› Automatic understanding of sketch maps

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Introduction

Sketch maps are an intuitive way to communicate spatial information. The goal of automatic understanding of sketch maps will enable people to intuitively share spatial information with automatic systems. This will improve human-computer-interaction. Possible applications for the use of sketch maps with automatic systems are:

- Volunteer Geographic Information Systems: *provide content by sketching*.
- Query by Sketch: *sketching what you seek*.
- Navigating without address: *sketching where you want to go*.

Goal of the research:

Automatic offline semantic recognition and integration of objects in images of hand-drawn sketch maps.

Challenges (Fig. 1):

- Algorithms have to deal with inaccurate drawings like gaps between lines, intersection of elements, open-ended streets, borders between streets, and people's drawing styles.
- There is no direct mapping between geometric and semantic interpretations: Different types of objects can be drawn in the same way. An example for that are rectangles: they can stand for parking lots, buildings as well as for undefined space between streets. On the other side, objects of one type can be drawn in different ways. For example churches can be drawn as rectangles, shapes with a spire or just as a cross.
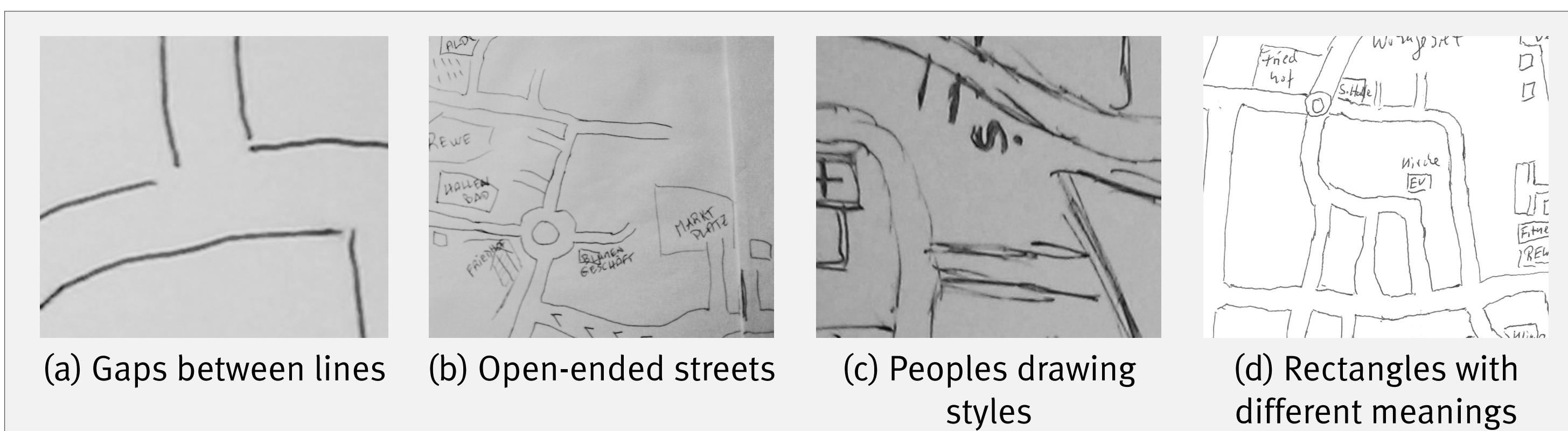

(a) Gaps between lines (b) Open-ended streets (c) Peoples drawing styles (d) Rectangles with different meanings

Figure 1:   Example images for challenges of sketch map understanding.

Methodology

Proposed steps for sketch map understanding (Fig. 2):

