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Graphics Recognition from Binary Images: One Step or Two Steps

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- Review a number of popular graphic object recognition methods.
- Classify existing methods into one-step paradigm and two-step paradigm.
- Analyze these methods in terms of the time efficiency and the quality of graphics results.
- Conclude the advantages and disadvantages of both classes of methods.
- Propose a new hybrid paradigm.

One-step methods

Image → Direct recognition → Graphic objects

Advantages

1. Recognize graphic objects with the uniform geometric constraint in their entirety.
2. Anti-noise.
3. Good at handling junctions and text-graphics touching.

Disadvantages

1. Cannot handle curves.
2. Missing too-short or too-thin lines, and too-small arcs.
3. Misrecognizing arcs/circles of too-large radii.

Two-step methods

Image → Vectorization → Raw vectors → Post-processing → Graphic objects

Advantages

1. Capable of recognizing all kinds of graphic objects.
2. Not sensitive to line length and line thickness.
3. Good at handling isolated graphic objects.

Disadvantages

1. Vectorization causes distortions at junctions and noisy parts, which affects the localization accuracy of graphic objects.
2. Postprocessing is time-consuming.

A new hybrid paradigm that integrates the advantages of above two paradigms and avoids their weaknesses.

- All kinds of graphic objects are handled well.
- The localization accuracies of straight lines, arcs and circles are better.
- The text segmentation from text-graphics touching cases is improved due to the pixel deletion of graphic objects.
- The curve recognition rate increases since the intersecting objects are removed.
- The whole process is accelerated since only a small portion of pixels remains for the vectorization and postprocessing.

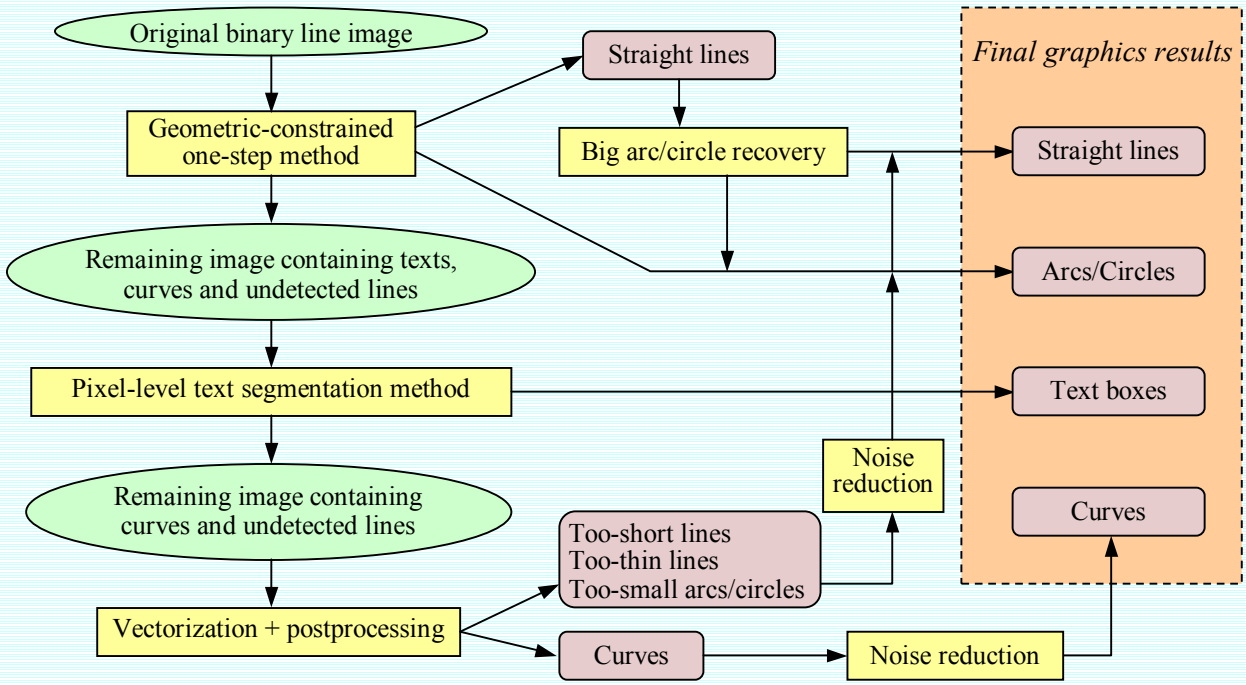

Figure 1: A hybrid paradigm for graphic object recognition

Notes:

This paper focuses on recognizing graphic objects from binary images. Existing methods fall into two classes: one-step methods and two-step methods. The former recognizes graphic objects from binary images directly, while the latter consists of vectorization and postprocessing. We first review a number of popular methods of both classes. These methods are analyzed in terms of the time efficiency and the quality of graphics results. The experimental results of time-efficiency comparison of seven popular methods are reported in the paper. Based on the analysis, we conclude the advantages and disadvantages of both classes of methods as follows.

Their advantages and disadvantages…

Neither one-step methods nor two-step methods can complete the graphic object recognition satisfactorily. Thus, we propose a new hybrid paradigm that integrates their advantages and avoid their weaknesses (as shown in the figure).

In this paradigm, a geometric-constrained one-step method is first applied to the raster image to recognize straight lines, arcs and circles. These graphic objects are recognized fast and accurately and their pixels are erased from the raster image right after the recognition. Since there may be some big arcs/circles being misrecognized as straight lines, a big arc/circle recovery process is performed to recover arcs/circles from the straight lines. Then the remaining image is extracted by a proper pixel-level text/graphics segmentation method. Since most text-graphics touching cases have been separated by the pixel deletion of recognized objects, the text segmentation performance on the current image is much better than that on the original image. Finally, vectorization and postprocessing are applied to the remaining image to recognize all remaining objects, including curves, short lines, thin lines, and small arcs/circles. At this time, the two-step method will be more efficient for two reasons: first, the image data has been simplified largely so that only a small portion of pixels are left; second, the original junctions between curves and recognized objects disappear so that the distortions are avoided. The output lines will be examined to filter out noises before being added to the final graphics results.

In summary, the improvements of the hybrid paradigm include:

- All kinds of graphic objects are handled well.
- The localization accuracies of straight lines, arcs and circles are better.
- The text segmentation from text-graphics touching cases is improved due to the pixel deletion of graphic objects.
- The curve recognition rate increases since the intersecting objects are removed.
- The whole process is accelerated since only a small portion of pixels remains for the vectorization and postprocessing.