Off-line Handwritten Bilingual Name Recognition for Student Identification in an Automated Assessment System

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Bilingual Student Identification System (BSIS)

- **Thai and English languages**
- **Whole word recognition**
- **Features were extracted from:**
  - **Upper contour**
 - **Lower contour**
  - **Loop images**

BSIS (Cont.)

- **Feature extraction techniques:**
  - **Proposed Water Reservoir, Loop and Gaussian Grid Feature (WRLGGF)**
  - **Modified Direction Feature (MDF)**
  - **Gaussian Grid Feature (GGF)**
- **Classifiers:**
  - **Support Vector Machines (SVMs)**
  - **Artificial Neural Networks (ANNs)**

Off-line Automatic Assessment System (OFAAS)
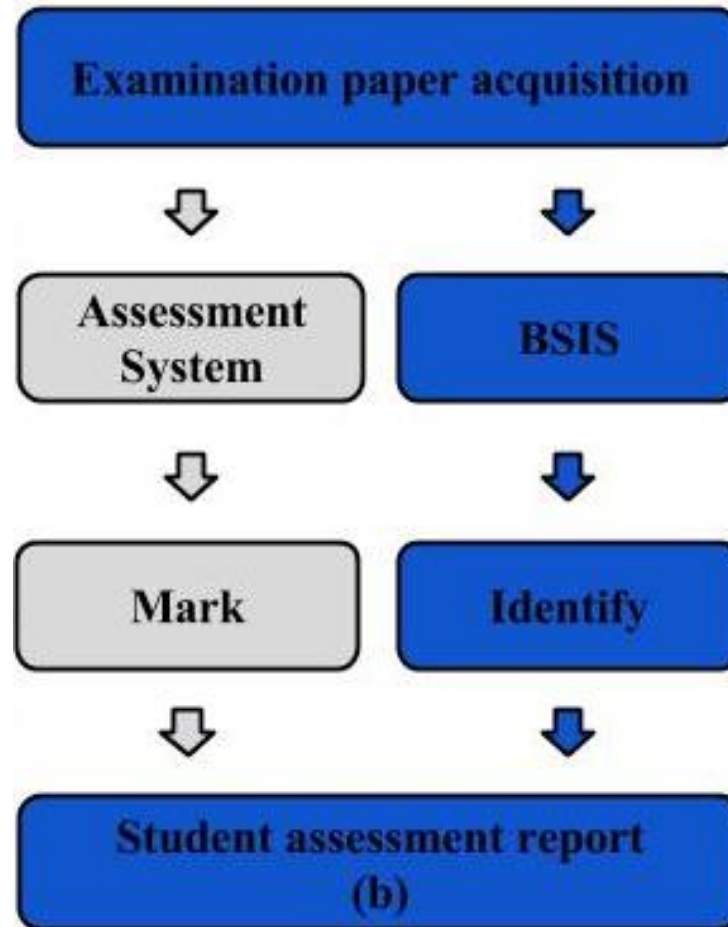
A Block Diagram Illustrating A Complete Off-Line Automatic Assessment System (OFAAS)

