# Re-Engineering of Objects in Construction Drawings

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Introduction

- technical drawings in analogous format
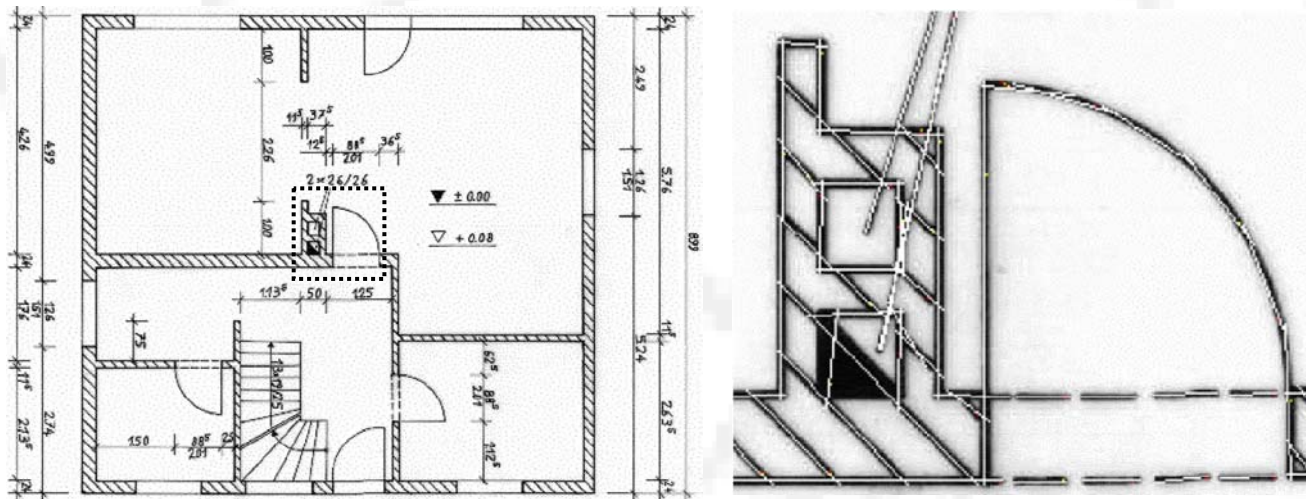- intuitive visual recognition of semantic meaning of the drawings
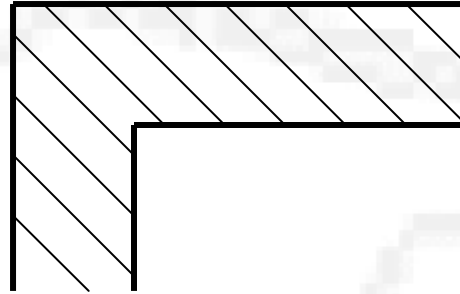
- digital version is essential for computer aided processes (planning, construction, building, utilization)
- computer based recognition is not intuitive
- this contribution is based on a master thesis

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Digitised Drawings

- scanned drawings in GIF or JPG format
- available resolution: 200 up to 300 dpi
- colour depth: 8 bits, 256 different colours
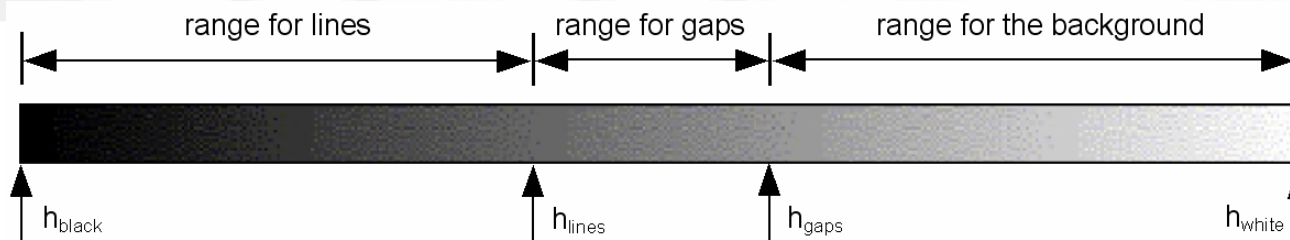- example: a hand drawing of a ground floor plan

