



TECHNISCHE  
UNIVERSITÄT  
DRESDEN

Master Thesis Presentation

# A Contribution to Computer-Assisted Reconstruction of Selected Line Features from Scanned Maps

JIAQIN NI

INSTITUTE OF CARTOGRAPHY, TECHNISCHE UNIVERSITÄT DRESDEN

06/11/2017



**Supervisors:** Dr. Nikolas Prechtel

TU Dresden – Institute for Cartography

Prof. Dr. Markus Wacker

HTW Dresden

Dr. Corné van Elzakker

University of Twente – ITC

# Contents

1. Introduction
2. Data and Environment
3. Workflow
4. Referencing Results
5. Further Work

# Introduction

## Research Background

- A growing need of digitised historical documents.
- Digitised historical map could becomes historical GIS data.
- Complex task with the requirement of a high degree of automation.
- Line feature detection, extraction and reconstruction.

## Research Objectives

- Contribution to a complete process of detection, separation, extraction and vectorisation.
- Focus on a specific group of line feature.

# Data and Environment

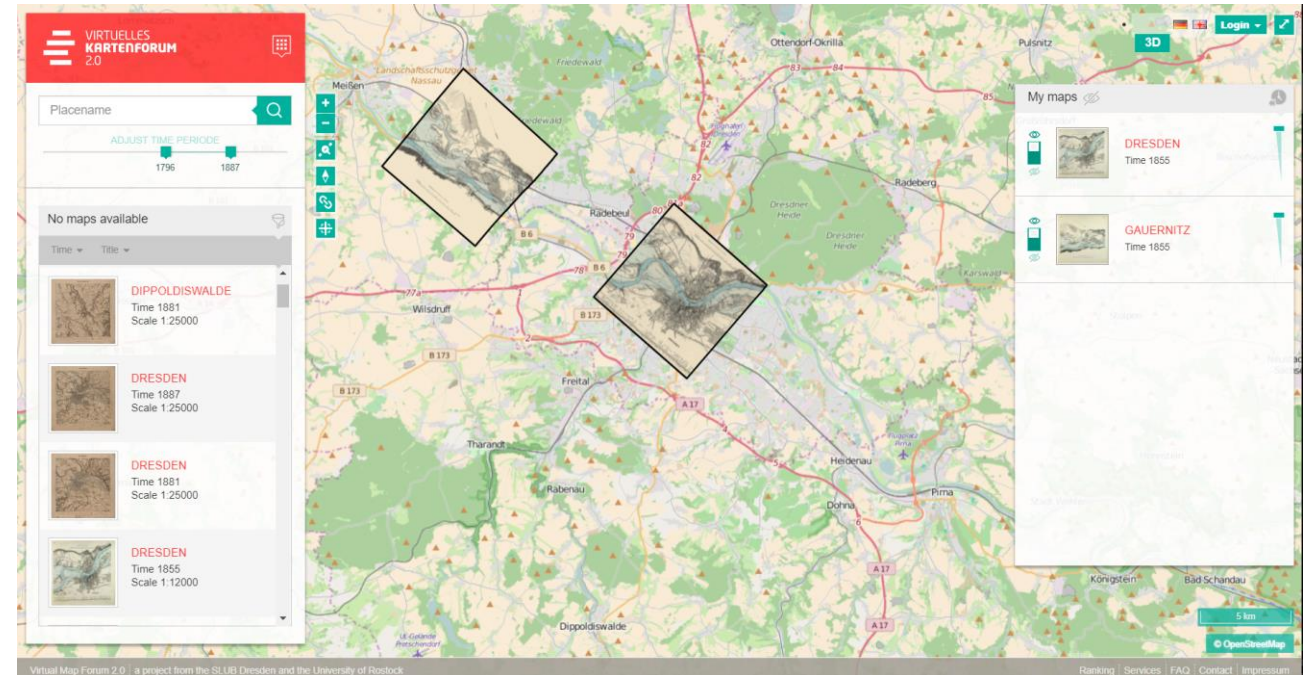
## Virtuelles Kartenforum 2.0

(<http://kartenforum.slub-dresden.de/>)

- A crowdsourcing approach to georeference the historical maps.
- Maps from the [SLUB archive](#).
  - 19,767 maps published up to and including 1800.
  - 41,220 maps from the years 1801 – 1945.

## Environment

- Python (version 2.7.13).
- OpenCV.
- Extra open source software and graphic interfaces.
- GIS software.

