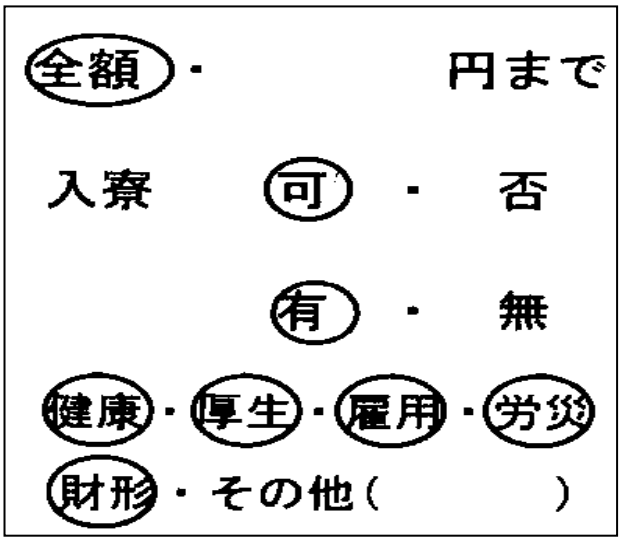

Fig. 3(a) Extracted image from a documentary image

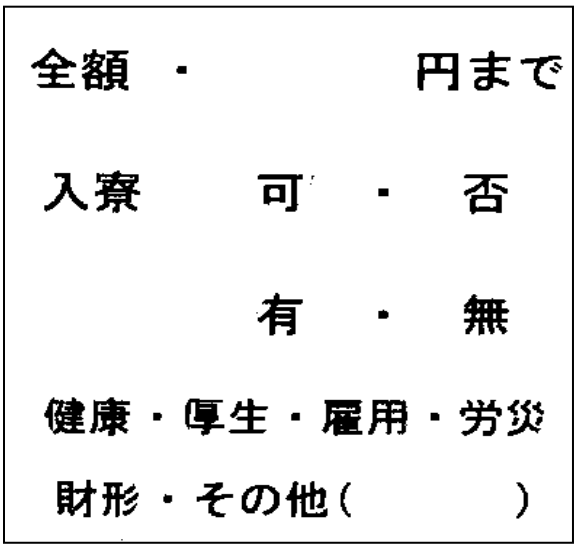

Fig. 3(b) The result after ellipse detection and deletion for Fig. 3(a)

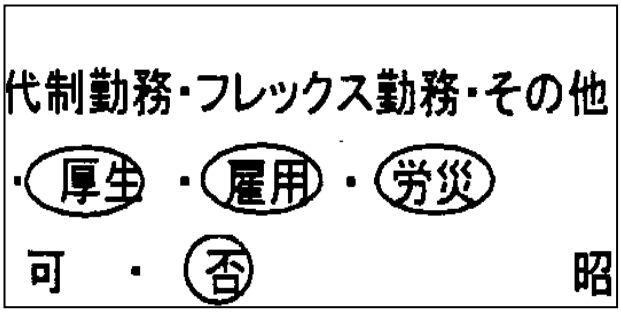

Fig. 4(a) Extracted image from a documentary image

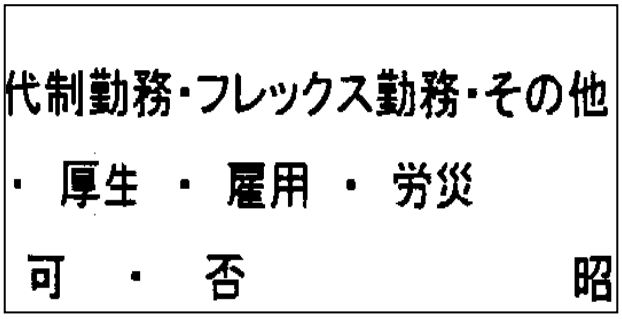

Fig. 4(b) The result after ellipse detection and deletion for Fig. 4(a)

