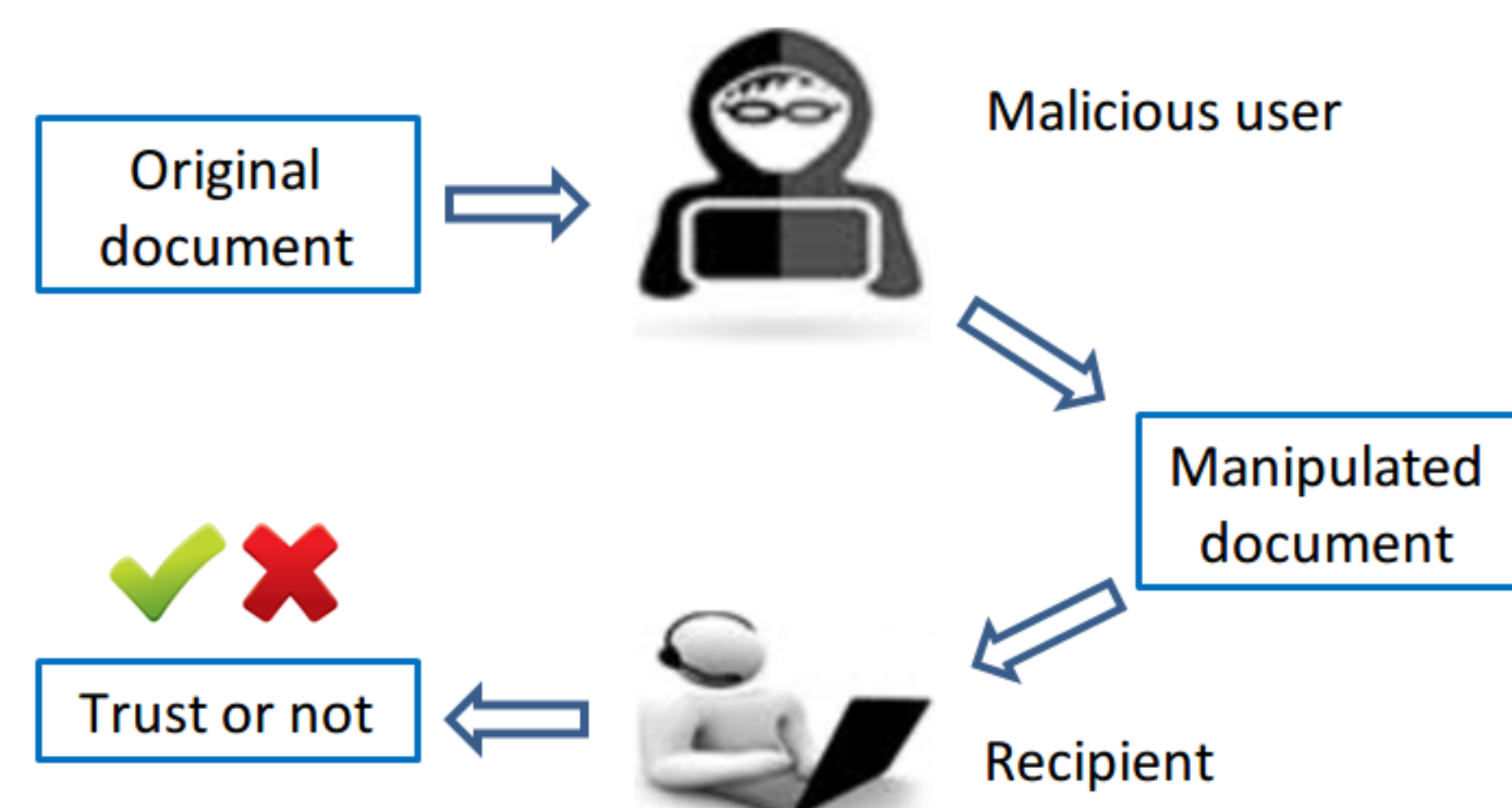


INTRODUCTION

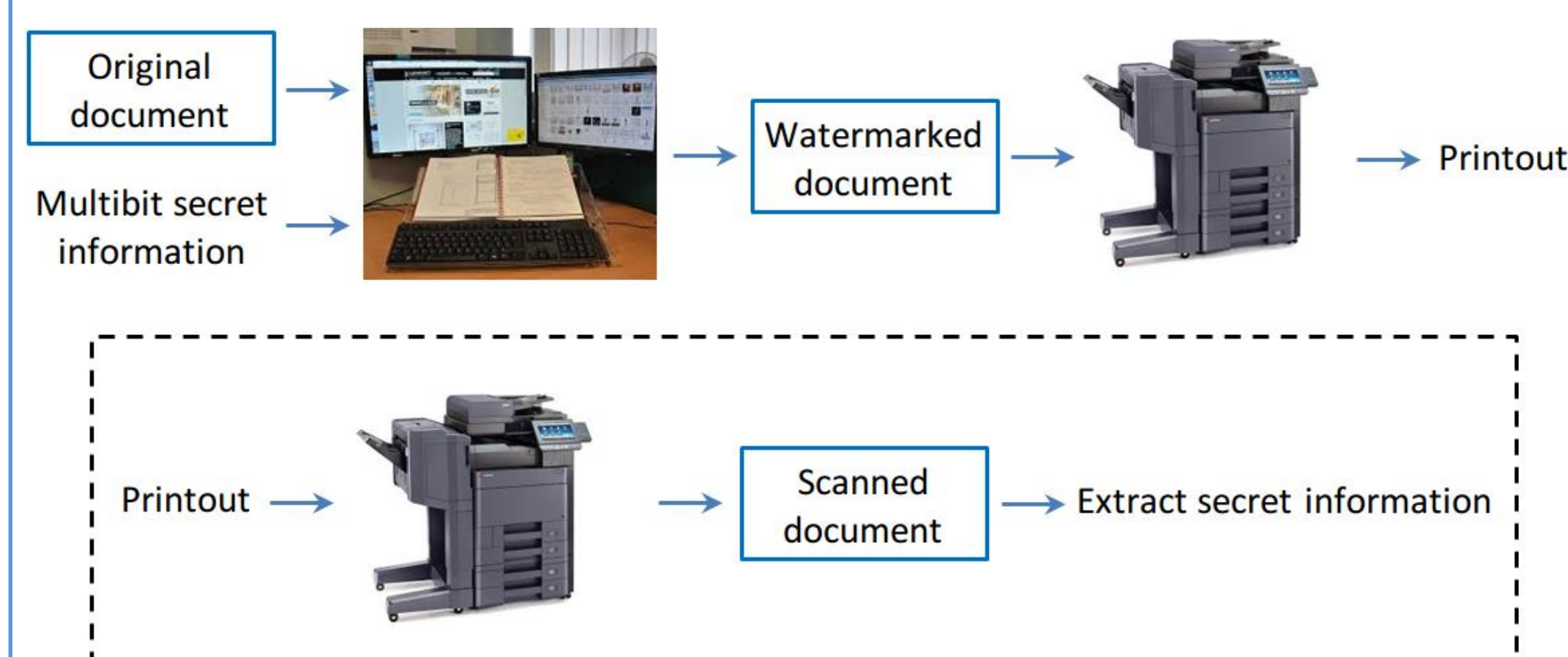
- Various handwritten documents are in use at notarized agreements, judicial documents, bank transfer forms, engineering drawing, etc.
- During document exchange over the digital channels, the handwritten documents are possibly intercepted and easily altered by malicious users.
- How to secure the handwritten documents by utilizing data hiding technique (digital watermarking/steganography) instead of forensic document examination (signature determination, handwriting identification, ink verification, etc.).



OBJECTIVE



- Detecting stable watermarking regions used to hide secret information for document security purpose.
- Resisting to various distortions including image processing operations, geometric transformation and print-and-scan process.
- Satisfying the essential requirements of capacity, robustness and imperceptibility.