inaccuracy of the hand drawing and dirtiness of the scan

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Identification of Lines

- classification of grey scale values for pixels

range for lines | range for gaps | range for the background

h_{black} | h_{lines} | h_{gaps} | h_{white}

- distance of pixels:
city-block-distance

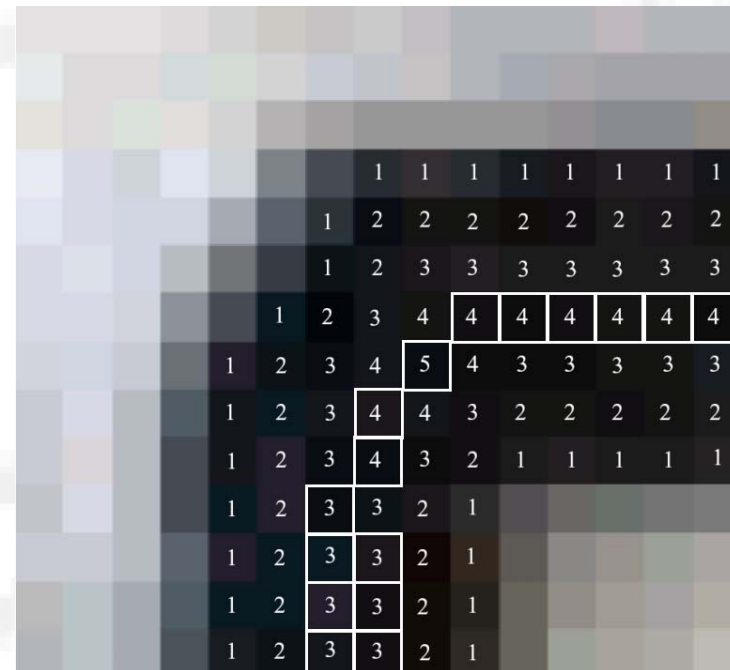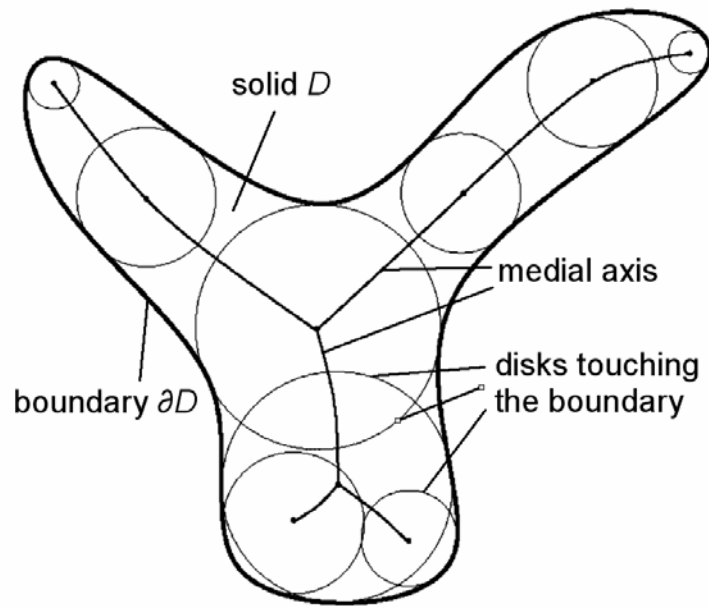| 4 | 3 | 2 | 3 | 4 |
3	2	1	2	3
2	1	a	1	2
3	2	1	2	3
4	3	2	3	4

- contour pixels:
grey value between h_{black} and h_{gaps} and
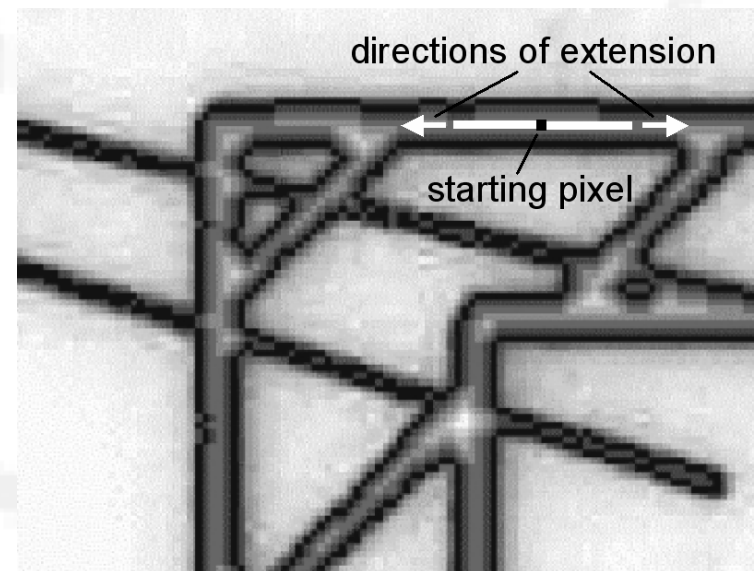at least one pixel with h_{gaps} and h_{white} with distance 1