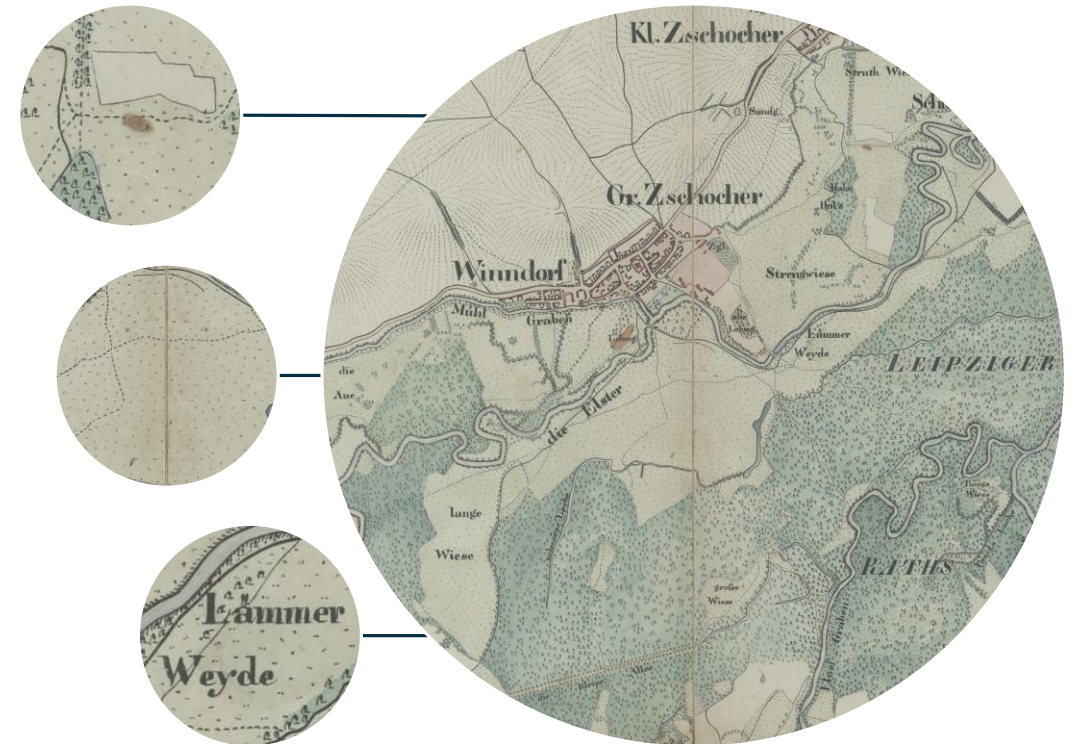


## About the historical maps in this thesis:

- 18th to the middle 19th century .
- geological maps, hydrographic maps, country maps, fortress plans, maps of residential areas, results of topographical land survey of Saxony between 1780 and 1806.
- Scale: between 1: 12,000 and 1: 8,000 .
- Lithography and hand painting.

## Graphical characteristics

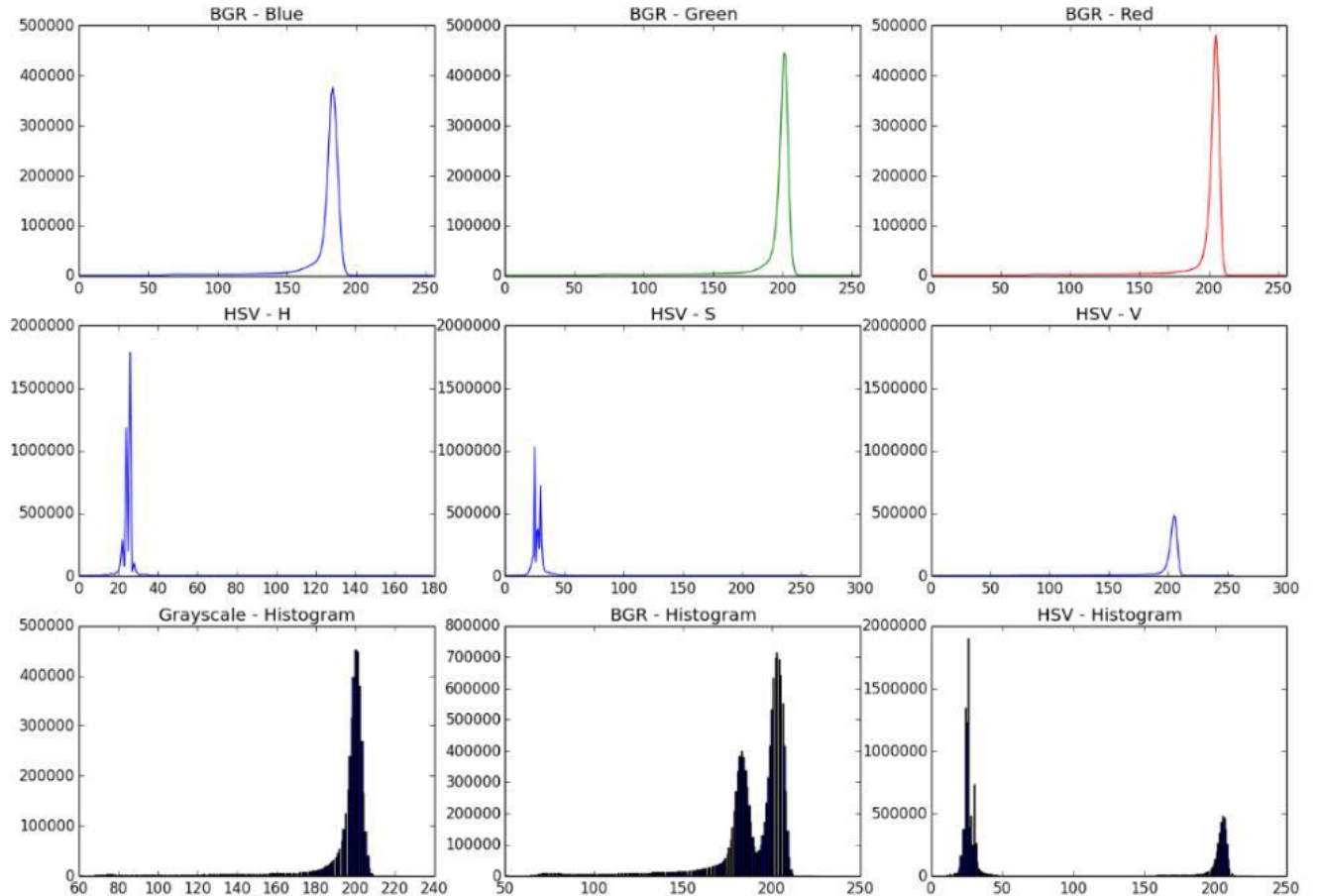
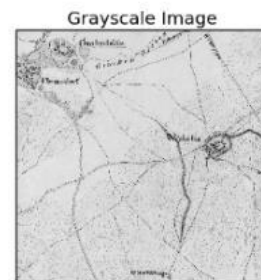
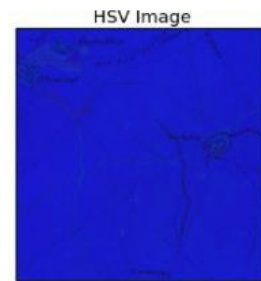
- Hachure lines.
- Uneven colour saturation.
- Mixing of foreground and background features.
- Stains and crease lines.
- Yellowish paper colour.
- Ancient fonts and irregular characters.



