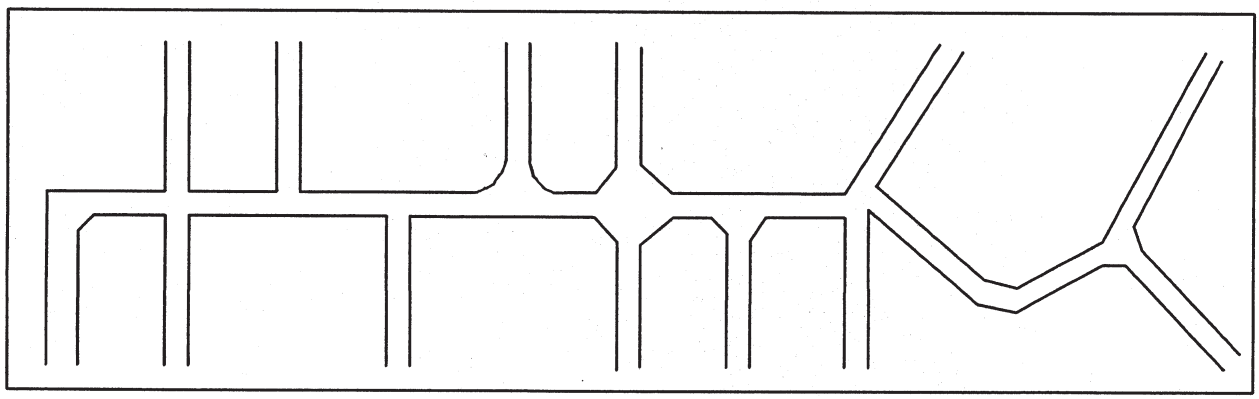


Fig. 13 after compilation

According to our experiment, the result of the first pattern is 100.0 % of 158 places done successfully. Second pattern is 93.8 % of 16 places. Third pattern is 60.0 % of 5 places. Fourth pattern is 75.0 % of 4 places. Fifth pattern is 82.9 % of 35 places. Sixth pattern is 95.8 % of 71 places. Seventh pattern is 86.6 % of 97 places. Total 93.2 % of 386 places where compilation was necessary involved all seven patterns and it was successfully compiled.

Table.1 roads before and after automatic compilation

No.	Processes	Objects	Errors	Success(%)
1	Merging for Connected Lines	158	0	100.0
2	Merging for Unconnected Lines	16	1	93.8
3	Omitting for Crossing without Shave	5	2	60.0
4	Omitting for Crossing with Shave	4	1	75.5
5	Omitting for T-figure Crossing whit Shave	35	6	82.9
6	Merging by Assistants without Cutting	71	3	95.8
7	Merging by Assistants with Cutting	97	13	86.6
Total		386	26	93.2

5. CONCLUSION

Failed places were divided into three patterns of distance parameters for the expansion, contraction and between different codes. The expansion distance would occur to cut other side of road edge in case of T-figure road crossing, in case where the expansion parameter is much longer than the target road width (fig.15).

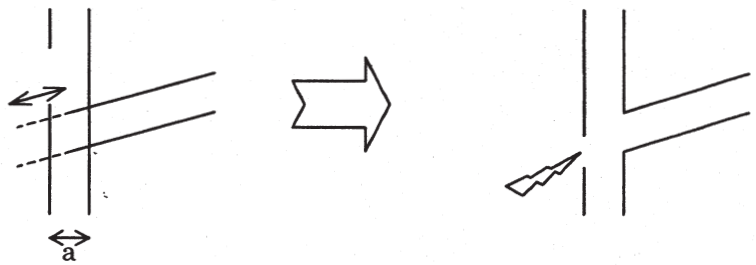


Fig. 14 scratch by expansion length longer than road width

The cut lines are shorter than omitting parameter distance, road line are omitted also. These cases are occurred near the end of a road (fig.16).

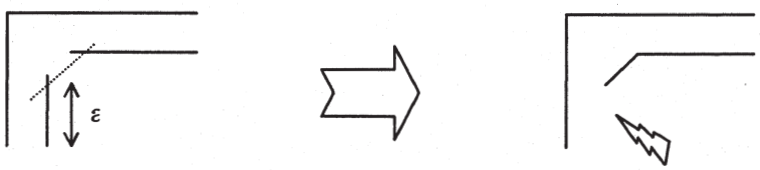


Fig. 15 scratch by cut lines in short

In case of a cut line by assistant lines is longer than omitting distance parameter, it remain (fig.17). Or road line between omitted lines are also shorter than omitting distance it is moved (fig.18).