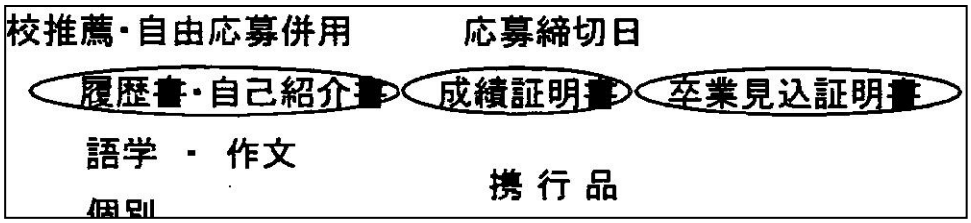

Fig. 5(a) Extracted image from a documentary image

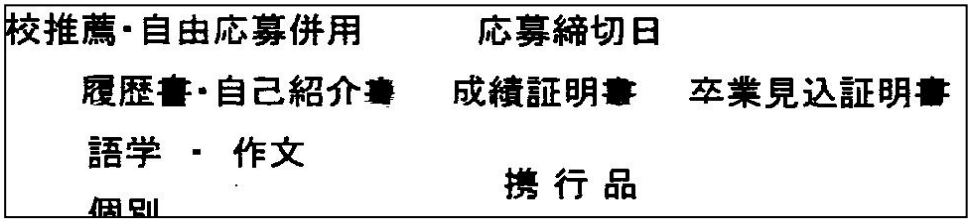

Fig. 5(b) The result after ellipse detection and deletion for Fig. 5(a)

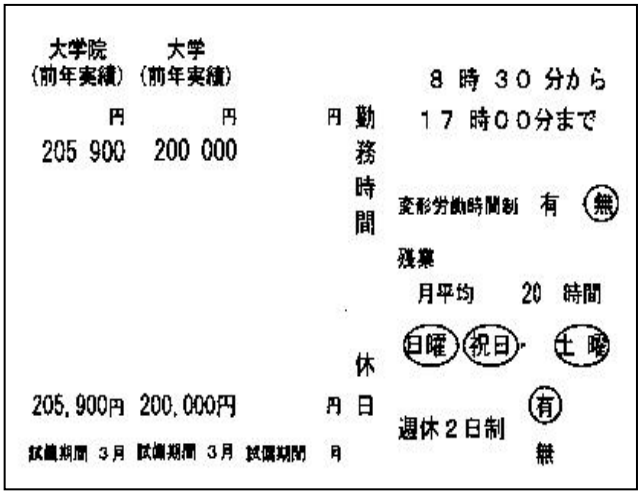

Fig. 6(a) Extracted image from a documentary image

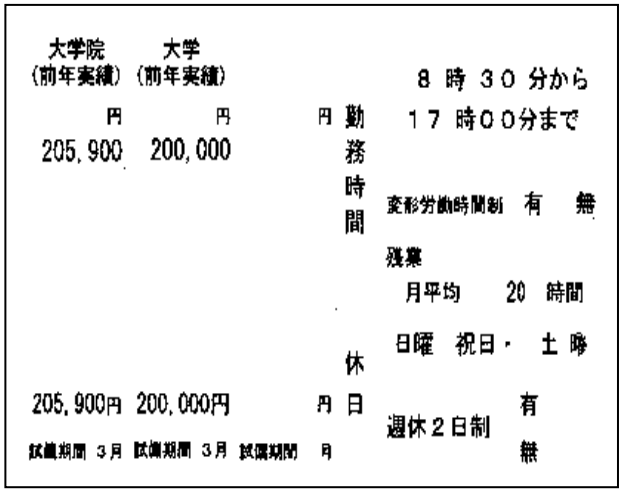

Fig. 6(b) The result after ellipse detection and deletion for Fig. 6(a)

Fig. 7(a) Extracted image from a documentary image

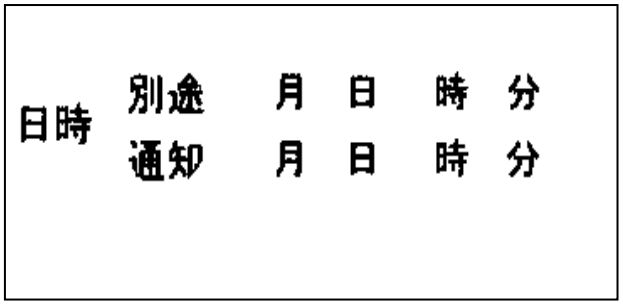

Fig. 7(b) The result after ellipse detection and deletion for Fig. 7(a)