# Workflow

## Image Properties Matrix

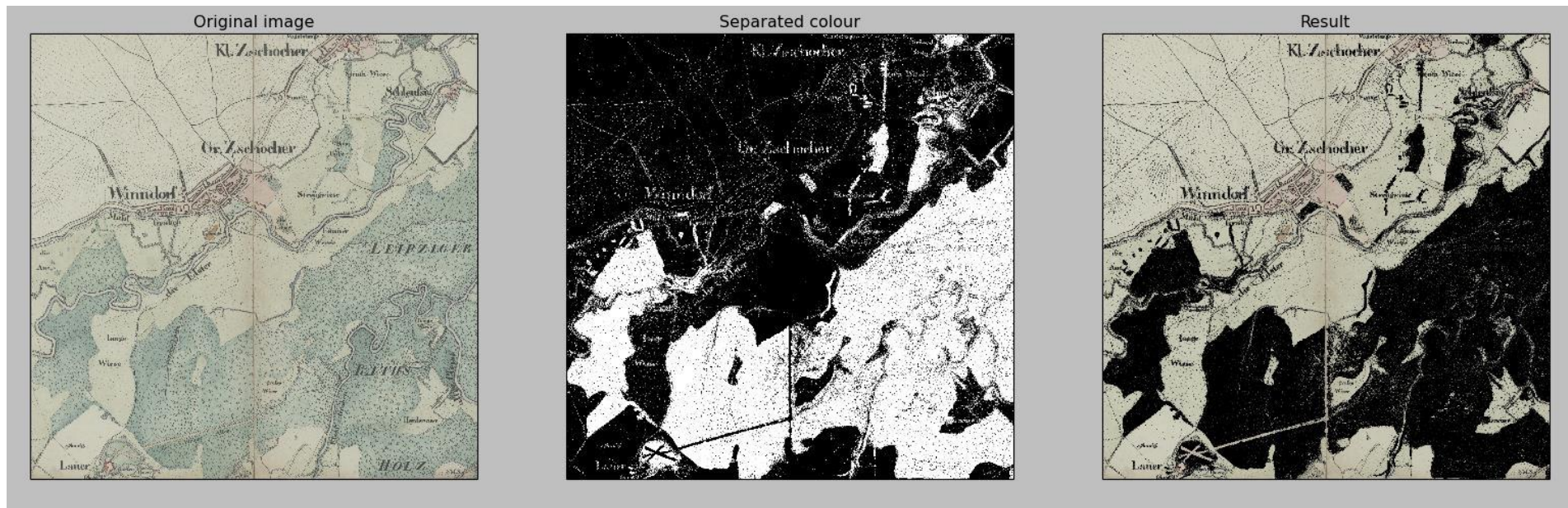
- Image in different colour spaces.
- Histograms of the image in separated channels.





## Colour Separation

- Uniform colour blocks (Vegetation, hydrological features etc.).
- Choosing a suitable colour space.
  - Limitation of RGB colour space: perceptual drawbacks, resulting in bins and holes in the colour space.
  - HSV colour space: perceptually intuitional connections between colour value and tone.
- Setting colour boundaries.
  - Both upper and lower boundaries in HSV colour space.





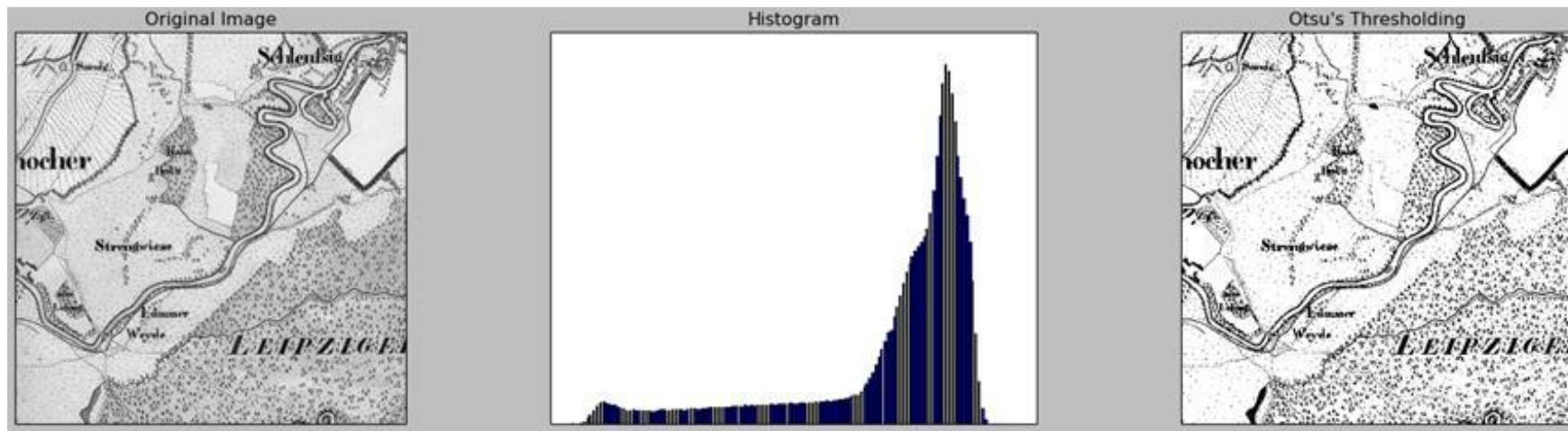
## Binarisation

- To generate a binarised image from the grayscale image.
- Local and global thresholding.

