

A Stroke Based Algorithm for Dynamic Signature Verification

Tong Qu

Abdulmotaleb El Saddik

Andy Adler

{tqu, elsaddik, adler}@site.uottawa.ca

University of Ottawa

Outline

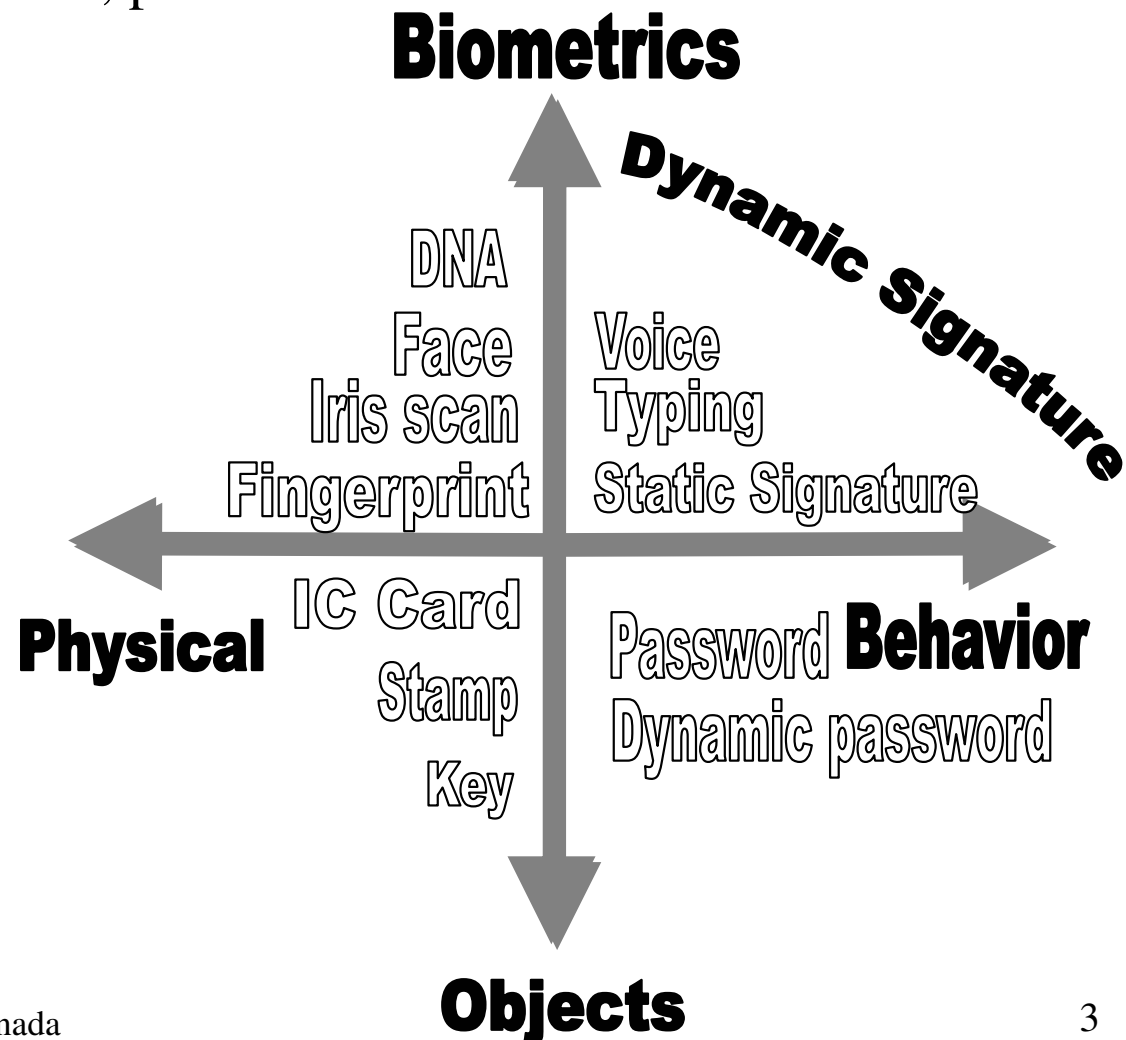
1. Introduction
2. Data acquisition and signature processing
3. Feature extractions
4. Signature verification
5. Experiments
6. Conclusions