Methodology
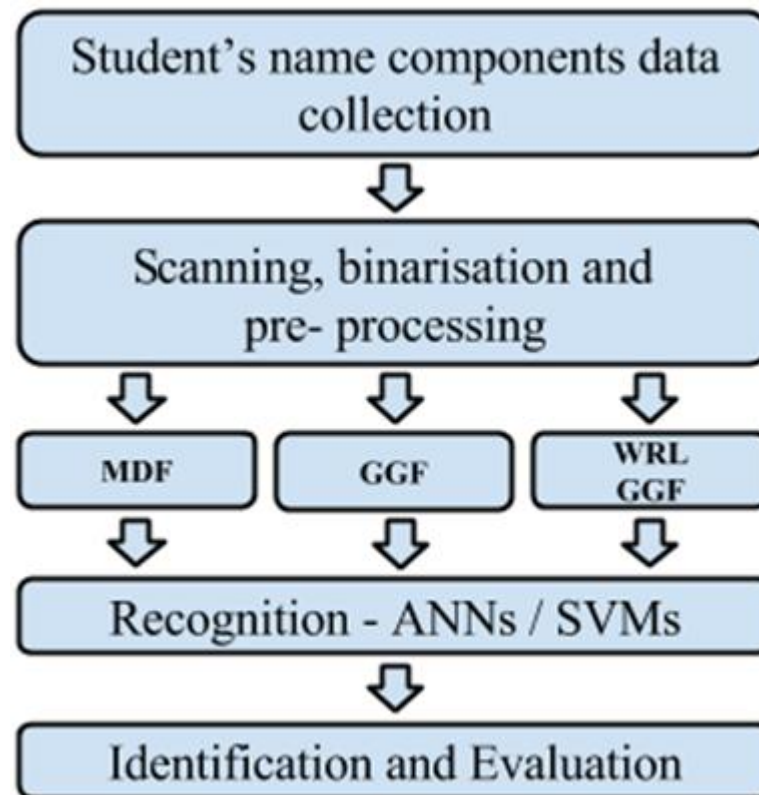
A Block diagram illustrating the proposed Bilingual Student Identification System (BSIS)
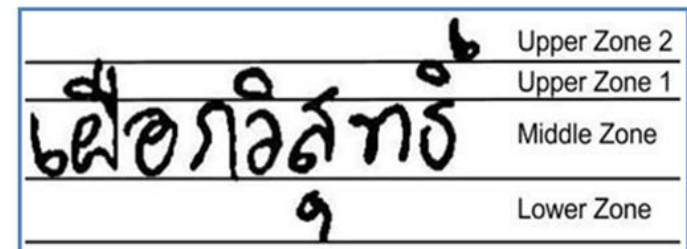
Thai Language

- up to 69 characters (excluding Thai numerals)

Thai Characters

Type	Type Members
Consonant	ก ข ฃ ค ฅ ฆ ง จ ฉ ช ซ ฌ ญ ฎ ฏ ฐ ฑ ฒ ณ ด ต ถ ท ธ น บ ป ผ ฝ พ ฟ ภ ม ย ร ล ว ศ ษ ส ห อ ฮ
Vowels	ะ า อิ อี อึ อื อุ อู เ แ โ ไ ใ อ้ อี้ อำ ฤ ฦ (where อ can be any other consonant)
Tones	อ่ อ้ อ๊ อ๋ (where อ can be any other consonant)
Punctuation Marks	อ์ ๆ ๚ (where อ can be any other consonant)

- Heads of Thai characters - small loops

Thai Language (Cont.)

- no space between words for the Thai language

- hard to segment words from a sentence

ตากลม

Meaning 1: sitting in the wind (ตาก ลม)

Meaning 2: eyes wide open (ตากลม)

- name components were recognised as a whole (whole word recognition)

Name Components Examples

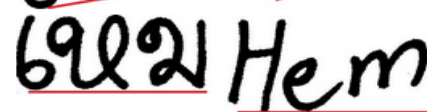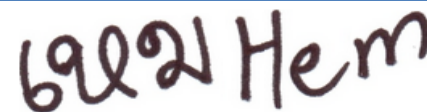# Preprocessing

Original grey-level image

Binarised image

After skew normalisation

After applying noise removal, filling, and boundary extraction

After loop extraction

After upper contour extraction

After lower contour extraction

Example images after each preprocessing step

Feature Extraction Techniques

The Modified Direction Feature Extraction Technique (MDF)(Blumenstein et al., 2004)

- builds upon the direction feature

- based on the calculation of transition features from background to foreground pixels in the vertical and horizontal directions

- Both the location transitions (LTs) calculated, and the direction value at that location are stored

- The vector size is 121

Feature Extraction Techniques (Cont.)

The Gaussian Grid Feature Extraction Technique (GGF)

(Nguyen et al., 2011)

- original developed for the signature verification problem
- employs pattern contours
    - divided into 12 × 12 zones of equal size.
    - in each block, the 4-direction chain code histogram of each block is created
    - every step from a pixel to its adjacent one of the four directions, which is either horizontal, vertical, left diagonal, or right diagonal, are tallied.
    - a Gaussian smoothing filter (σ = 1.2) is applied to each directional 12 × 12 matrix
- The vector size is 864

