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

- 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
  - …

- Dot Size
  - = pen pressure

- Circle
  - = lifted pen
System Architecture

Dynamic Signature Verification System

Data Acquisition

- Sensors
- WINTAB API (Measure data at Serial port)
  - Raw Data
  - Preprocessing
    - Input Module
    - Signature Preprocessing

Signature Verification

- Classifier (Compare the test signature with template)
- Signature template database
  - Test
  - References
  - Output verification results

Feature Extraction

- Feature Extractors
- Output Module

Output verification results
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

Feature extraction system

Data acquisition system

Time Domain Feature Extraction
Frequency Domain Feature Extraction
Distribution Feature Extraction

Selected Features

Signature Verification System

Selected Features
1. Identify stroke boundaries

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

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

- **Gaussian distribution** for a person’s genuine signature and forgeries

**Graphs:**
- **Average writing speed for a set of signatures**
- **Correlation value of significant stroke for a set of signatures**

**Score** (e.g. a feature value)

- **EER**

- **Genuine**

- **Forgery**

- **false accept**

- **false reject**

**Probability Distribution**
5. Signature Verification Experiments

Experiment 1

- # of volunteers: 10
- # of signatures: 110
- Training set: 50 signatures
- Test set: 60 signatures
- 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
- …

5 best stroke based features

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

FRR and FAR comparison

<table>
<thead>
<tr>
<th>System Description</th>
<th>False Reject Rate (FRR)</th>
<th>False Accept rate (FAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 feature based system (without stroke features)</td>
<td>30%</td>
<td>46.67%</td>
</tr>
<tr>
<td>6 feature based system (with stroke features)</td>
<td>6.67%</td>
<td>13.33%</td>
</tr>
</tbody>
</table>
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
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