A* Path Planning for Line Segmentation of Handwritten Documents

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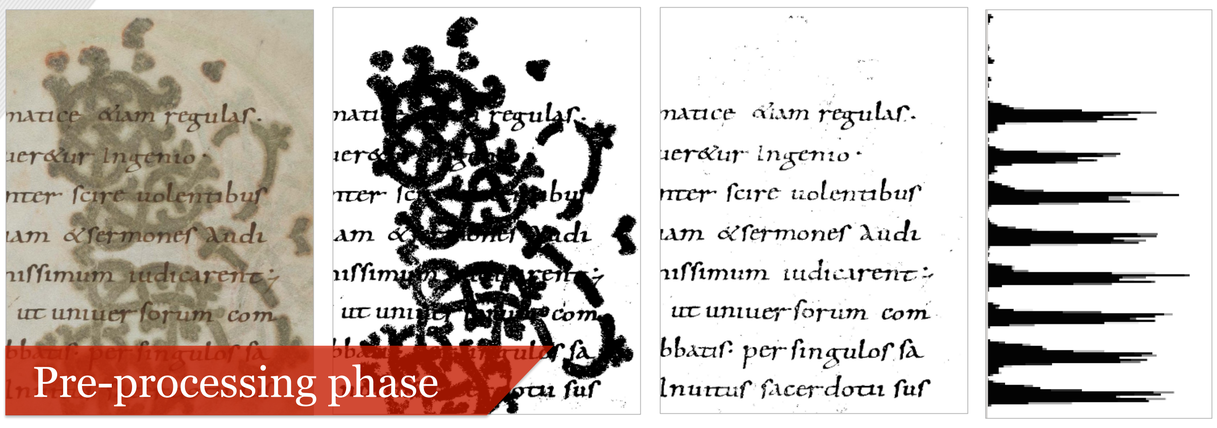
Abstract

> The novelty of the proposed approach lies in the use of **a smart combination of simple soft cost function** that allows an artificial agent to compute paths separating the upper and lower text fields.

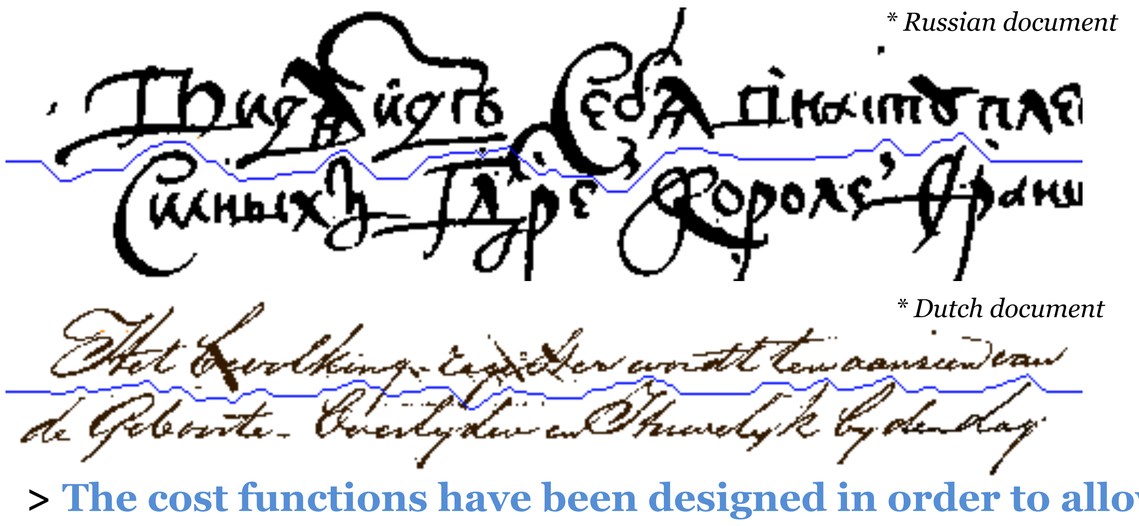
> The use of soft cost functions enables the agent to **compute near-optimal separating paths** even if the upper and lower text parts are overlapping in particular places.