Feature Extraction Techniques (Cont.)
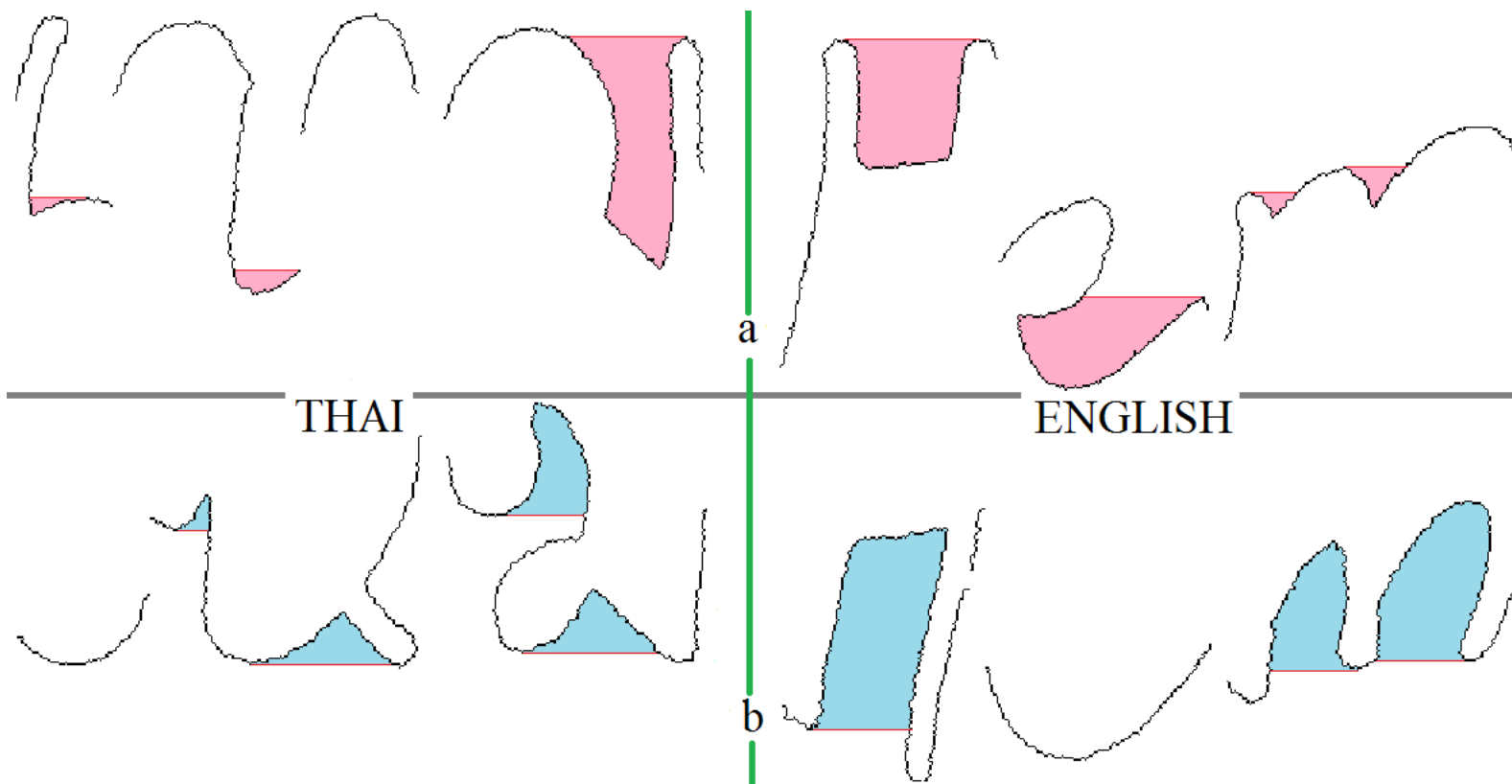
Water Reservoir Feature (WRF) Extraction Technique

(Pal et al., 2003)

