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Azad University, Mashhad Branch, Iran

Offline Signature Recognition using Modular Neural Networks with Fuzzy Response Integration

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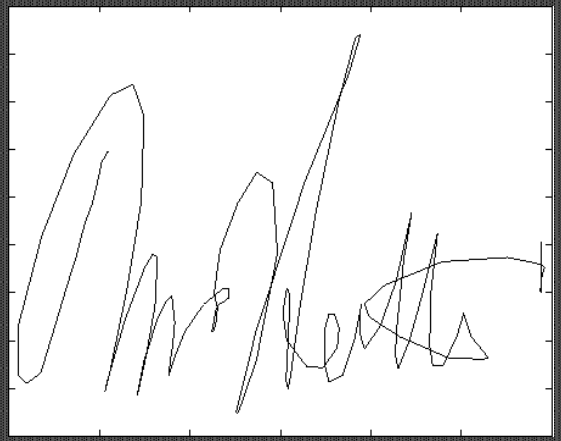
Introduction

- Developing biometric recognition systems for security and identity verification purposes is very active area of research nowadays [1].
- Among all biometric features, the handwritten signatures are one of the most popular and reliable ones.
- There are two main methods for signature recognition:
  - Online Methods
  - Offline Methods

[1] D. Zhang (2000) Automated biometrics technologies and systems. Hong Kong Polytechnic University Ed. Kluwer Academic publishers Chapter 10: 203-206

Problem Statement

- The problem is concerned with the automatic recognition of a person's signature that is captured on a paper of size 460*792 and is stored in PC.
- We have a set of N different people, and each has a unique personal signature but can have different samples of that unique one.



The Proposed Method

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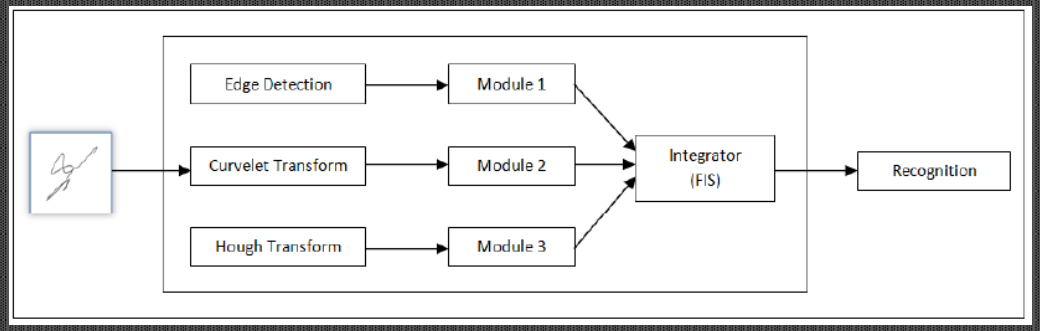
- The system proposed in this paper consists of a modular neural network with 3 separate modules.



- Each module is given as input the features extracted with different feature extraction methods:
  - Edge Detection
  - Curvelet Transform
  - Hough Transform

Edge Detection

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- For images of handwritten signature, the edges can capture much of the overall structure present within, because people normally write using a single color on a white background.
- We have chosen Canny Edge Detector for our system.

Curvelet Transform

- Curvelet can capture the intrinsic geometrical structures such as smooth contours in natural images.
- Curvelets can represent a smooth contour with fewer coefficients.
- The curvelet transform is implemented by decomposing the image into a series of disjoint scales.

Hough Transform

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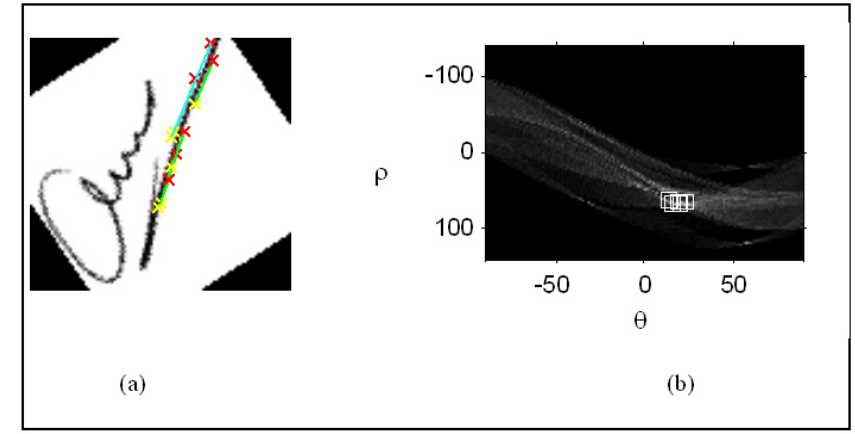
- The Hough transform can extract line segments from the image.
- In order to reduce the size of the matrix, and the size of the corresponding ANN, the information of the Hough matrix are compressed by 25%.