Pre-processing

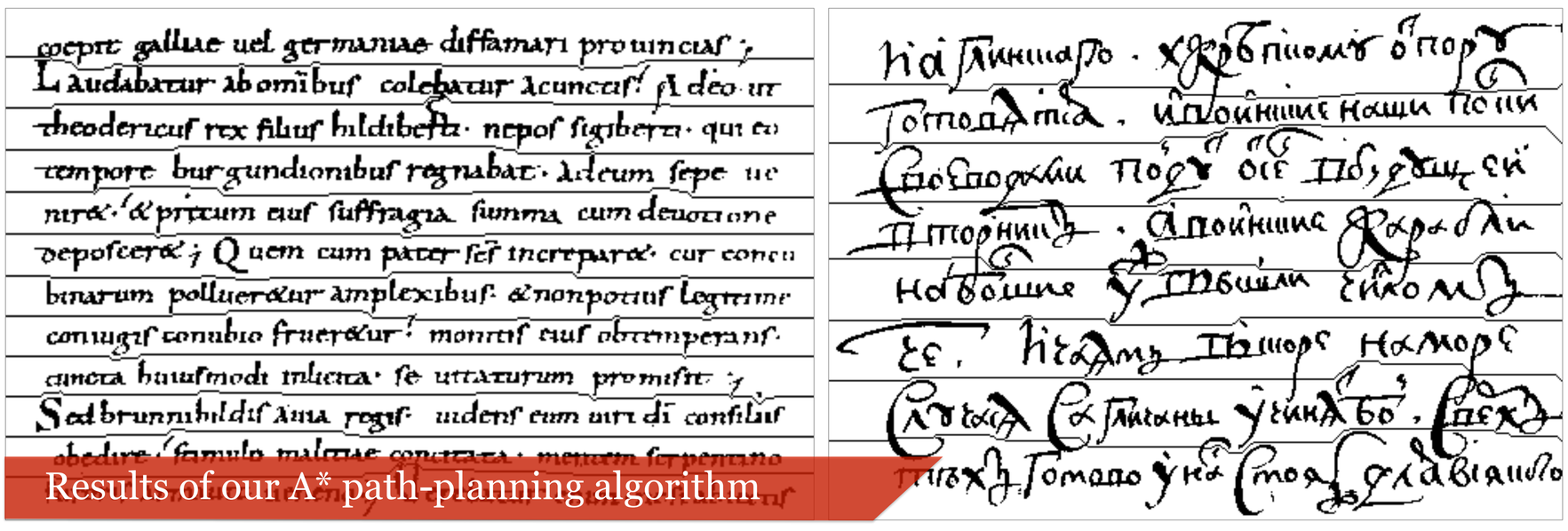


a) The original handwritten document image
b) Background noise is removed by Otsu's algorithm
c) The result of Sauvola's algorithm (a window size of 20x20 pixels)
d) Smooth ink density histogram and local maxima represent the text lines.

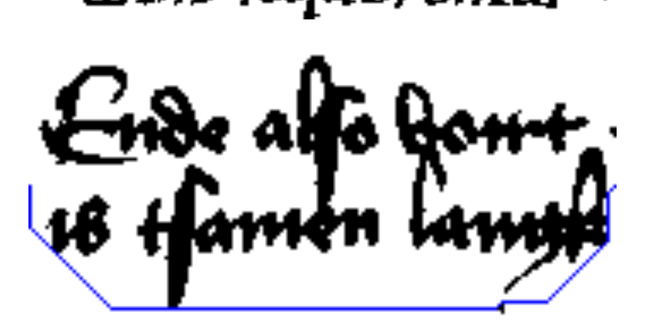
The A* Path-Planning Algorithm for Text Line Segmentation



> **The cost functions have been designed in order to allow the separating path to go through text areas**



The A* Algorithm with simple cost function



> **The agent correctly separates two character lines**

> **Some lines are not segmented correctly, the agent cannot divide the two touching text lines**

Proposed Cost Functions for line segmentation with A* Path-Planning Algorithm

1. The Ink Distance Cost Functions $D(n) = \frac{1}{1+\min(d(n,n_{y_u}),d(n,n_{y_d}))}$

   $D(n)^2 = \frac{1}{1+\min(d(n,n_{y_u}),d(n,n_{y_d}))^2}$

2. The Map-Obstacle Cost Function $M(n)$

3. The Vertical Cost Function

   $V(n) = abs(n_y - n_y^{start})$

4. The Neighbor Cost Function

   $N(s_i, s_j)$

> The **proposed A* path-planning algorithm** uses the following combined cost-function

$$C(s_i,s_j) = c_d D(s_i) + c_{d2} D(s_i)^2 + c_m M(s_i) + c_v V(s_i) + c_n N(s_i,s_j)$$

Evaluation

Hit rate $H_r = \frac{G(S_{max})}{|GT \cup R|}$

Hit rate and line accuracy of line segmentation

Dataset	Hit rate	Line Accuracy
MLS *(our method)*	***0.9280***	***0.9000***
Saint Gall *(our method)*	***0.9980***	***0.9999***
(Baechler *et al.*)	0.9600	0.9540
(Garz *et al.*)	0.9865	0.9797

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The **MLS** dataset is available at

http://www.ai.rug.nl/~mrolarik/MLS/