Feature Extraction Techniques (Cont.)
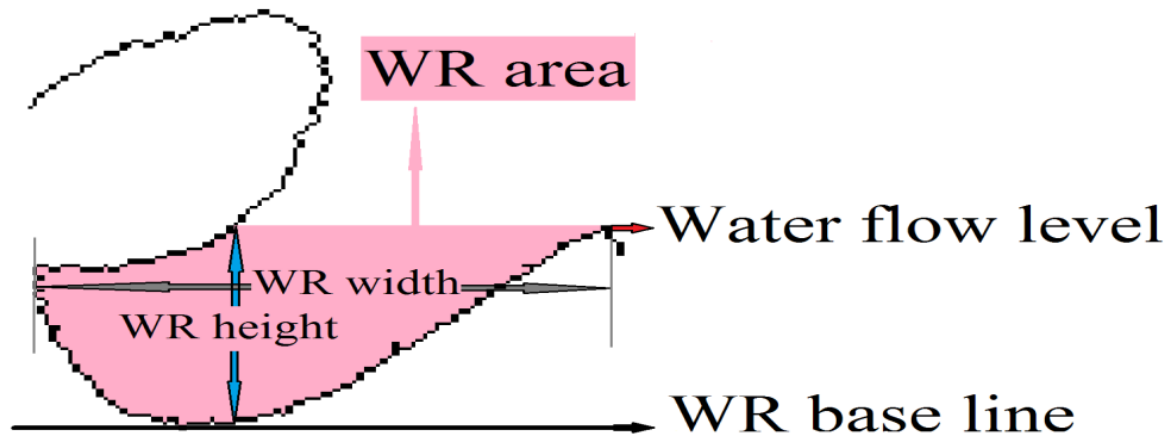
Water reservoir properties (Pal et al., 2003)

- The number of WRs is set to four per window
  - makes the WR feature vector 196 (7 windows × 4 WRs × 7 features) in size per contour image
  - the vector size equal to 392 for both upper and lower contour images.

Feature Extraction Techniques (Cont.)

Loop Feature (LF) Extraction Technique

- both Thai and English languages may contain loops in each character

- for the Thai language, the loops play an important role in distinguishing characters

- feature vector size is 192

  - comprised of 3 zones $\times$ 15 loops from each zone $\times$ 4 features of each loop + 12 additional features for the average loop area, average loop width and height, and total number of loops of each zone

Feature Extraction Techniques (Cont.)

Water Reservoir, Loop, and Gaussian Grid Feature (WRLGGF) Extraction Technique

- developed based on three feature extraction techniques being WRF, LF and GGF.

- The final WRLGGF vector, size of 1,448 (392 from WRF + 192 from LF + 864 from GGF)

Dataset

- **Each Thai and English dataset:**
  - **consists of 2,060 handwritten name components (206 name components x 10 samples of each name component)**
    - 4,120 samples in total
  - **103 writers**
    - 206 writers in total
  - **all samples were written with minimum constraints**
    - writing instruments and handwriting styles were not restricted within the given space

Dataset (Cont.)

- name components both first and last names may begin, end, or include some common words
  - **such as "wat", "chai", "ya", "kit"**
    - common characteristics shared by writers
  - **can be quite confusing for automatic classification**
- varied word lengths
  - **from 2–7 syllables which can be up to 18 characters**
- duplicated last names

Classification

ANNs

- trained with the resilient backpropagation algorithm

- trained using $412 \times 8 = 3{,}296$ samples

- tested using $412 \times 2 = 824$ samples

SVMs

- libsvm was employed in conjunction with the WEKA toolkit

- ten-fold cross validation was used across all 4,120 handwriting samples

Experimental Settings

- 412 outputs for the 412 first and last names
  - The duplicated name components from different writers, for example "Smith" from "John Smith" and "Smith" from "Judy Smith" were classified into 2 different outputs
    - in the future it is believed that this will be useful in developing the BSIS that can identify and verify students from their name components
  - However, in the recognition phase, "Smith" can be recognised as either "Smith" of John's output or of Judy's output.
  - BSIS will identify who the name component belongs to