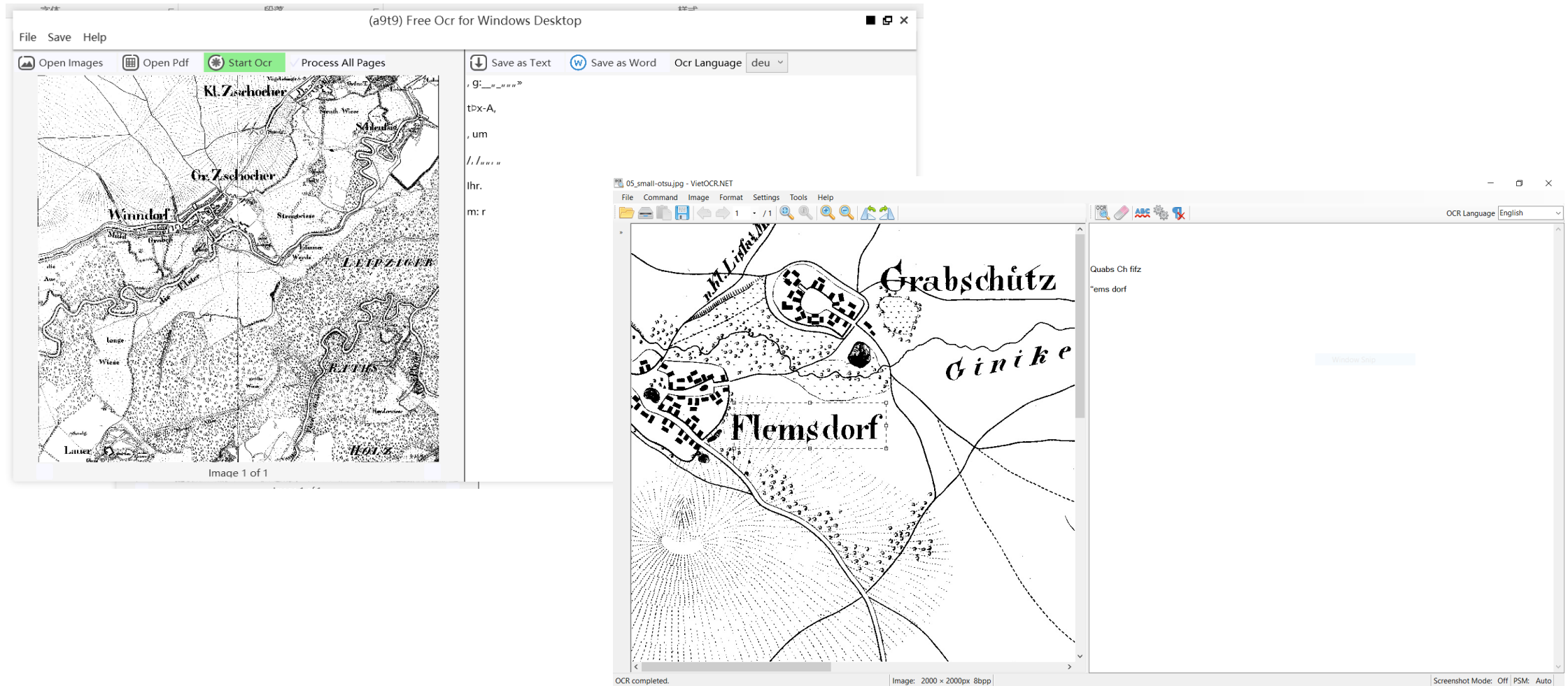


Left: Global thresholding  
Right: Local thresholding

- Thresholding methods.
  - Otsu's Thresholding, Triangle Method etc.

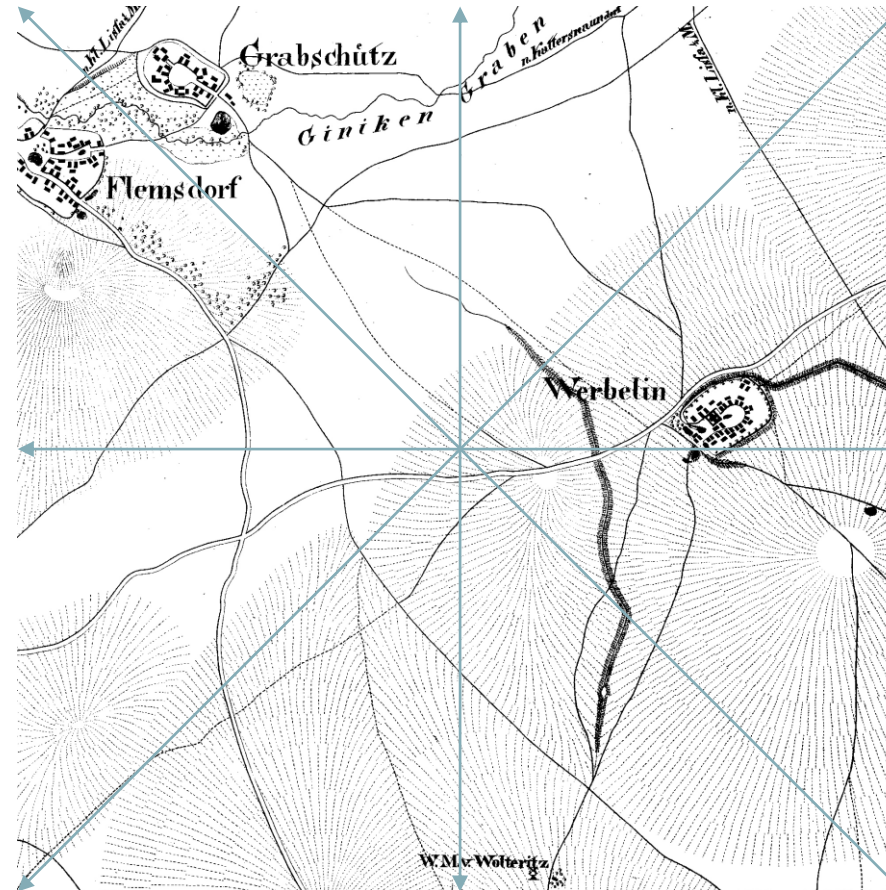
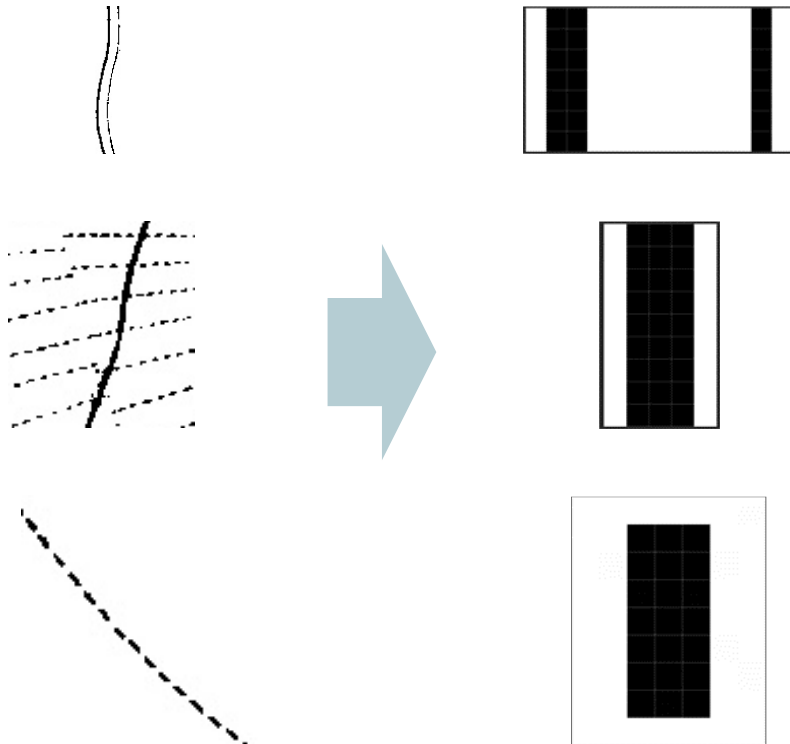


