HANDWRITTEN CHARACTER CLASSIFICATION USING THE HOTSPOT FEATURE EXTRACTION TECHNIQUE

Olarik **Surinta**
Lambert **Schomaker**
Marco **Wiering**
o.surinta@rug.nl, {mwiering, l.schomaker}@ai.rug.nl

ABSTRACT

- The novel feature extraction technique called **the hotspot technique** is proposed for representing handwritten characters and digits.
- This technique is applied to three data sets and combined with by the ***k*-Nearest Neighbors (*k*-NN) algorithm**.
- The results revealed that the hotspot technique provides **the largest classification accuracies**.

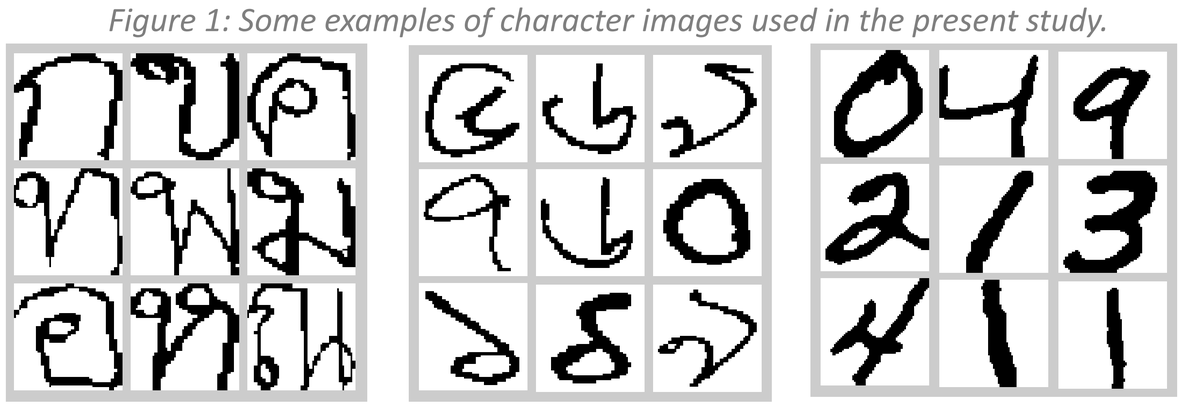
Keywords: *Handwritten Character Recognition, Feature Extraction, k-Nearest Neighbors, Classification.*

INTRODUCTION

- The objective is to reduce the data dimensionality by extracting the most important features from character images.
- The main aim is to propose a ***fast and easy*** to use feature extraction method that obtains a ***good performance***.
- The hotspot technique extracts important information from the character images and is fairly robust to translation and rotation variances.

DATA COLLECTION AND PRE-PROCESSING

Figure 1: Some examples of character images used in the present study.



- ***5,900*** **records of The Thai data set**
- ***65 classes***
- ***9,595*** **records of The Bangla numeric data set**
- ***10 classes***
- ***10,000*** **records of The MNIST data set**
- ***10 classes***

- Pre-processing starts off with cropping the exceeding parts of scanned images.
- These images are transformed into binary images and scaled to 40 × 40 pixels.

"HOTSPOT"
Feature extraction technique

- This technique consists of two parameters
  - ***the number of hotspots***
  - ***the number of chain code directions***
- ***The distance values*** between the closest black pixels and the hotspots in each direction are used as representation for a character.
- Size of the hotspot was defined as ***NxN*** (*Figure 2*).
- The direction of the hotspots is defined by the chain code directions (*Figure 3*).
- The results demonstrated that the best setting uses **25 hotspots** and **4 directions**, the hotspot technique provides ***100 features***.

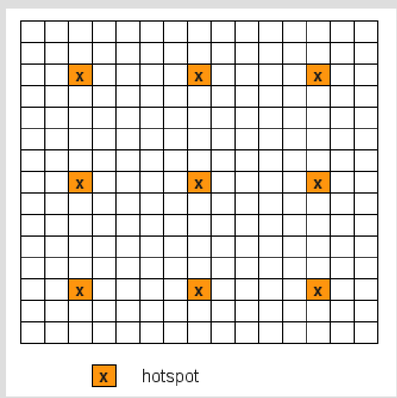


Figure 2: An example to illustrate the location and distribution of the hotspots.

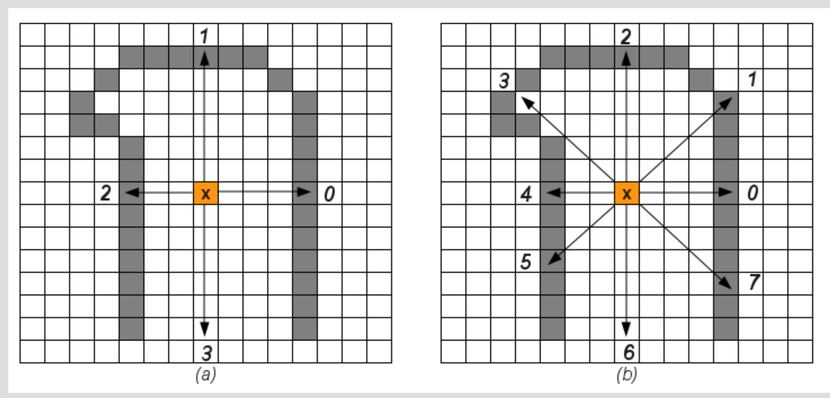


Figure 3: The chain code directions for identifying the distance, (a) 4 directions chain code and (b) 8 directions chain code.

- The hotspot feature vector is defined as:

$$P_s = \{(x_s, y_s), \{d_i\}, \{D_{si}\}\}$$

  - If there is no object pixel found then the distance is set to d_{max}.

$$D_{si} = \begin{cases} \sqrt{(x_s - x_i)^2 + (y_s - y_i)^2} & \text{if } (x_i, y_i) \text{ exists,} \\ d_{max} & \text{else} \end{cases}$$

EXPERIMENTAL RESULTS

- The feature vectors obtained from the hotspot techniques are classified by the ***k*-NN** algorithm.
- Randomly divided the data into a test (10%) and training set (90%) **10 different times**.
- The **best** feature extraction techniques for classification is **hotspot technique**, (*Table 1*).

Data set	Feature extraction technique		
	Hotspot	Mark direction	Direction of chain code
Thai	83.3 σ = 0.5	**88.0** σ = 0.6	71.3 σ = 0.7
MNIST	**89.9** σ = 0.3	85.1 σ = 0.3	83.5 σ = 0.2
Bangla numeric	**90.1** σ = 0.4	87.6 σ = 0.4	82.7 σ = 0.4

university of groningen

Research group:
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