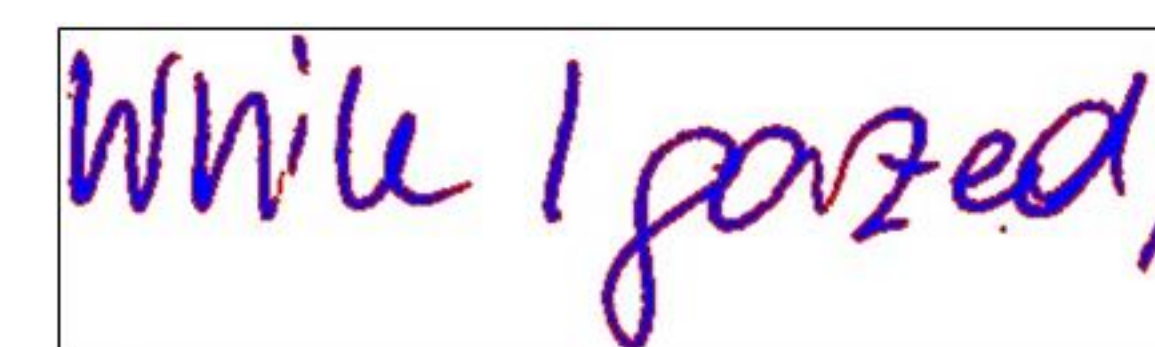
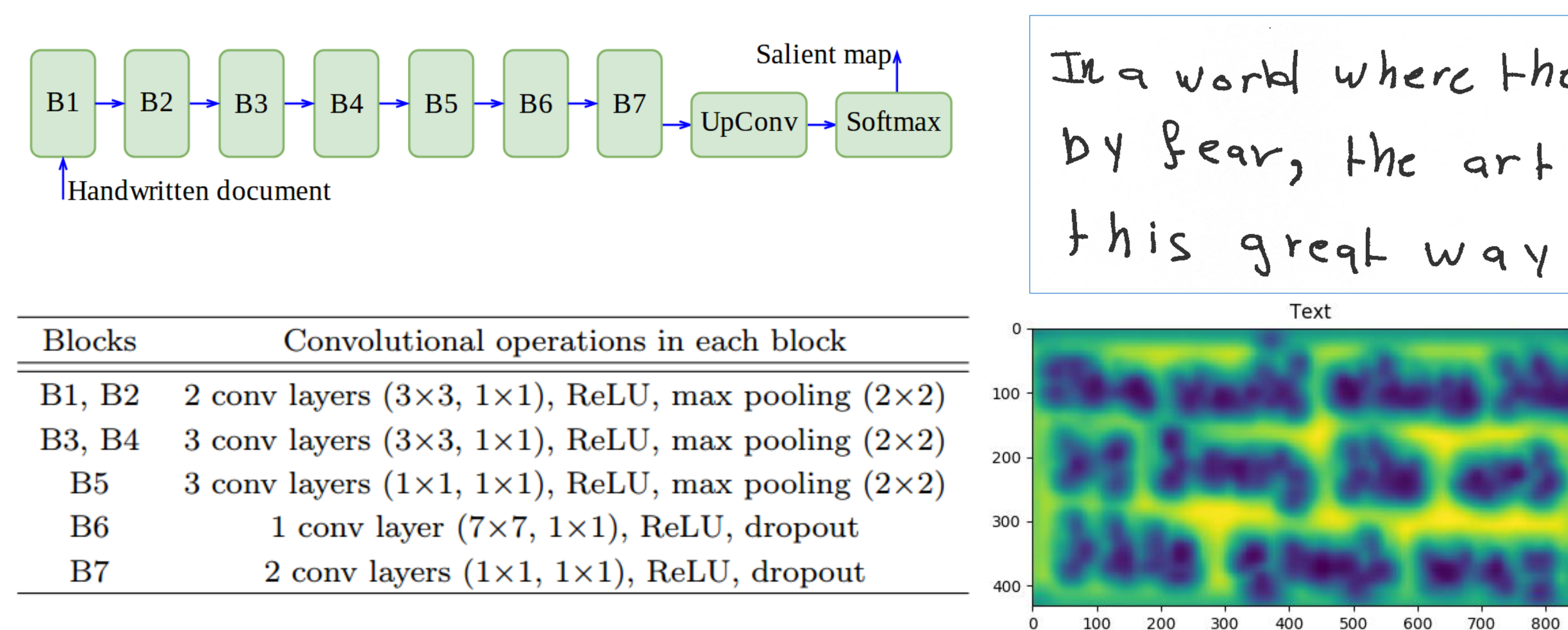