1. Introduction

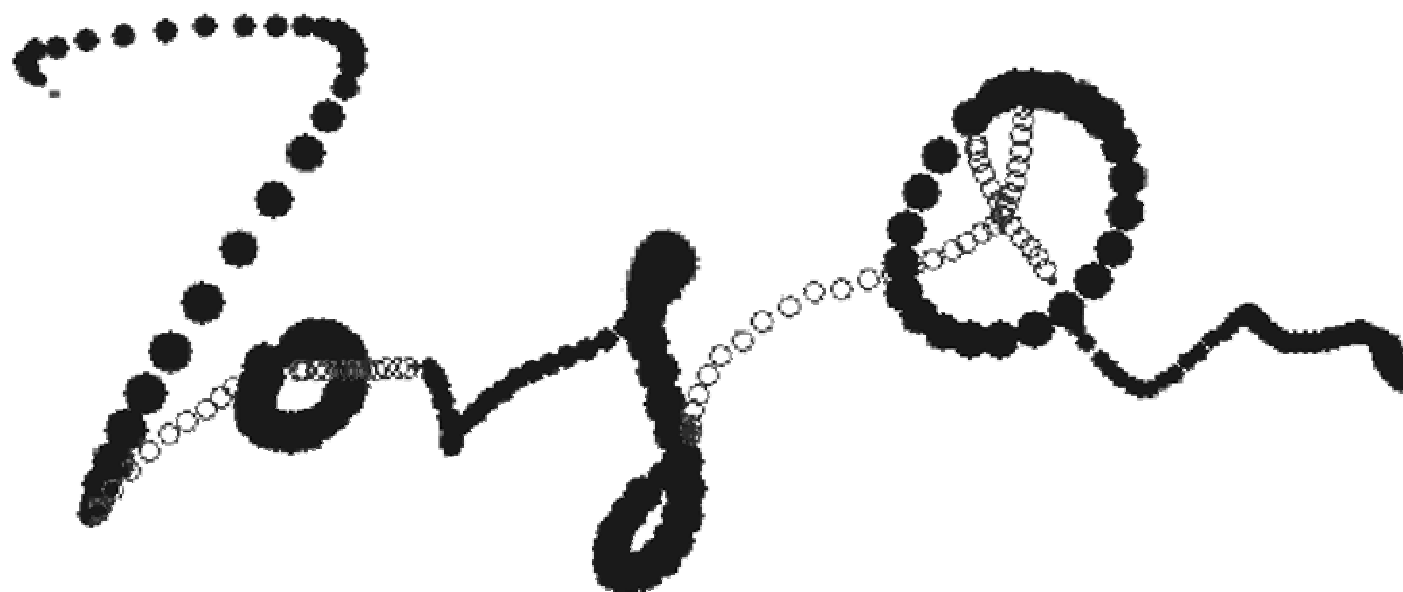
Dynamic Signature Verification in Biometric Techniques

- A biometric technique for authentication
 - Could replace today's password, pin number etc

- Application
 - Security
 - Banking
 - E - Commerce
 - Document Management
 - ...



Dynamic signature



- Dot Size
= pen pressure
- Circle
= lifted pen

➤ *Parameters of interest*

- Pen tip velocity and acceleration
- Time between strokes
- Pressure
- Stroke sequencing
- ...