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Identification of Lines

- medial axis of solids in Euclidean space

- shortest distances to contour pixels

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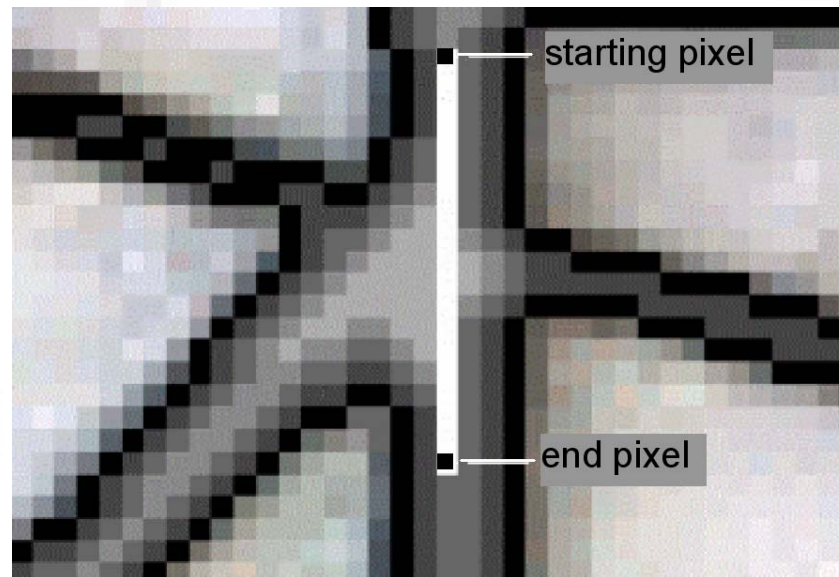Waiheke Island, Auckland, New Zealand, 23-25 April 2003

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Identification of Lines

- line searching

    - starting from any unused pixel on the medial axis

    - extension and rotation of the potential line

    - maximizing the sum of distance values of pixels of the potential line

    - stop of the extension if a contour pixel is reached

directions of extension

starting pixel

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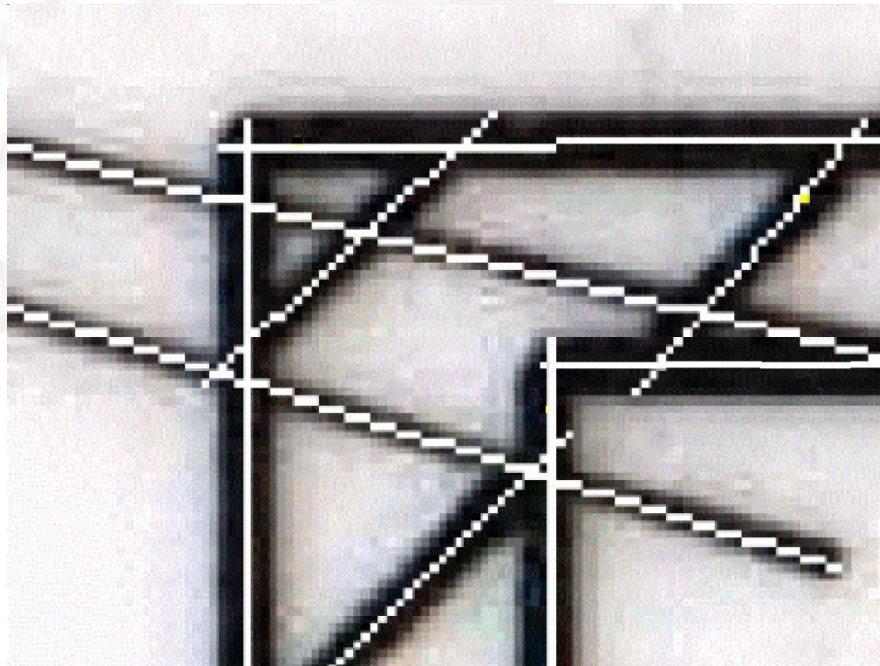Waiheke Island, Auckland, New Zealand, 23-25 April 2003