METHOD

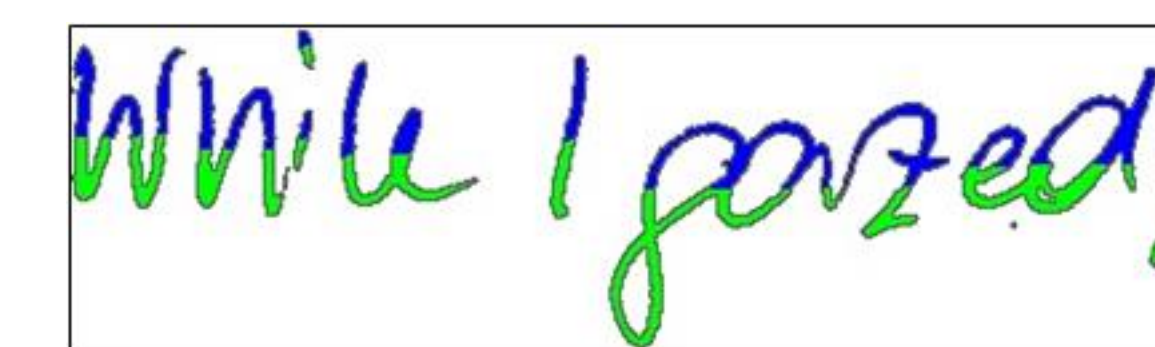
Pre-processing and standardization

- Updating document content: gray level values with high intensity
- Identifying rotation angle and scaling factor
- Transforming document into standard form

Watermarking region detection



Object's stroke and fill



Two sets of connected objects

Watermark hiding process

- Dividing each connected object into two sets P and Q
- Computing sum of values in P (s_1) and sum of values in Q (s_2)
- Making absolute difference (d_i) between s_1 and s_2

$$\begin{cases} s_1 = \sum_{k=1}^m p_k; s_2 = \sum_{k=1}^n q_k \\ d_i = |s_1 - s_2| \end{cases}$$