BSIS criteria
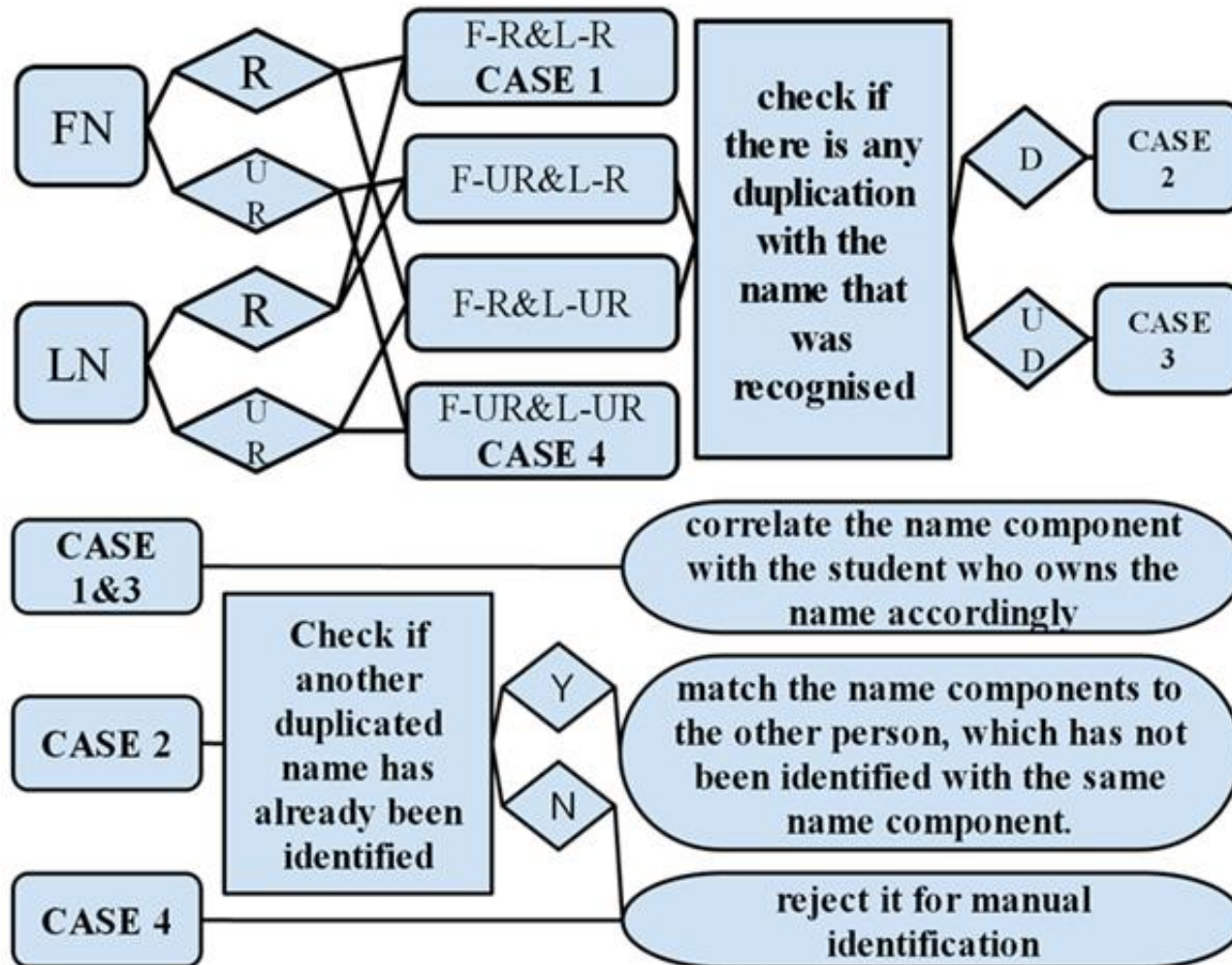
Results

Recognition Rates Attained Employing MDF , GGF, WRGGF, LGGF or WRLGGF Feature Extraction Techniques in conjunction with The Artificial Neural Network (ANN) and Support Vector Machine (SVM) Classifiers

Classifier	Feature Extraction Techniques				
	MDF	GGF	WR GGF	L GGF	WRL GGF
ANN recognition rate (%)	84.83	69.66	63.95	68.45	78.15
Hidden units	127	120	111	97	121
Iterations	2000	3000	2000	4000	2000
SVM recognition rate (%)	96.63	98.59	99.17	98.81	99.25

Results (Cont.)

Comparison Between the Results of The Proposed BSIS System and Previous Work (Suwanwiwat et al., 2012)

System – Technique – Classifier	RR (%)	Database Size
English SIS – MDF – ANN	98.59	2,040 words
English SIS – GGF – ANN	93.62	2,040 words
English SIS – GGF – SVM	99.55	2,040 words
English SIS – WRLGGF – SVM	**99.61**	**2,040 words**
English SIS – WRGGF – SVM	99.56	2,040 words
English SIS – LGGF – SVM	99.41	2,040 words
BSIS – WRLGGF – SVM	**99.25**	**4,120 words**

Conclusions and Future Work

- more experiments will be carried out on a larger database and also on other scripts to observe the results

- compression/feature selection techniques may be applied in future work

- a hybrid MDF combining LF and WRF, will be investigated.

- the work will be extended to student verification

  - the system can detect if the students who sat an examination were really the persons who own the name and not someone else

THANK YOU

QUESTIONS?