

# CROSSING NUMBER FEATURES: FROM BIOMETRICS TO PRINTED CHARACTER MATCHING

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# CHALLENGES OF DOCUMENT INTEGRITY CHECK



P&S process impact

- Ink dispersion in the paper.
- Inhomogeneous lighting conditions during the acquisition.
- Re-sampling inherent to the P&S process.



(a)



(b)

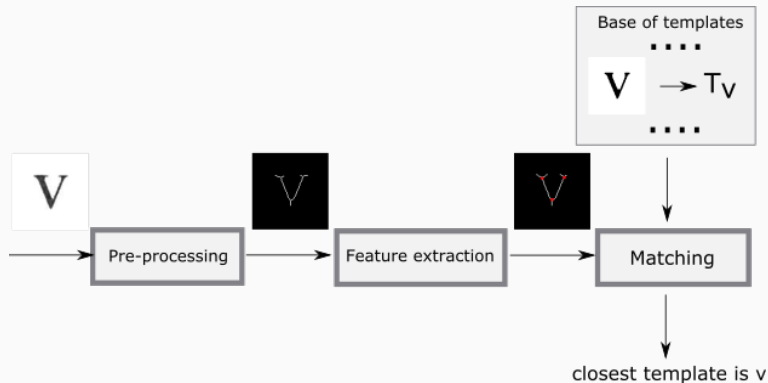


(c)



(d)

# PROPOSED PIPELINE



# PRE-PROCESSING STEP

## 1. Morphological operations

- Pre-processing 1: opening with square structural element of size  $3 \times 3$ .
- Pre-processing 2:  $2 \times 2$  open-close operation.

## 2. Binarization process

- using classical Otsu thresholding method

## 3. Thinning (skeletonization) process

- using classical thinning method based on medial axis transform



(a)



(b)



(c)

# SINGLE VS DOUBLE P&S PROCESS

	$M_1$	$M_2$	$M_3$	$SM_1$	$SM_2$	$SM_3$
Pre-processing 1						
P&S 300 dpi	91.92%	86.54%	84.62%	94.23%	82.69%	<b>95.00%</b>
P&S 600 dpi	95.77%	90.77%	73.46%	<b>97.31%</b>	86.15%	<b>97.31%</b>
double P&S 600 dpi	66.92%	65.77%	54.23%	73.08%	66.54%	<b>74.23%</b>
Pre-processing 2						
P&S 300 dpi	85.38%	86.15%	83.46%	84.62%	78.08%	<b>88.08%</b>
P&S 600 dpi	89.62%	88.85%	90.00%	90.00%	85.38%	<b>91.15%</b>
double P&S 600 dpi	78.08%	75.38%	76.54%	80.00%	70.77%	<b>83.46%</b>

**Table:** Percentage of correctly recognized characters using suggested crossing number comparison techniques.

- Contributions
  - Crossing numbers based features for printed character matching
  - Feature extraction from character skeleton
  - Smoothed features: more than 95% of accuracy (300/600 dpi)
  - Interesting results for double P&S
  - Generalization for different fonts
- On-going and future work
  - Modification of the pre-processing operations
  - Compact text hashing for integrity check

QUESTIONS ?

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