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Identification of Lines

- line searching
    - hot spots of distance values at connections of scanned lines
    - line searching may stop too early at contour points
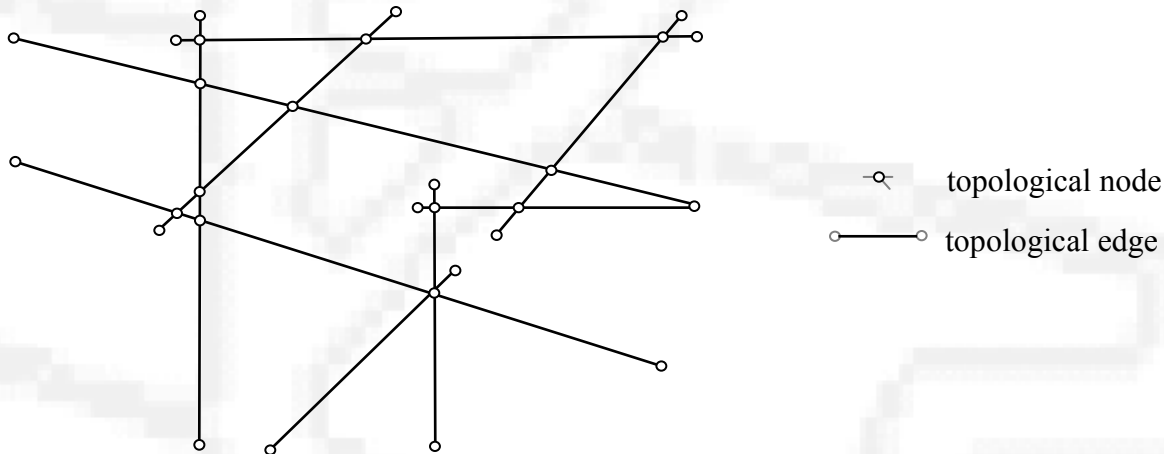   - cut off the hot spot values

starting pixel

end pixel

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Identification of Lines

- line searching
  - rough line as result of the line searching process
  - dirtiness of rough lines has to be corrected

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Topological Analysis

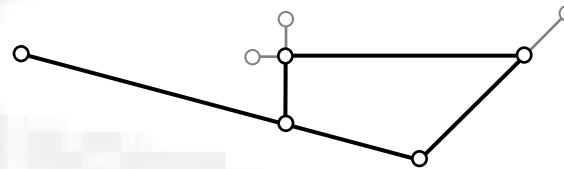- topological result of the line search process

topological node

topological edge

- topological information
  nodes, edges, relations edges <-> nodes

- geometrical information
  nodes coordinates, edge length, edge thickness

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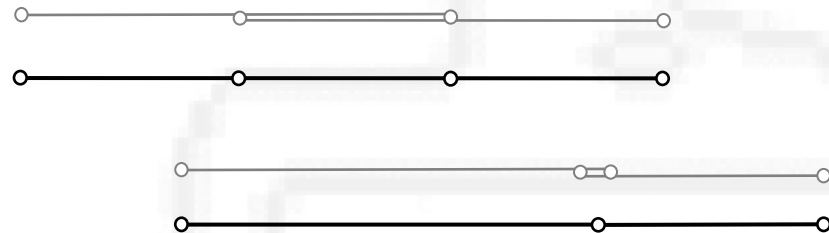
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Topological Analysis