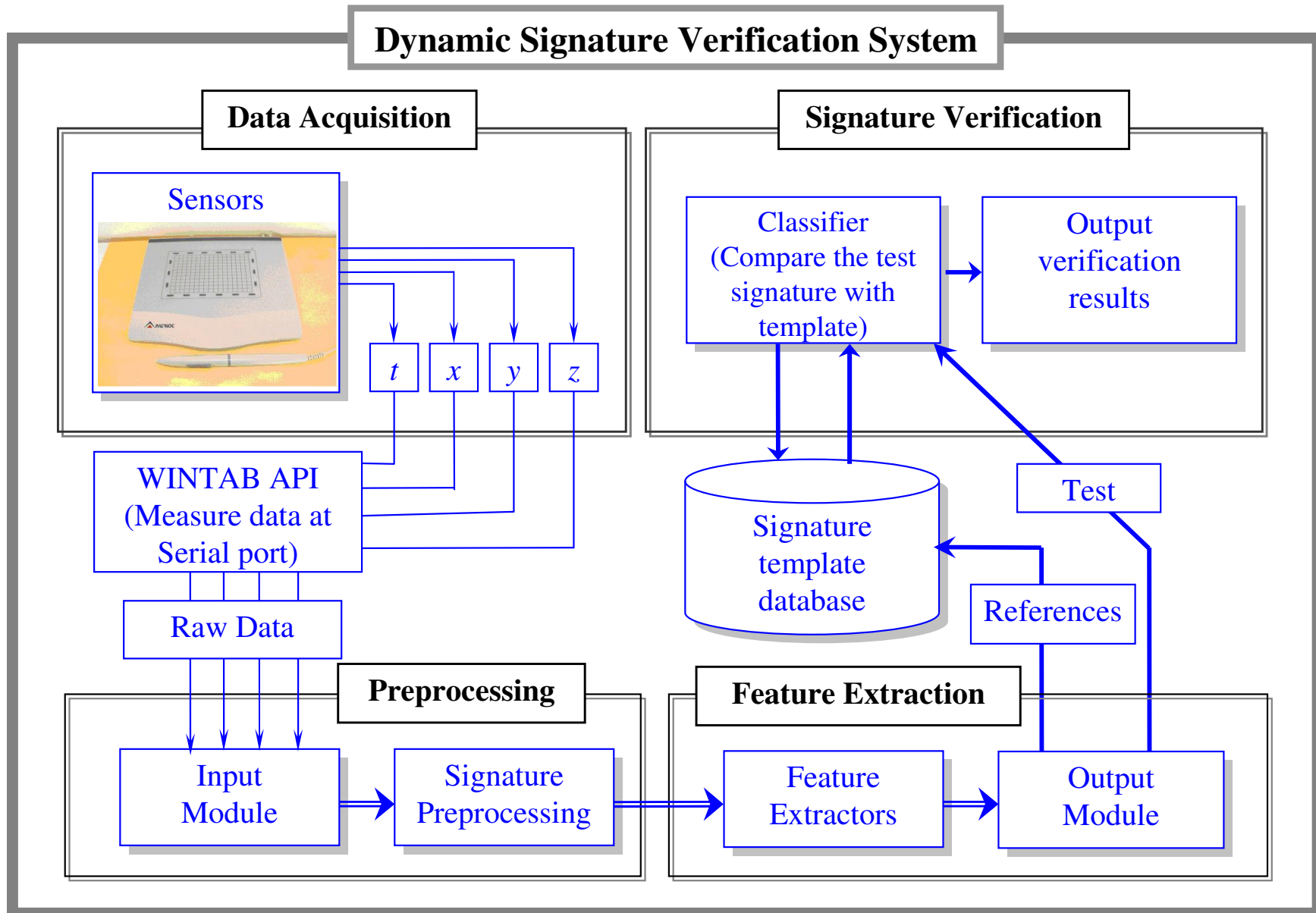
➤ *Advantages*

- Natural and intuitive
- Commonly accepted for authentication
- Less intrusive than iris, fingerprint, etc.

➤ *Related work*

- Time warping
- Euclidian or other distance measure
- neural network
- ...