## OCR?



## Pattern Matching and Feature Identification

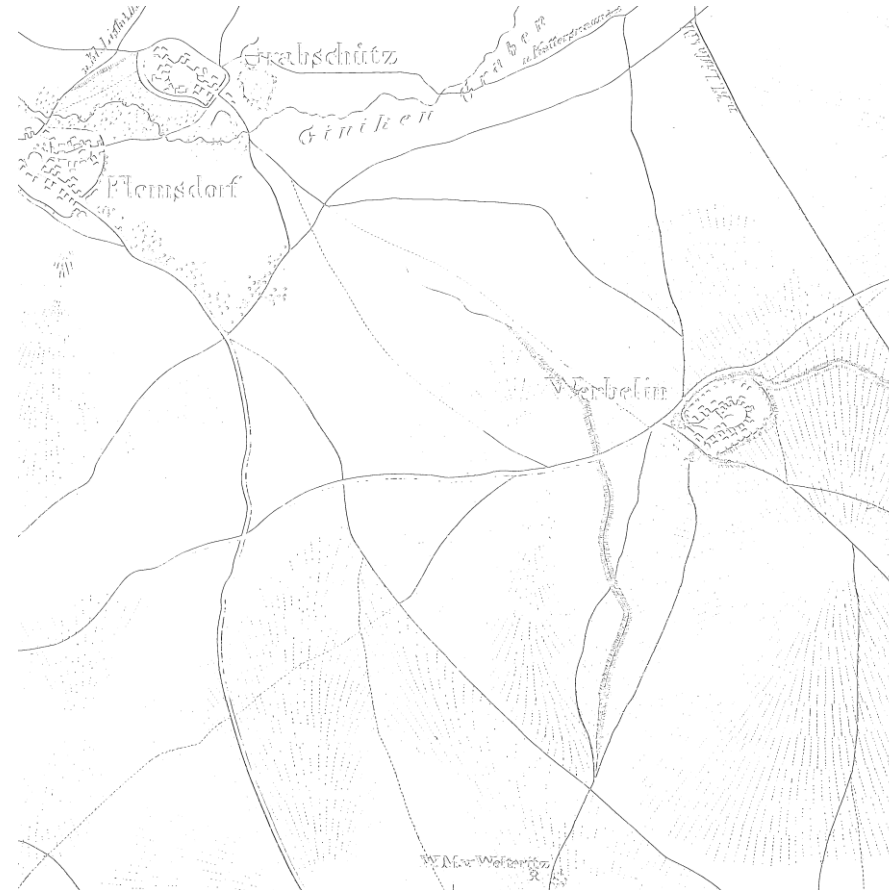
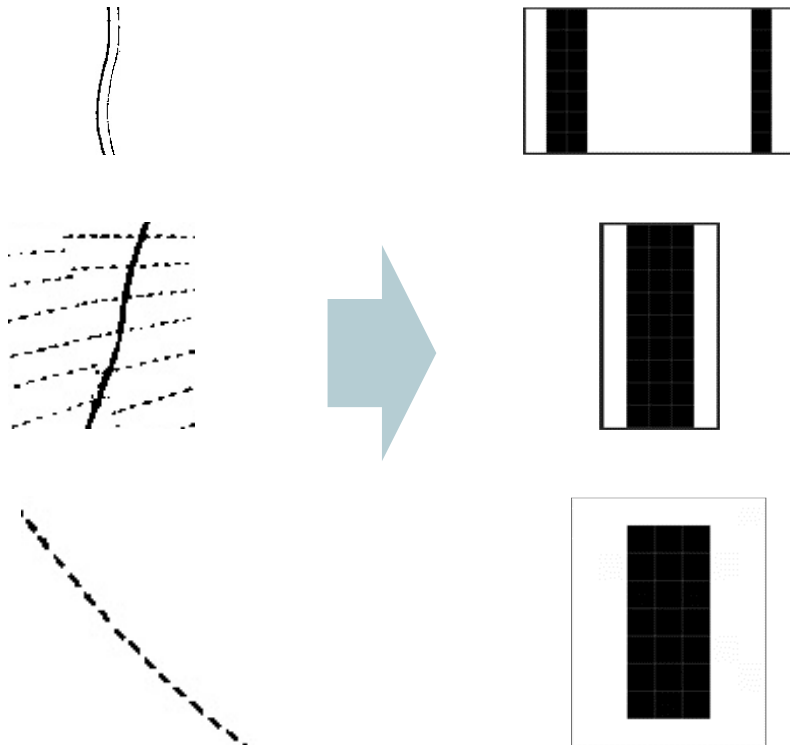
- Patterns were generated from the profile of the roads.
- The image was traced in four directions.