- **Text / graphic separation:**
  By separating text and graphic elements, further steps can work on one of them instead of processing both. Note that symbols - though semantically graphic elements - are treated as text.
- **Segmentation:**
  The goal is to segment the image into single objects. These objects are used for further recognition steps. There are two ways for doing so:
  - Edge based segmentation:
    Edge based segmentation for sketch maps has the goal to group lines to objects. Some of the problems edge based segmentation algorithms have to deal with are unconnected edges, open endings and complicated drawing styles (see Fig. 1).
  - Region based segmentation:
    A region based approach for segmentation connects the background pixels to regions instead of grouping the lines. Such an algorithm has to deal with connections between regions, like they occur at open street endings and gaps between border lines.
- **Structural Recognition:**
  The goal of the structural recognition is to compute geometric attributes of objects and to classify the objects according to their geometric appearance.
- **Optical Character Recognition (OCR):**
  Based on the separated text, OCR can extract the written text. This can - and probably has to - be used for semantic recognition of objects.
- **Semantic Recognition:**
  The goal of the final semantic recognition is to understand the meaning of objects. For this step, geometric information, relations between objects and recognized text can be used.
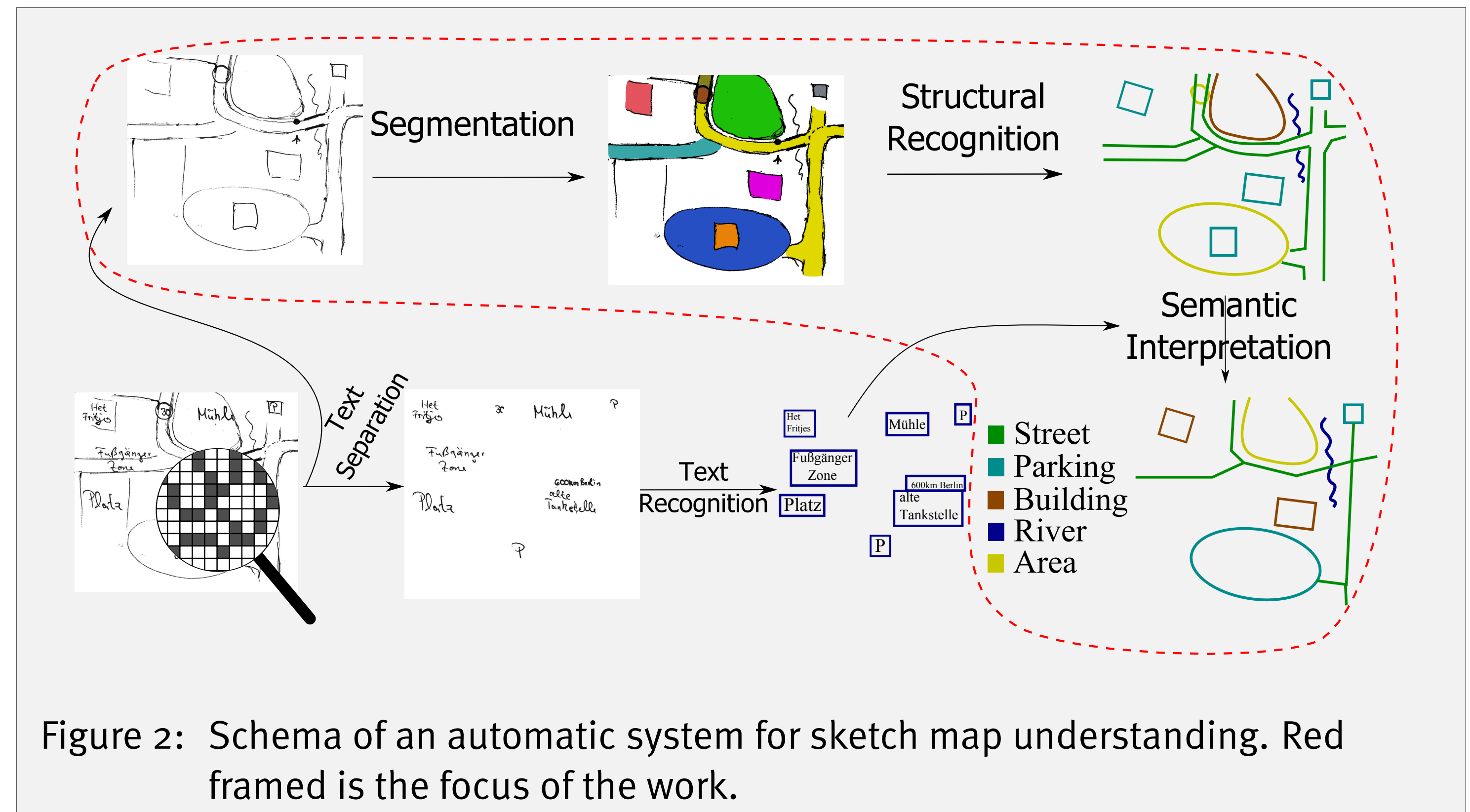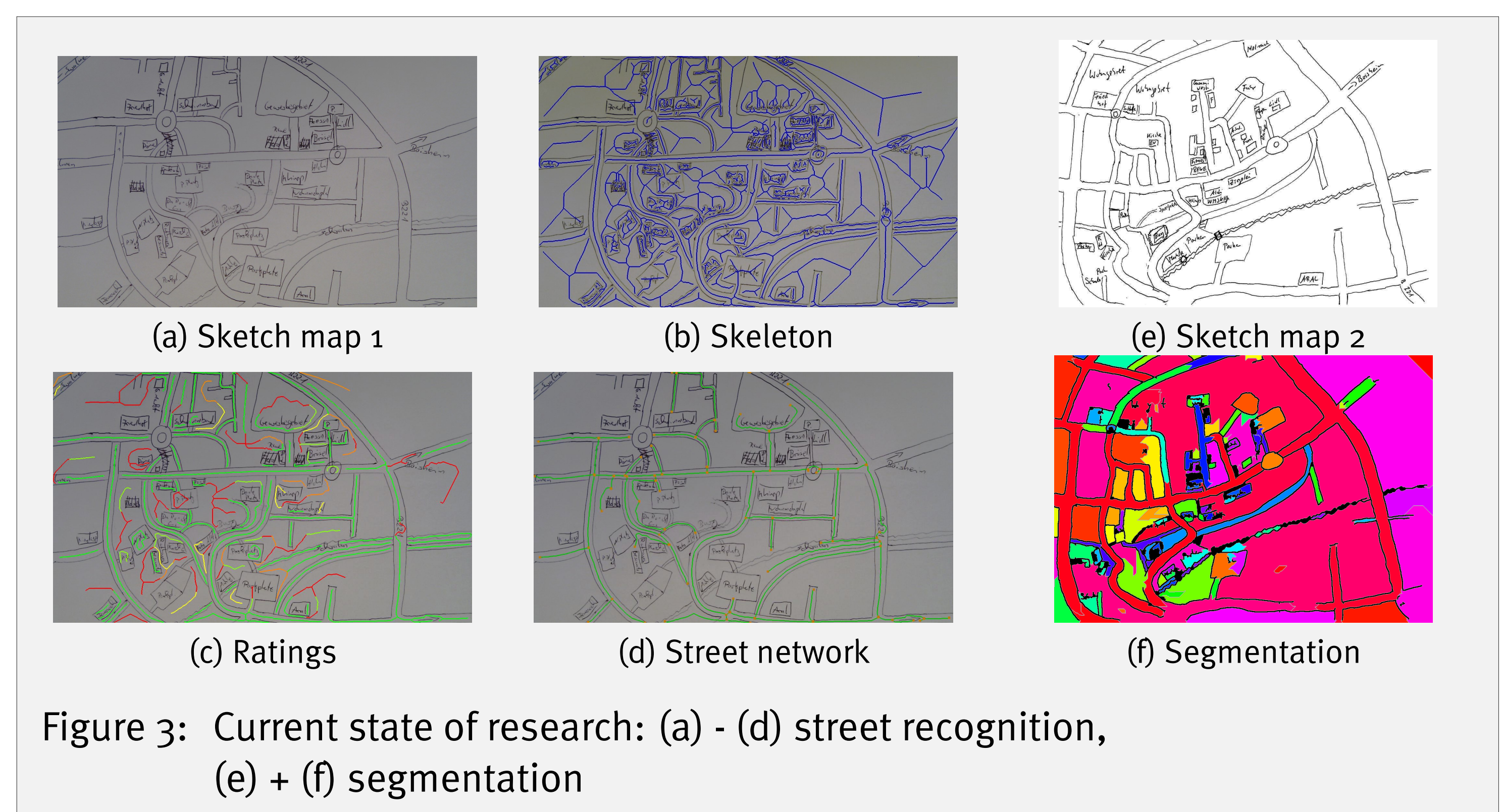