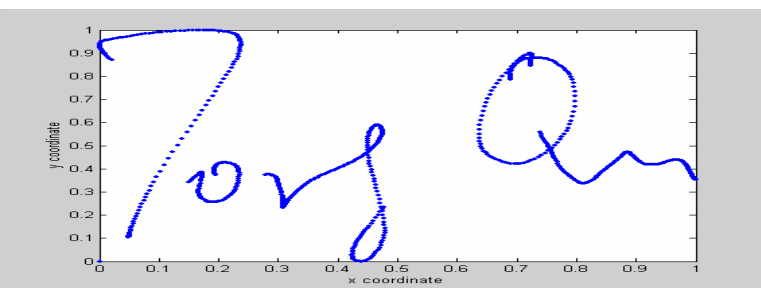
System Architecture



2. Data Acquisition and Signature Processing



Patriot digital pad



A sample signature

Pressure

Displacement x

Velocity x

Acceleration x

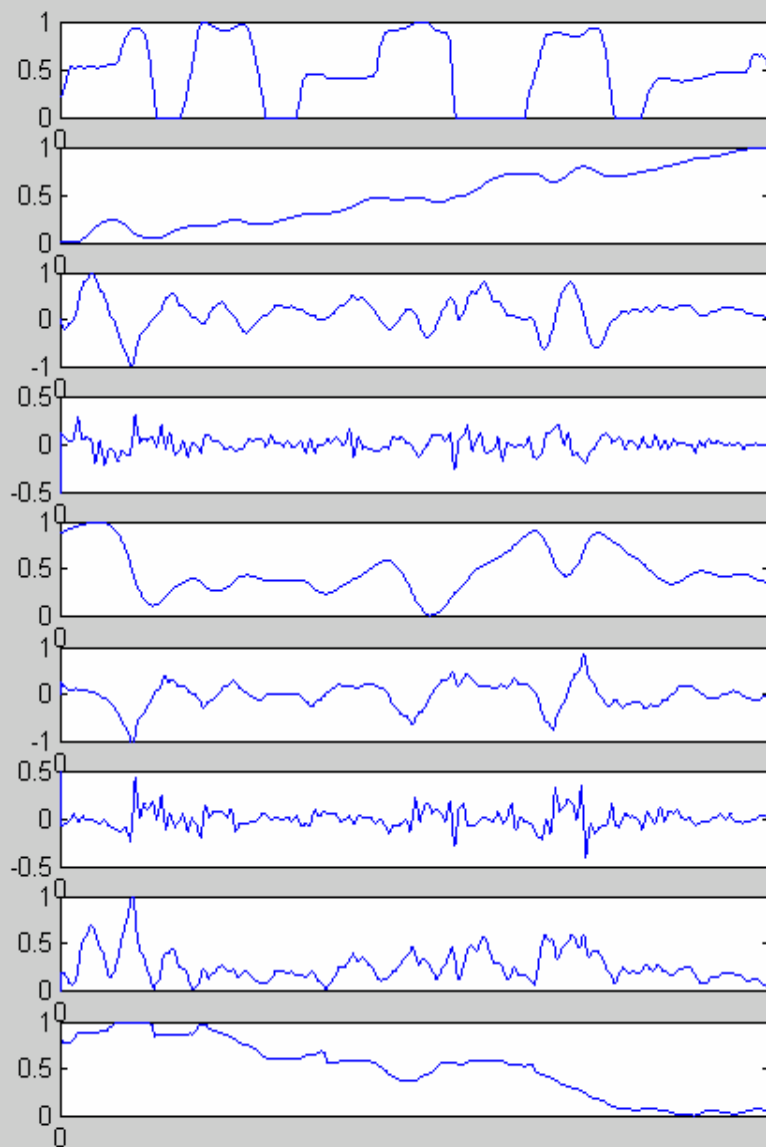
Displacement y

Velocity y

Acceleration y