## Pattern Matching and Feature Identification

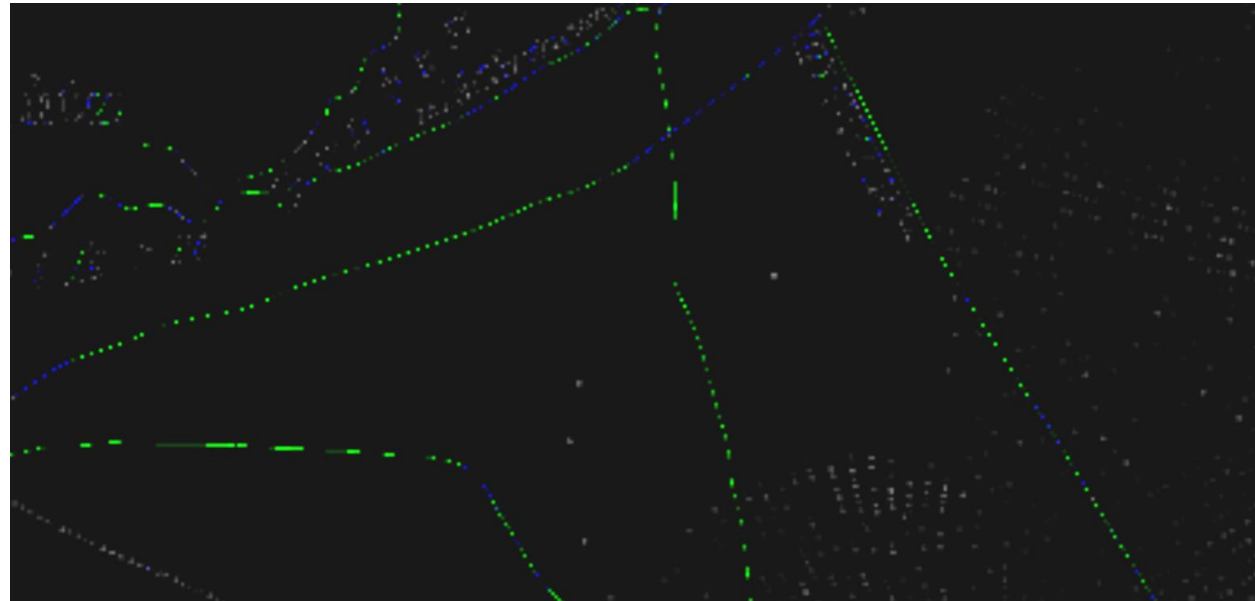
- Patterns were generated from the profile of the roads.
- The image was traced in four directions.



Result of pattern tracing.

## Pattern Matching and Feature Identification

- Make use of a plugin “Curve Tracing”.
- The original algorithm was proposed by Steger.
  - Blue - the pixels that will be traced.
  - Green – the pixels that could be regarded as the starting points.



## Pattern Matching and Feature Identification

- Make use of a plugin “Curve Tracing”.
- The original algorithm was proposed by Steger.
  - Blue - the pixels that will be traced.
  - Green – the pixels that could be regarded as the starting points.

Pixels that were traced as curve lines were marked in red.





## Vectorisation

- Take use of Potrace, a free software to trace bitmaps and generate vector files.
  - Convert PBM, PGM, PPM, or BMP images into SVG, PDF, EPS, PostScript, DXF, GeoJSON, PGM, Gimppath, or Xfig files.
  - Plenty of softwares and graphic interfaces.
- CR8tracer
  - Filter Threshold - the lowest gray value that will be converted.
  - Despeckle size - the largest size of the noises to be removed
  - Alphamax - the threshold of the corners.
  - Optitolerance - the tolerance for curve optimization.
  - Turn policy - how to resolve ambiguities in path decomposition.



## Potrace

Transforming bitmaps into vector graphics



Tracing Options

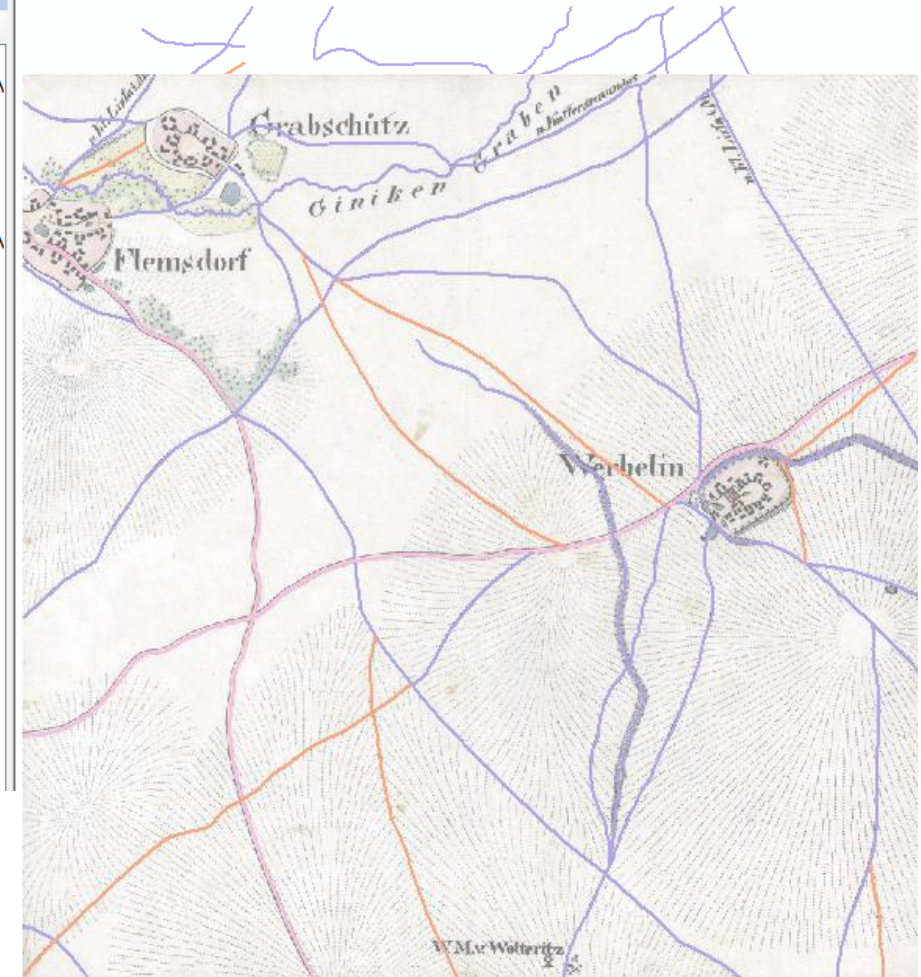
Filter Threshold	<input type="text" value="0.500"/>	0.000 - 1.000
Despeckle size	<input type="text" value="28"/>	> 0
Alphamax	<input type="text" value="1.000"/>	0.000 - 1.333
<input checked="" type="checkbox"/> Optitolerance	<input type="text" value="0.200"/>	> 0.000
Turn policy	<input type="text" value="Minority"/>	