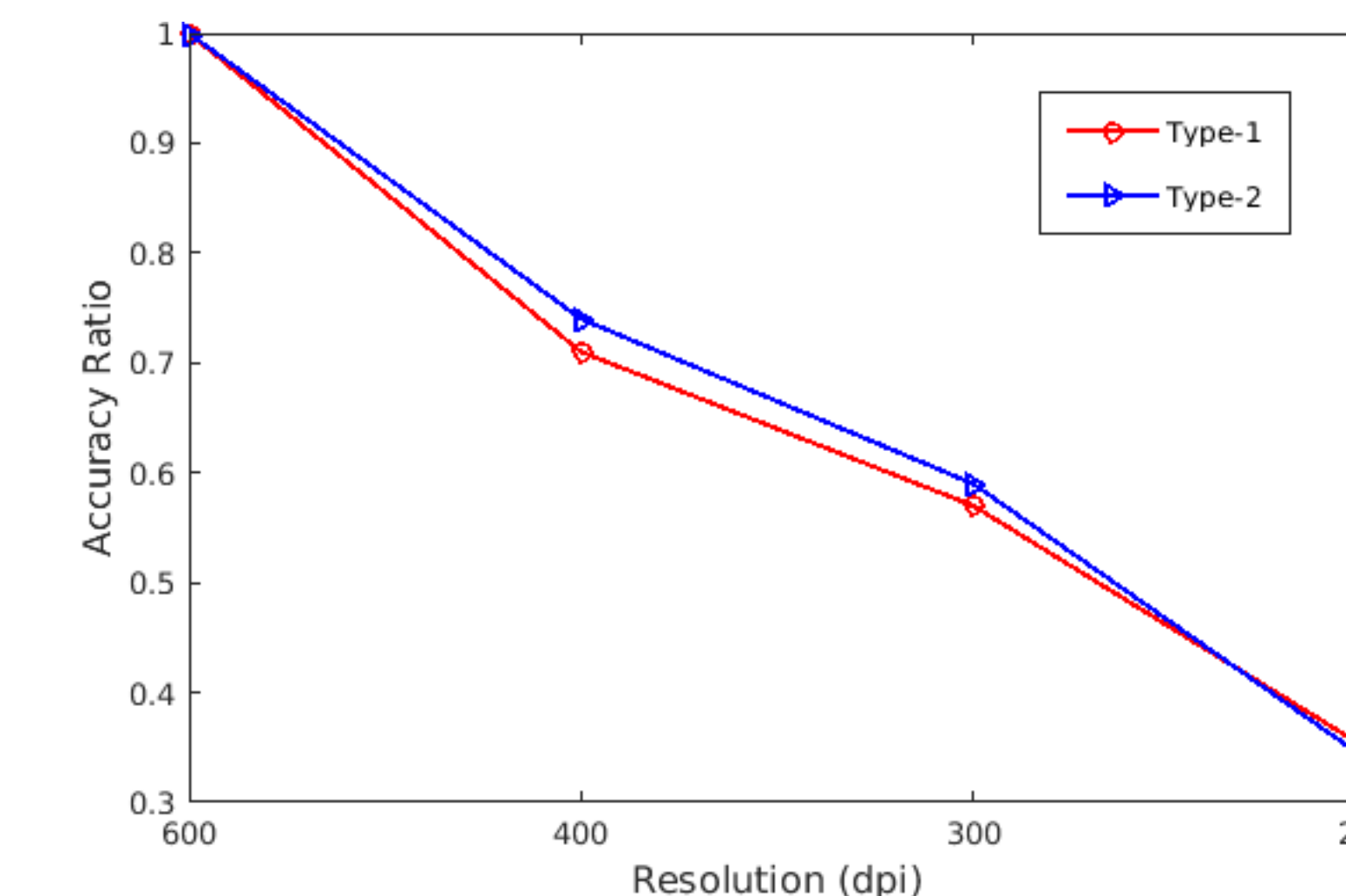
Watermark detection process

$$wm_i = \begin{cases} 0, & \text{if } s_1 \leq s_2 \\ 1, & \text{otherwise} \end{cases}$$

Robustness

Distortions	Accuracy Ratio					
	Doc1	Doc2	Doc3	Doc4	Doc5	Doc6
JPEG 40%	1	1	1	1	1	1
JPEG 30%	0.88	0.82	0.85	0.83	0.79	0.86
Rotation 5° (a)	1	1	1	1	1	1
Rotation 7° (b)	1	1	1	1	1	1
Rotation 9°	0.86	0.80	0.76	0.79	0.85	0.83
Scaling 0.7	0.79	0.82	0.75	0.84	0.81	0.78
Scaling 0.8 (c)	1	1	1	1	1	1
Scaling 1.3 (d)	1	1	1	1	1	1
Scaling 1.4 (e)	0.83	0.87	0.82	0.77	0.80	0.84
(a) + (c)	1	1	1	1	1	1
(a) + (d)	1	1	1	1	1	1
(b) + (e)	0.69	0.71	0.74	0.67	0.64	0.72

JPEG compression + geometric distortion



Print-and-scan distortion

CONCLUSION

- Firstly proposing a watermarking approach for security issue of handwriting documents.
- Making use of the cutting-edge technique of FCN in detecting watermarking regions.
- Effectively applying for handwriting and general typewriting documents.
- Resisting to image processing operations and printing and scanning distortions.
- For future works, enhancing the robustness against complicated distortions such as print-photocopy-scan process and print-camera capture.

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