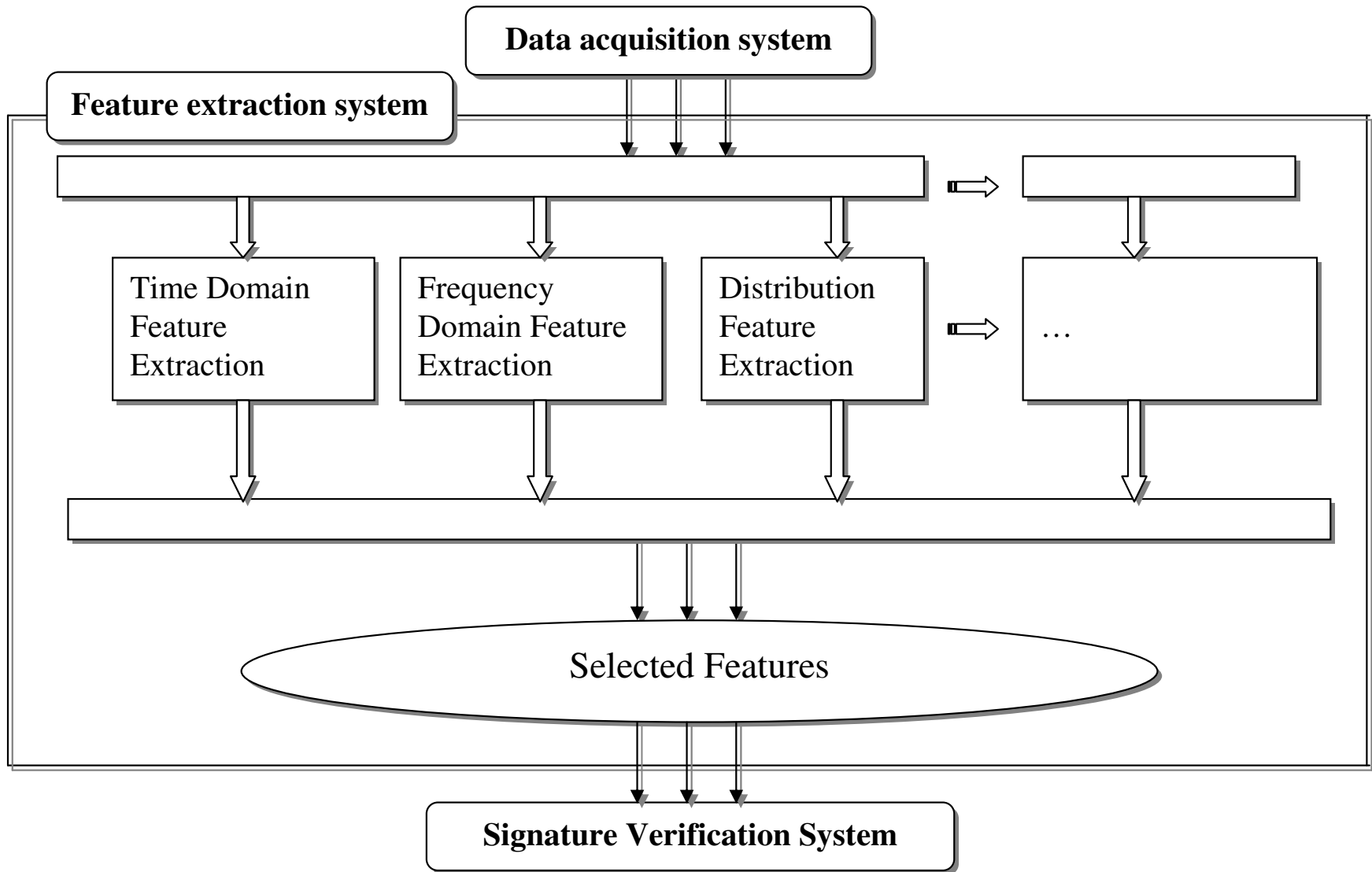
Absolute Velocity

Angle



Sampling time

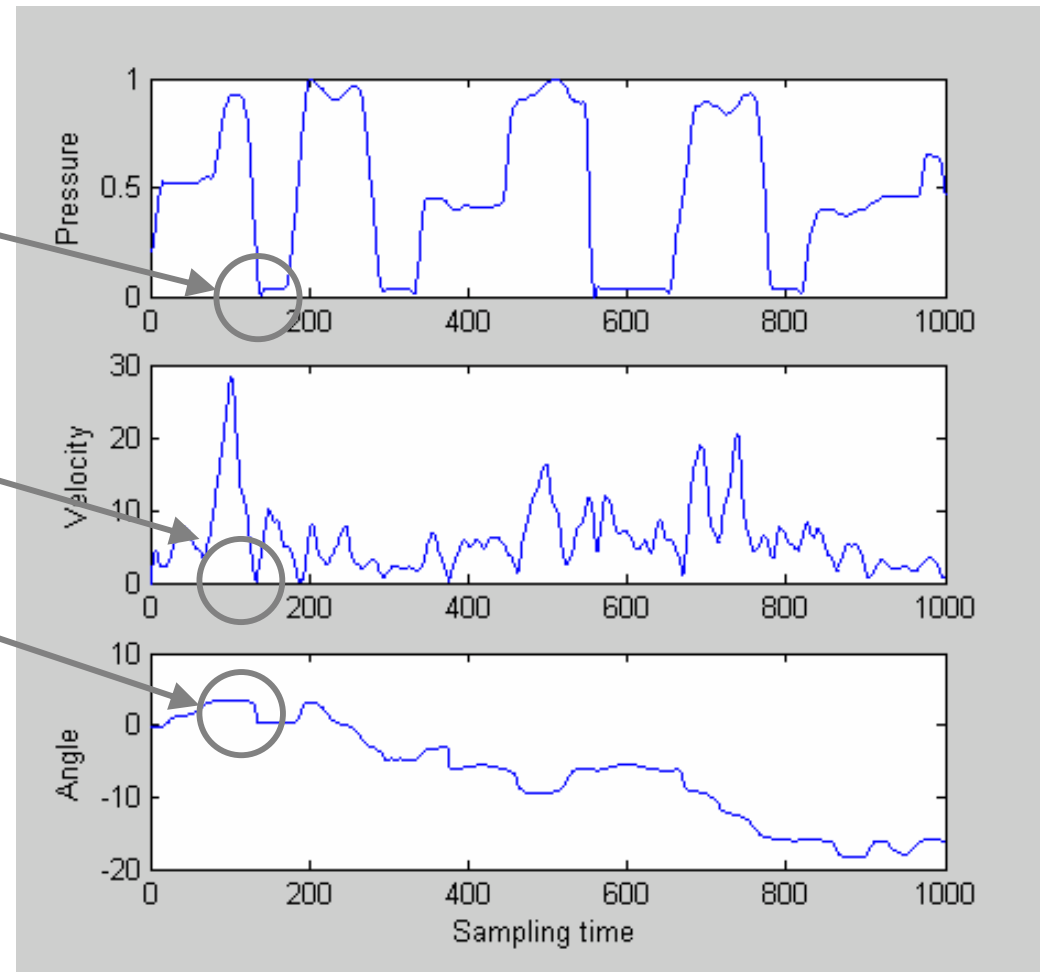
3. Feature Extraction Methods



Stoke Based Feature Extraction

1. Identify stroke boundaries

- pen tip pressure ≈ 0
- pen velocity ≈ 0
- rapid change in pen angle



Stroke Based Feature Extraction