## Building Referencing Features

- Manually vectorised line features.
- Sorted by different road types.
- Adjustment on cell size.
  - From default value to 1 (Same as the raster images).
- Applying a logical adding operation to overlay the extracted features and the referencing image.

Table				
LineFeature5				
	OBJECTID *	SHAPE *	SHAPE_Length	TYPE
	1	Polyline	1006.263584	2
	8	Polyline	6599.473618	1
	9	Polyline	2339.815963	2
	10	Polyline	673.220457	2
	11	Polyline	3815.877618	3
	12	Polyline	1510.340821	2
	13	Polyline	3171.401947	2
	14	Polyline	2789.044293	3
	15	Polyline	7881.050681	1
	16	Polyline	1415.109297	2
	17	Polyline	3978.587241	2
	19	Polyline	801.241637	2

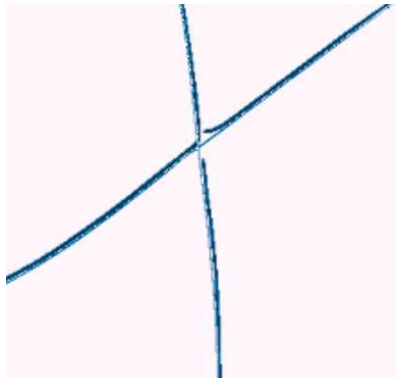
Table Of Contents	
Layers	
F:\文档\2017SS\vectorization\	
LineFeature5	
TYPE	
1	
2	
3	
F:\文档\2017SS\vectorization\	
LF5Raster_Output.png	
07.jpg	
RGB	
Red: Band_1	
Green: Band_2	
Blue: Band_3	



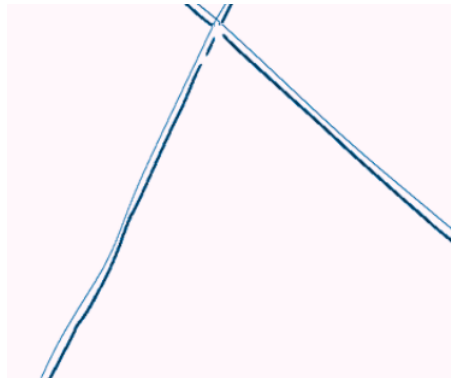
# Referencing Results

## Referencing

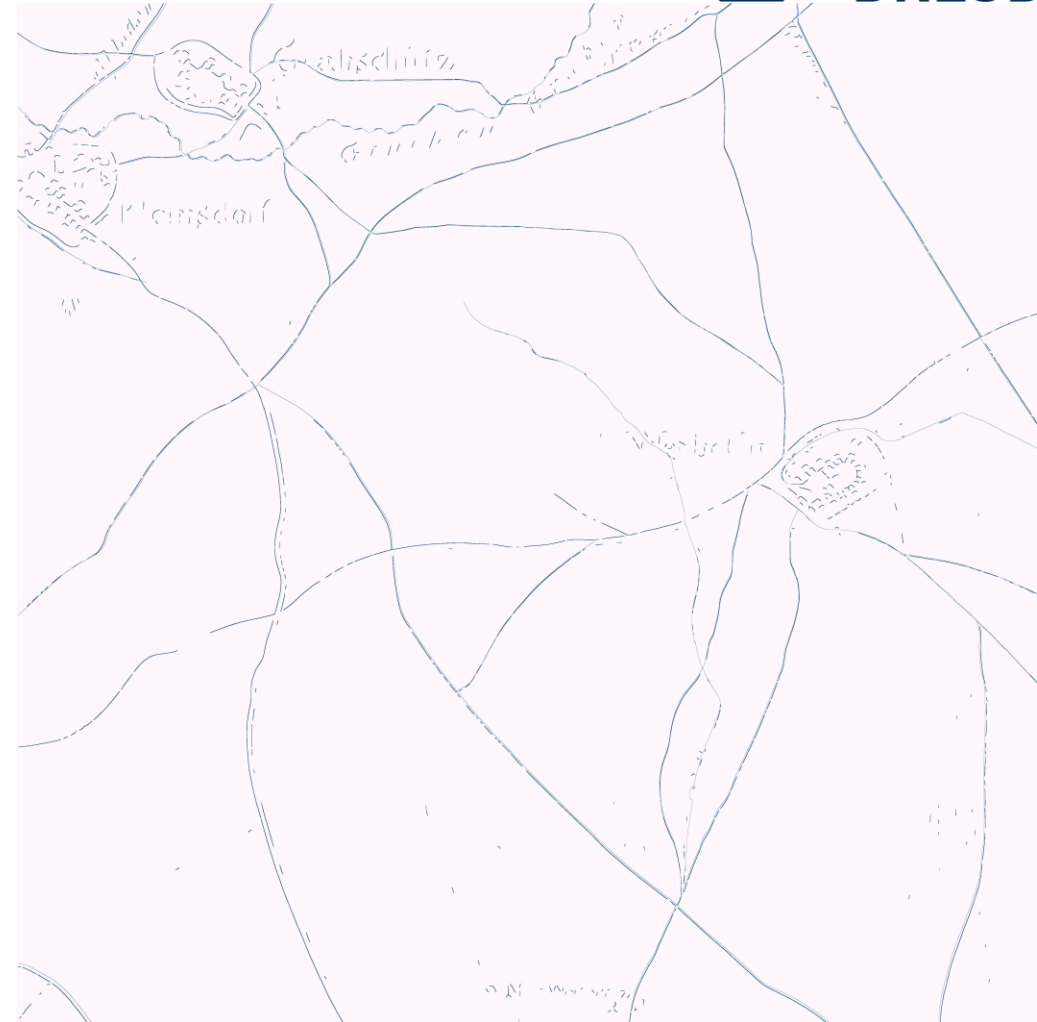
- A hit-or-miss procedure
- If a pixel in both images belong to foreground features:
  - The pixel will be marked as a “blank” pixel
- Otherwise:
  - The pixel will remain in original colour.