- topological clean up process
  - cut off of small excess edges

  - neighbourhood of nodes and edges

  - adjustment of nodes and edges
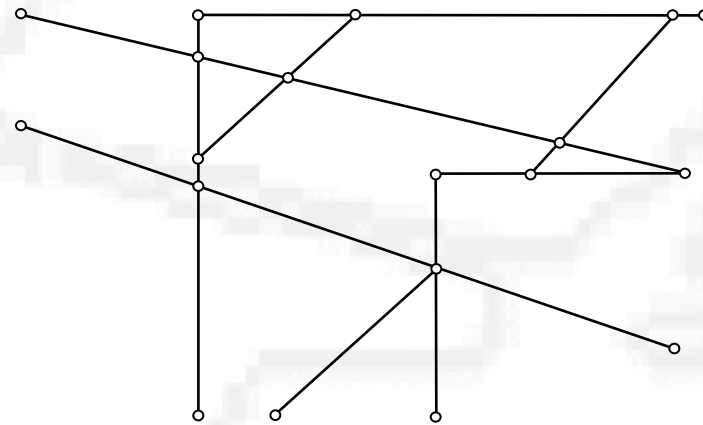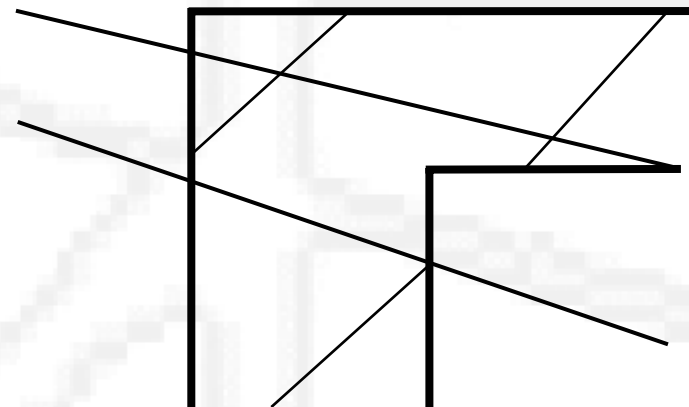
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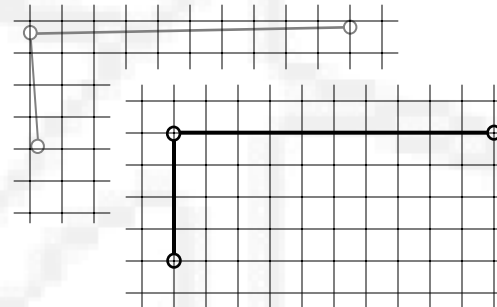
Topological Analysis

- topological clean up process

  – result of topological
    clean up process

  – assembly of edges
    and generation of lines

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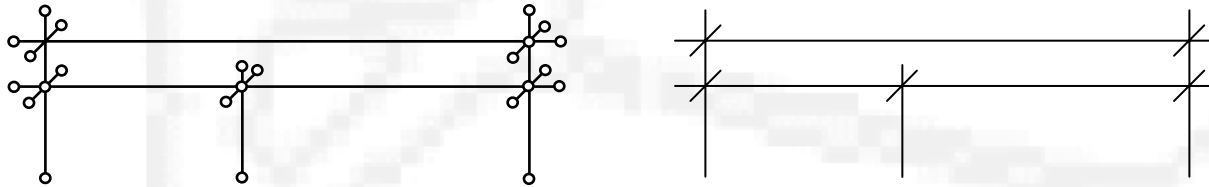Waiheke Island, Auckland, New Zealand, 23-25 April 2003

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Recognition of Objects

- topological information of nodes and edges („is connected with", „has an intersection with",...)

- geometric information of assembled lines („is parallel with", „intersection angle of 45º", …)

- fuzzy values for geometric information

- example for objects:
  - dimensions lines
  - hatching lines
  - wall lines
  - window and door lines

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Recognition of Objects
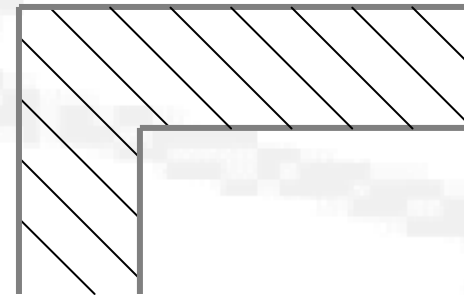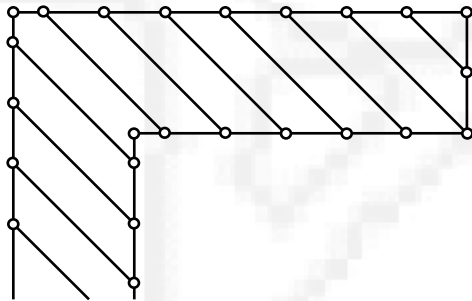
- criteria for dimensions lines