Mamdani Fuzzy Inference System

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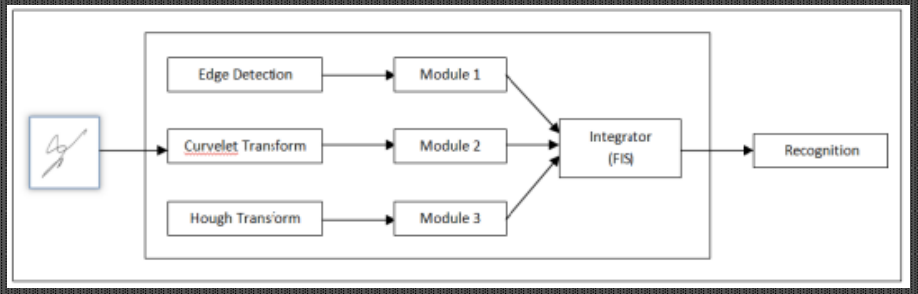
FUZZY IF-THEN RULES FOR THE PROPOSED SYSTEM

Rules	Edge Detection	Curvelet Transform	Hough Transform	Decision
1	A	A	A	A
2	A	A	B	A
3	A	A	C	A
4	A	B	A	A
5	A	B	B	B
6	A	B	C	B
7	A	C	A	A
8	A	C	B	C
9	A	C	C	C
10	B	A	A	A
11	B	A	B	B
12	B	A	C	A
13	B	B	A	B
14	B	B	B	B
15	B	B	C	B
16	B	C	A	C
17	B	C	B	B
18	B	C	C	C
19	C	A	A	A
20	C	A	B	A
21	C	A	C	C
22	C	B	A	B
23	C	B	B	B
24	C	B	C	C
25	C	C	A	C
26	C	C	B	C
27	C	C	C	C



Experimental Results (1/3)

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- A data base of images with the signature of 30 people has been built and 9 samples of the signature from each person has been collected: This gives a total of 270 images.

Experimental Results (2/3)

- In order to obtain comparative measures we divide our experiments into two separate tests:
  - First, we use each module as a monolithic ANN for signature recognition.
  - Second, we train our MNN using all three modules concurrently and the Mamdani fuzzy integral as our integration method.
- In all tests, 210 images were chosen randomly and used for training, and the remaining 60 were used for testing.

Experimental Results (3/3)

- The ANNs were trained with the Scaled Conjugate Gradient (Trainscg) algorithm, with a goal error of 0.001.
- Moreover, all networks had the same basic ANN architecture, with two hidden layers.

THE BEST RESULTS OBTAINED FOR MONOLITHIC ANNs VS. OUR MODULAR NEURAL NETWORK

Feature Type	Epochs	Neurons	Time	Correct	Accuracy (%)
edge detection	142	100-80	00:00:44	50/60	83.3
curvelet transform	137	100-80	00:00:10	56/60	93.3
Hough transform	139	100-80	00:01:50	54/60	90
modular neural network	-	-	-	58/60	96.6

Conclusion

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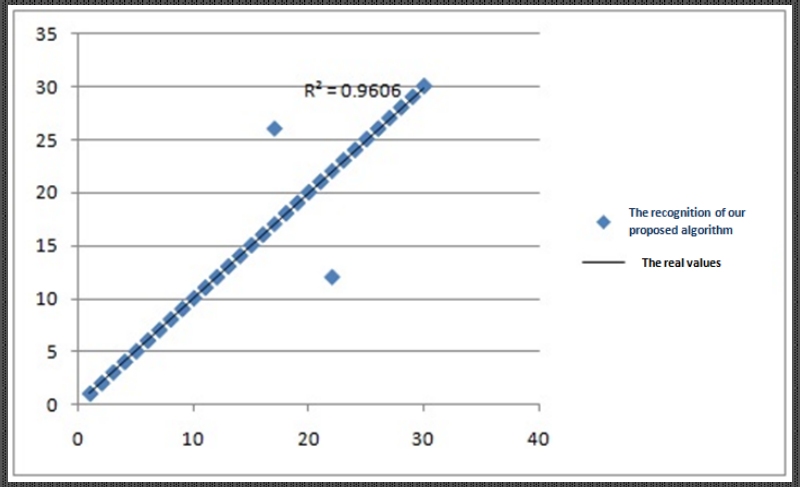
- The modular approach always outperforms, with varying degrees, the monolithic ANNs.
- The results also show that even with the simple image features used in this work, each of the ANN modules is indeed capable of learning very good discriminating functions.



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QUESTIONS

Thanks For Your Attention!