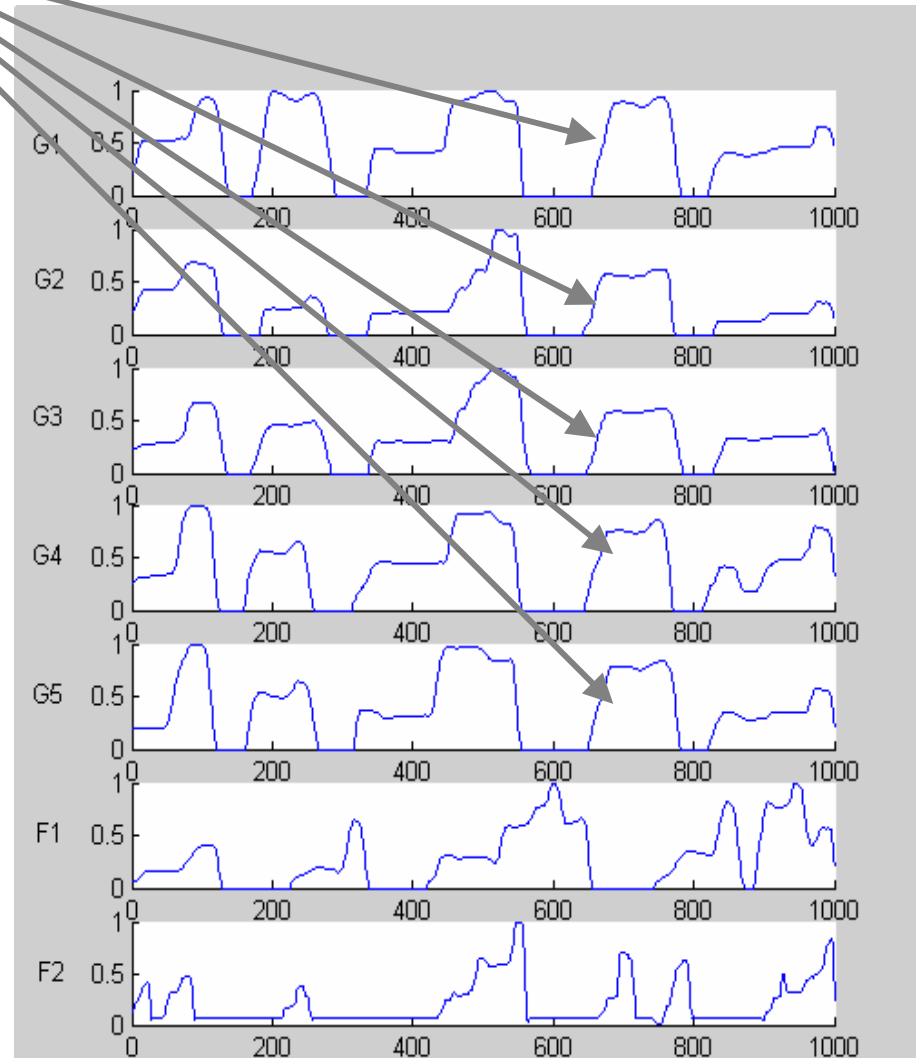
Significant stroke

2. Find significant stroke

- Correspondence matching
- Maximum correlation values w.r.t reference signatures

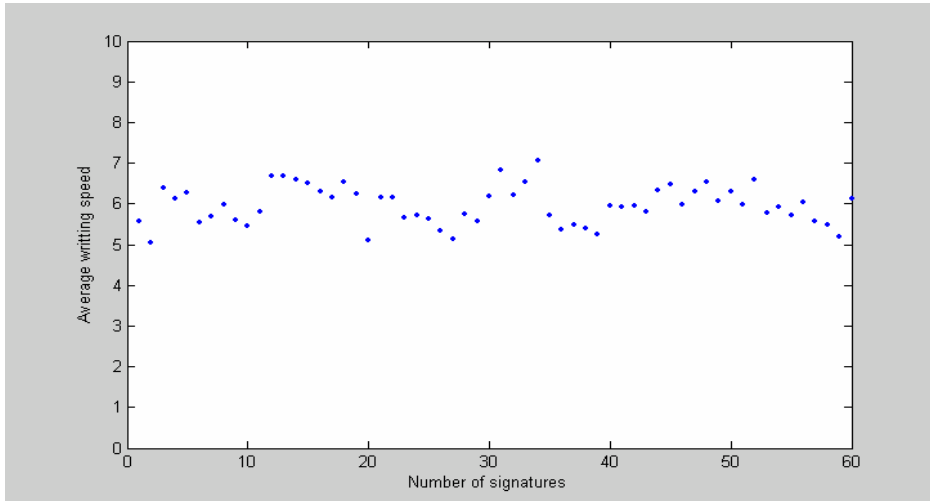
3. Extract features from significant stroke

- Correlation values
- Stroke duration
- Stroke length
- ...