Blank pixels



Coloured pixels

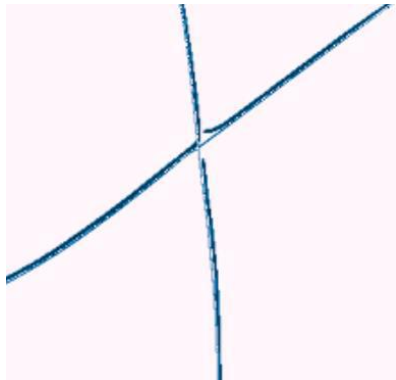


The overlaid result

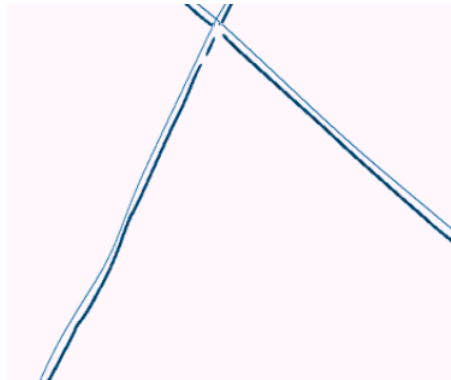


# Referencing Results

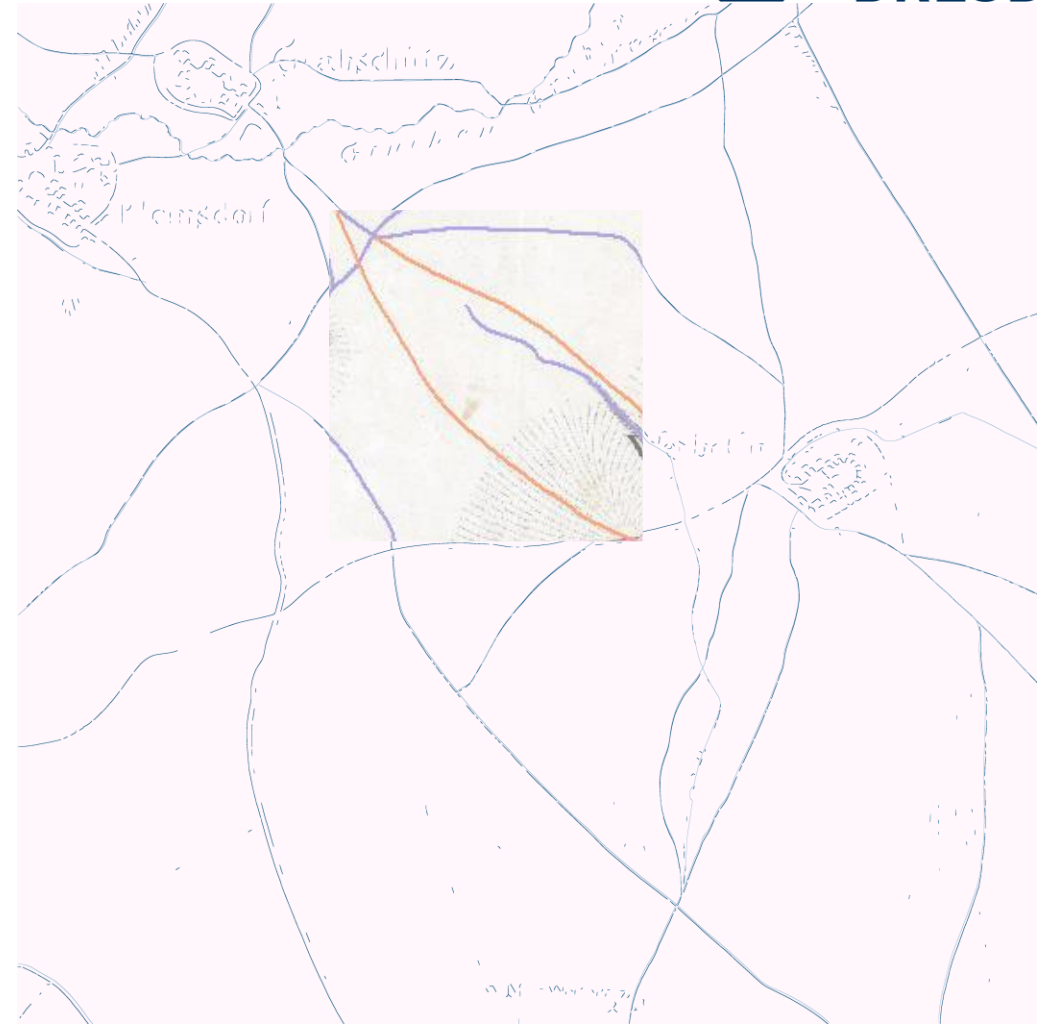
- Pixels couldn't totally coincide in two images.
  - Slight displacement between two images.
  - Cell size adjustment.
- The result of extracting dash lines was not satisfied.



Blank pixels



Coloured pixels



The overlaid result

# Further Work

A solution to the paradox between proper cell size and resolution.

The pattern matching method needs to be improved.

- Removing small noise clusters.
- Patterns of the dash lines.

Keep surveying for more useful open source tools, beyond the constraint of working environment and programming languages.



Thank you for your attention.