Figure 2: Schema of an automatic system for sketch map understanding. Red framed is the focus of the work.

Current State of Research

Street recognition [3]:

- Computes the skeleton of the background to get line segments.
- Rates line segments by their likelihood to be a street segment.
- Uses relations between segments to extract the street network.

(a) Sketch map 1 (b) Skeleton (e) Sketch map 2

(c) Ratings (d) Street network (f) Segmentation

Figure 3:   Current state of research: (a) - (d) street recognition, (e) + (f) segmentation

Sketch map segmentation [2]:

- The method detects bordered objects.
- The segmentation is done region based by using a flood filling algorithm.
- To deal with oversegmentation, a subsequent merging of segments is done. This merging is based on the length of inner edges and the compactness of the resulting segments.

Working on hierarchical segmentation and recognition (See e.g. [1]):

- By using trainable classifier for hierarchical structures, the segmentation becomes also trainable.
- One result will be to overcome the current segment merging that uses heuristic strategies.

References

[1] Narendra Ahuja and Sinisa Todorovic. From region based image representation to object discovery and recognition. In *Structural, Syntactic, and Statistical Pattern Recognition*, volume 6218 of *Lecture Notes in Computer Science*, pages 1–19. Springer Berlin / Heidelberg, 2010.

[2] Klaus Broelemann and Xiaoyi Jiang. A region-based method for sketch map segmentation. Presented at the GREC Workshop 2011, Seoul, Korea.

[3] Klaus Broelemann, Xiaoyi Jiang, and Angela Schwering. Automatic street graph construction in sketch maps. In *Proceedings of the 8th Workshop on Graph-based Representations in Pattern Recognition*, pages 275–284, Münster, Germany, 2011.

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