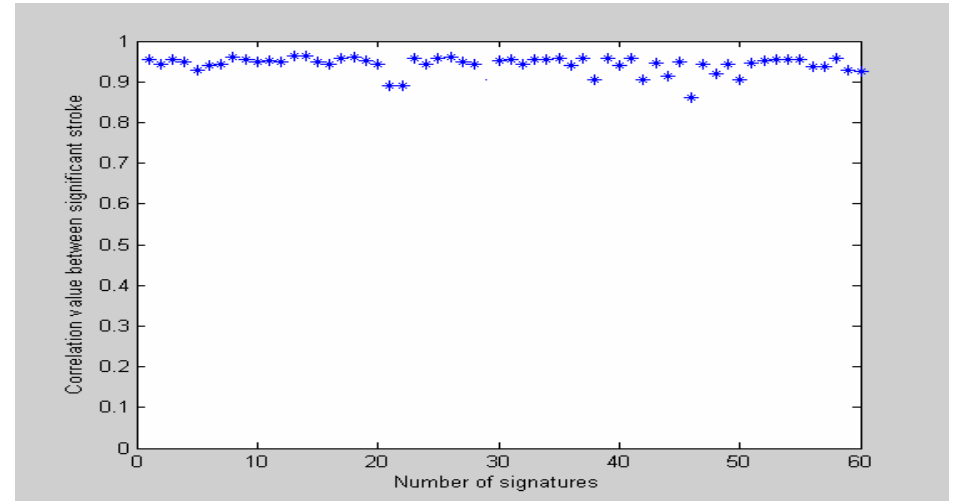


Stroke-based normalized pressure vs. time

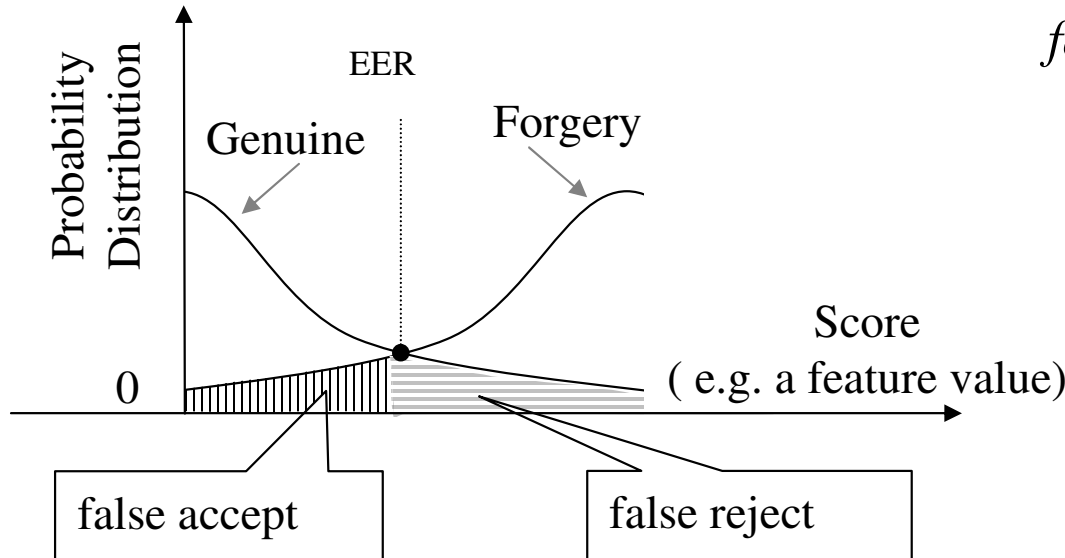
4. Feature Distribution for Signature Verification



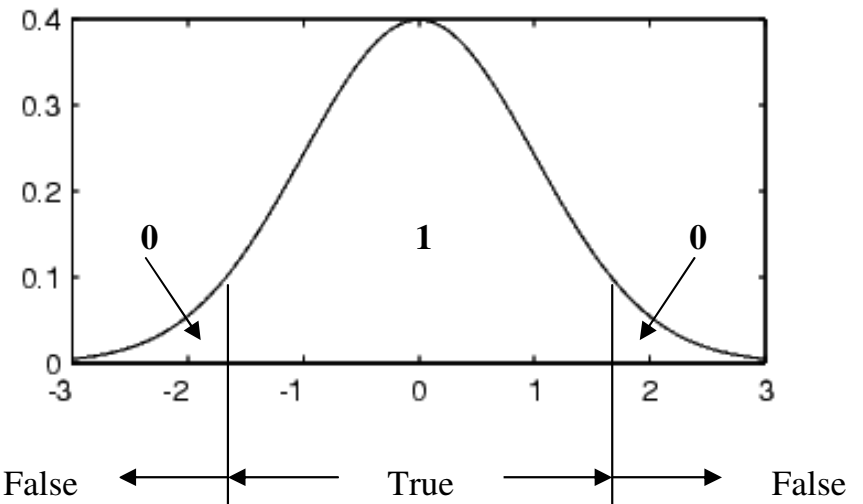
Average writing speed for a set of signatures



Correlation value of significant stroke for a set of signatures



Gaussian distribution for a person's genuine signature and forgeries



Binary representation of signature verification (1 – genuine, 0 – forgery)

5. Signature Verification Experiments

Experiment 1

- # of volunteers : 10
 - # of signatures: 110
 - Training set : 50 signatures
 - Test set: 60 signature
- Objective: To compare the effect of non-stroke based features with stroke based features when they apply in a verification system

4 best non-stroke based features

- Average writing speed
- Total time during the signing process
- Var_pressure in 10 sliding windows
- Mean_x_displacement in 100 windows
- ...