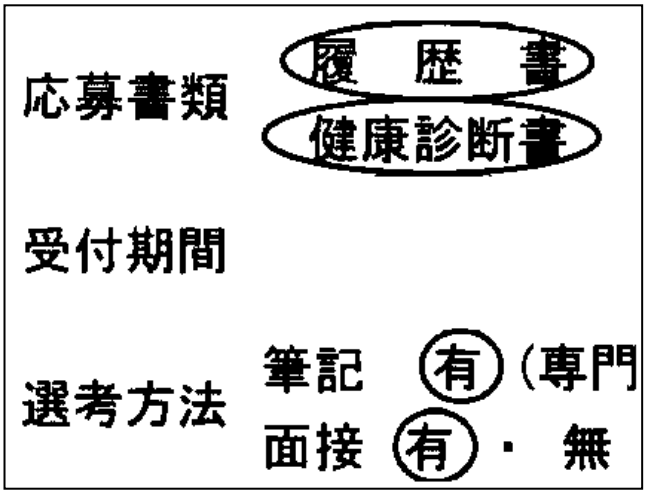

Fig. 8(a) Extracted image from a documentary image

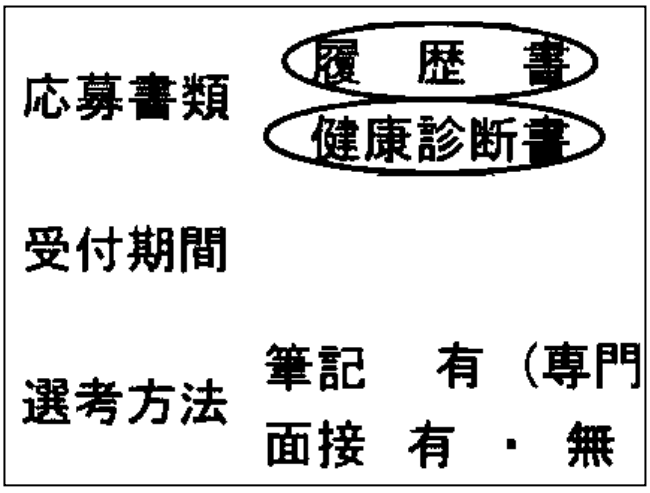

Fig. 8(b) The result after ellipse detection and deletion for Fig. 8(a)

Twelve documentary images including 56 ellipses enclosing characters were used for the experiments. They were processed for binarization, tilt correction, and ellipse deletion in order.

4.1 Results

Figure 3(a), 4(a), 5(a), 6(a), and 7(a) show the extracted images from different documentary images including ellipses enclosing characters. Their ellipse deletion results are shown in Fig. 3(b), 4(b), 5(b), 6(b), and 7(b) respectively. Figure 8(a) also an extracted image from a documentary image and its ellipse deletion result is shown in Fig. 8(b). This includes two accurate deletions and two false deletions. Here, ellipse deletion is conducted after detecting them. This proposal could delete ellipse enclosing characters with a success rate of 91%(51/56).

Table 1 Processing time comparison

	Average Processing time
Raster scanning	5.5 *sec*
Parallel scanning	1.9 *sec*

As mentioned above, new ellipse detection algorithm was developed combining a parallel scanning. We conduct experiments for the proposed algorithm with raster scanning and parallel scanning concept. According to parallel scanning, concept, 65% of processing time could be reduced as shown the table 1.

5. Conclusions

In this paper, we introduce a new simple ellipse detection approach. In this algorithm, ellipses were detected regardless of the ellipse orientation and the entire image was not scanned for ellipses detection. This algorithm finds the ellipses determining its circumscribing rectangle. The new algorithm showed good performance regarding the detection rate and processing time.

In the case when the ellipse is connected to other objects outside, it is not be able to find the real circumscribing rectangle for the desired ellipse. As a result of this, some ellipses were not detected effectively in the experiments. As a future work, we plan to improve this algorithm to solve this problem.

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