Edge Thinning Used in the SUSAN Edge Detector

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Abstract

This note describes the edge thinning algorithm used in the SUSAN edge detector (see [9] or [8]).

Keywords: edge detection, feature detection, thinning.

1 Introduction

This note describes the rules used for the "binary thinning" which is applied to the edge images (found using the SUSAN edge detector - see [9] or [8]) after non-maximum suppression has taken place. The rules are simple and quick to carry out, requiring only one pass through the image. Similar text originally appeared in Appendix B of [7].

Much work has been done on the thinning of "thick" binary images, where attempts are made to reduce shape outlines which are many pixels thick to outlines which are only one pixel thick. (For examples and reviews of work on "skeletonization" see [6], [4], [1], [2] and [5].) However, because of the non-maximum suppression which is applied before thinning in edge detectors such as SUSAN, this kind of approach is not necessary.

2 The Thinning Algorithm

The thinning that *is* performed by the SUSAN binary post-processing follows a few simple rules which remove spurious or unwanted edge points and add in edge points where they should be reported but have not been. The rules are similar to those described in [6], and some of them are used in [3]. They fall into three categories; those removing spurious or unwanted edge points, those adding new edge points and those shifting edge points to new positions. The rules are now listed according to the number of edge point neighbours which an edge point has (in the eight pixel neighbourhood), and examples are shown in Figure 1.

0 neighbours. Remove the edge point.

1 neighbour. Search for the neighbour with the maximum (non-zero) edge response, to continue the edge, and to fill in gaps in edges. The responses used are those found by the initial stage of the SUSAN edge detector, before non-maximum suppression. They are slightly weighted according to the existing edge orientation so that the edge will prefer to continue in a straight line. An edge can be extended by a maximum of three pixels.

2 neighbours. There are three possible cases:

1. If the point is "sticking out" of an otherwise straight line, then compare its edge response to that of the corresponding point within the line. If the potential point within the straight edge has an edge response greater than 0.7 of the current point's response, move the current point into line with the edge.
2. If the point is adjoining a diagonal edge then remove it.
3. Otherwise, the point is a valid edge point.

More than 2 neighbours. If the point is not a link between multiple edges then thin the edge. This will involve a choice between the current point and one of its neighbours. If this choice is made in a logical consistent way then a "clean" looking thinned edge will result.

These rules are applied to every pixel in the image sequentially left to right and top to bottom. If a change is made to the edge image then the current search point is moved backwards up to two pixels leftwards and upwards. This means that iterative alterations to the image can be achieved using only one pass of the algorithm.

References

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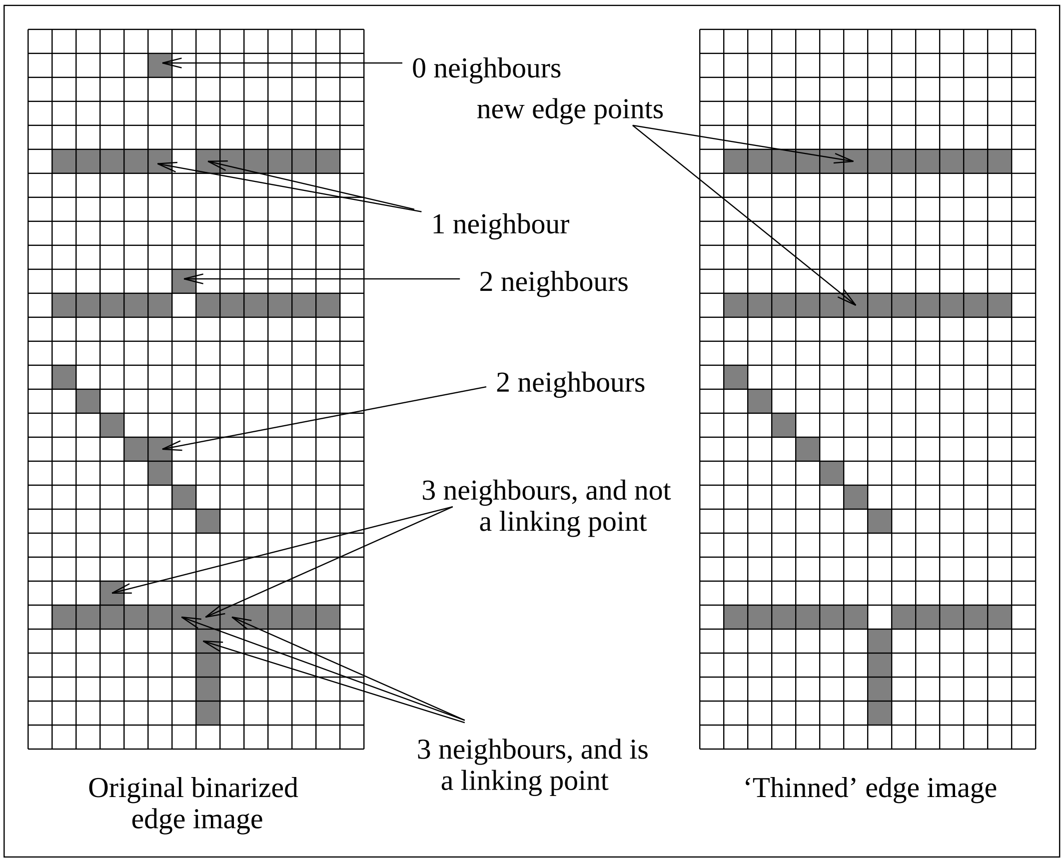

Figure 1: Examples of the different thinning rules. Note that the new edge points will only be created if the edge response allows this.

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