Stroke based features

- Correlation coefficient for the pressure significant strokes
- Time duration for velocity significant stroke
- ...

FRR and FAR comparison

	False Reject Rate (FRR)	False Accept rate (FAR)
4 feature based system (without stroke features)	30%	46.67%
6 feature based system (with stroke features)	6.67%	13.33%

5. Signature Verification Experiments

Experiment 2

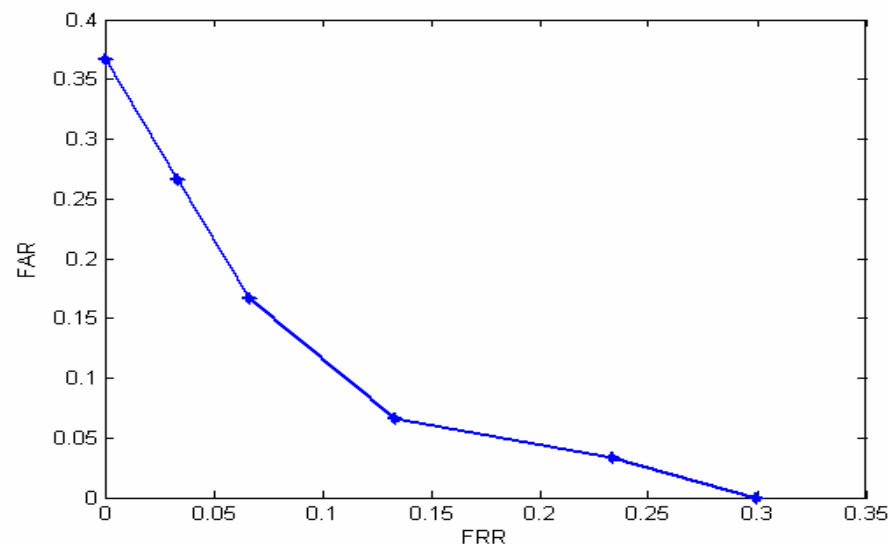
- # of volunteers : 10
- # of signatures: 180
- Training set : 120 signatures
(60, 20 and 5 signatures)
- Test set: 60 signature
- 6 features based system

Experiment 3

- # of volunteers : 10
- # of signatures: 55
- Training set : 25 signatures
- Test set: 30 signature
- 6 features based system

Results

- FRR of 3.33% < 6.67% in Exp. 1
- FAR of 6.67% < 13.33% in Exp. 1
- A large training set get better performance
- Smaller training sets don't have high cost



FRR and FAR tradeoff curve on variable thresholds

5. Signature Verification Experiments

Dynamic Signature Verification Using Stroke Based Feature Extraction Algorithm

File Edit View Insert Tools Window Help Control Manual

User Interface for Dynamic Signature Verification Using Stroke Based Feature Extraction Algorithm

Procedure:

- 1) User sign several signatures;
- 2) Show training signals;
- 3) Another user input signature;
- 4) Show test signal;
- 5) Comparison;
- 6) Check;
- 7) Clear test block;
- 8) Next user.

Signal Block
Blue - Template signature
Red - Current signature

Sample Dynamic Signature
Blue - pressure values
Red - pen lifted up from the pad surface

Feature Block
Dot - Reference signatures
Circle - Current signature

Signals

Template Signal

Current Signal

Right

000---RIGHT---000

OK

Features

Reference Features

Current Feature

Checking

Clear

MCR Lab
Multimedia Communication
Research Lab
University of Ottawa
Ottawa, ON, CANADA
<http://www.mcrlab.uottawa.ca>

VIVO Lab
Video Image Vision
Audio Lab
University of Ottawa
Ottawa, ON, CANADA
<http://www.site.uottawa.ca/school/research/vivo/>

6. Conclusions and future work

Conclusions

- A novel stroke based feature algorithm
- A DSV system was successfully designed, developed, and tested
- Stroke based features improve accuracy
- Reduced 23.33% in FRR and 33.33% in FAR
- Larger training sets perform better
- A FRR and FAR tradeoff curve

Future work

- Bigger reference signature set
- More features
- Updated digital pad