  – small thickness value

  – rectangular intersections with other dimension lines

  – 45º intersections with short dimension lines

  – these intersection points are in the middle of these short dimension lines

  – endpoints are no intersection points

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Recognition of Objects
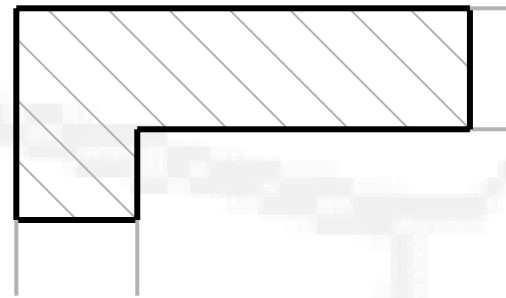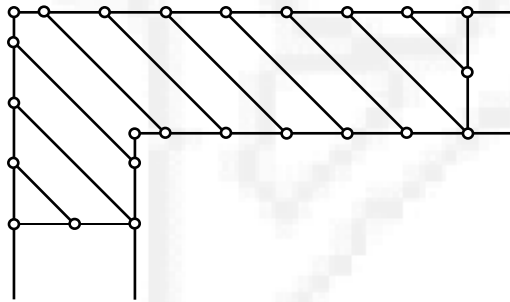
- criteria for hatching lines

    – small thickness value

    – hatching lines for the same object are parallel

    – no intersection point with other hatching lines

    – 45º intersections with wall lines at the endpoints of the hatching line

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Recognition of Objects

- criteria for wall lines

  - large thickness value
  - at least two pairs of parallel lines
  - intersection points with other wall lines only at the endpoints
  - 45º intersections with hatching lines
  - all wall lines of one wall object form a closed loop

Recognition of Objects
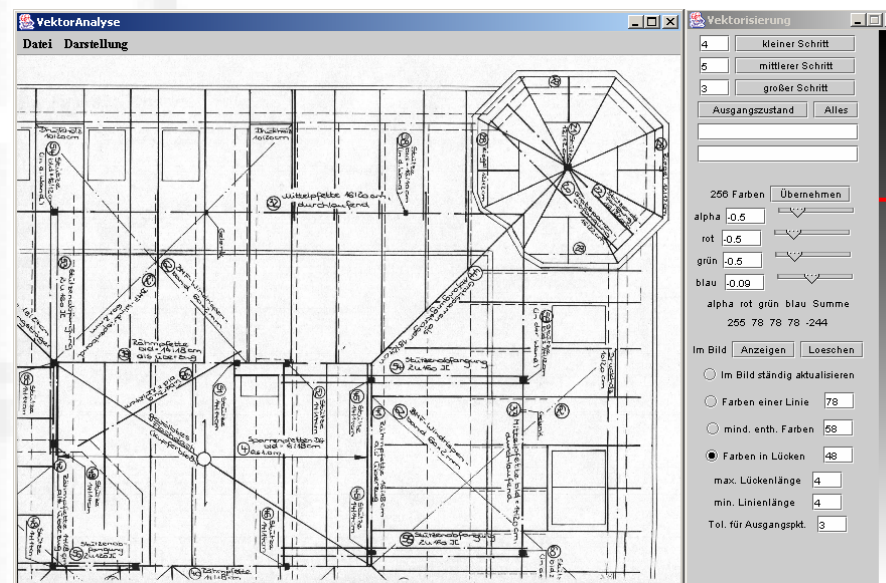
- criteria for window and door lines

  - medium thickness value
  - a pair of parallel lines (door lines: dashed lines)
  - at the endpoint rectangular intersection with wall lines
  - a pair of window / door lines and a pair of walls form a closed loop

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Conclusion

- **software tool**
  - to identify lines within scanned technical drawings
  - to clean up the identified lines via topological information
  - to recognize drawing objects via geometric and topological information

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Outlook

- recognition of letterings and handwritings
- speed up of line identification
- starting a cooperation with colleagues from the institute of concrete structures
- easier definition of the objects to be recognized
- development towards a software tools which might be taught by the user

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