Automatic Identification of Participants in Haptic Systems

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Agenda

- Introduction
- Haptics-Biometric Systems
- Approach
- Results
- Conclusions and Further Work

Introduction

Authentication Systems

- Something that you have (e.g., key)
- Something that you know (PIN)

Biometrics Systems

– Allow identification of individuals

- Something that you are/do

- Iris Recognition
- Voice Recognition
- Face Recognition
- Fingerprint

Haptics Systems

– Introduce the complex sense of touch, force and hand kinaesthetic in human-computer int

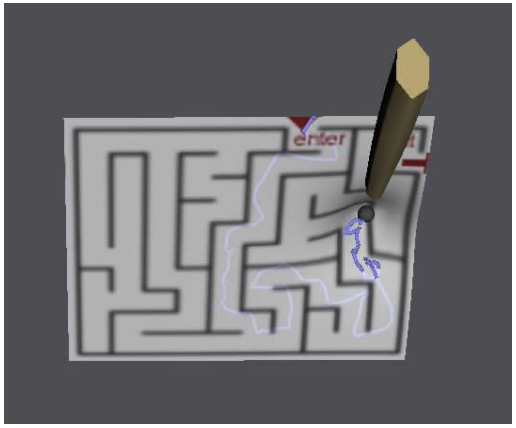
Can we authenticate using haptics?

- Exploring the feasibility of automatically identifying participants using haptic systems
- It would lead to important and interesting applications (e.g control access in haptic systems)
- Propose a research avenue for identification
- To explore the user's behaviour

Methodology

- Data Acquisition
  - Haptic-based applications
  - Simple maze solving experimentation
- Analysis:
  - First Degree Statistics
  - Dynamic Time Warping
  - Spectral Analysis

Data Acquisition



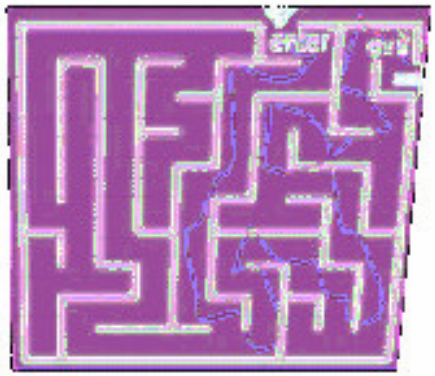
- Haptic-Based Application
- Description:
  - 3D Elastic Membrane Maze solving process
- Software:
  - Python-VRML/Reachin API implementation

Hardware:

- Reachin Display system
  - Phantom, Display and Stereo-glasses

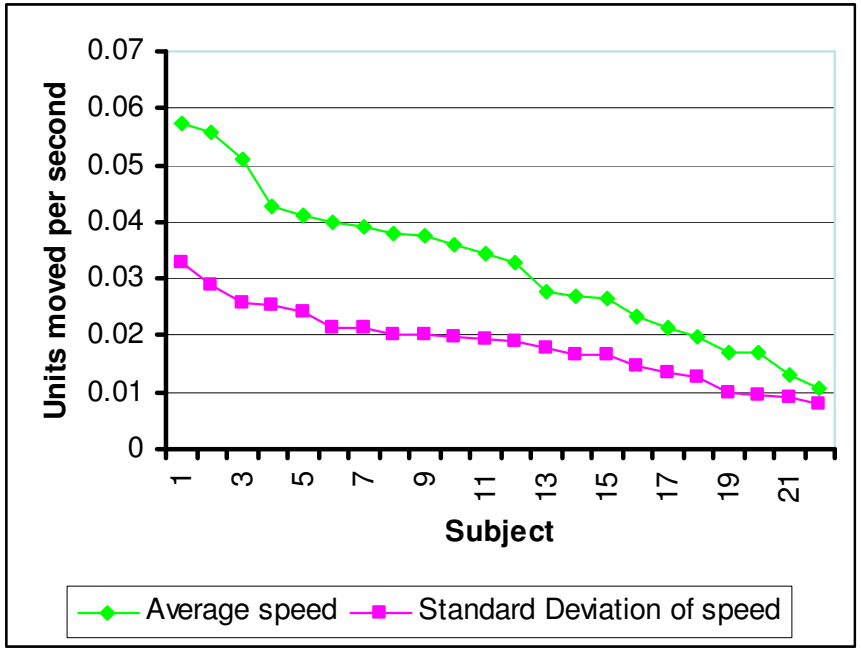
Experiment

- To construct a Haptic maze on an elastic membrane
- User is asked to navigate the stylus through the maze
- Each person performed exactly the same maze 10 times.
- A group of 22 volunteers took part in the experiment



First Degree Statistics

- Each subject's comparable positions through the maze were evaluated
- Velocity was calculated in pixels/per second
- Velocity was relatively steady for most of the subjects
- Subjects with higher stylus speed showed different acceleration values.

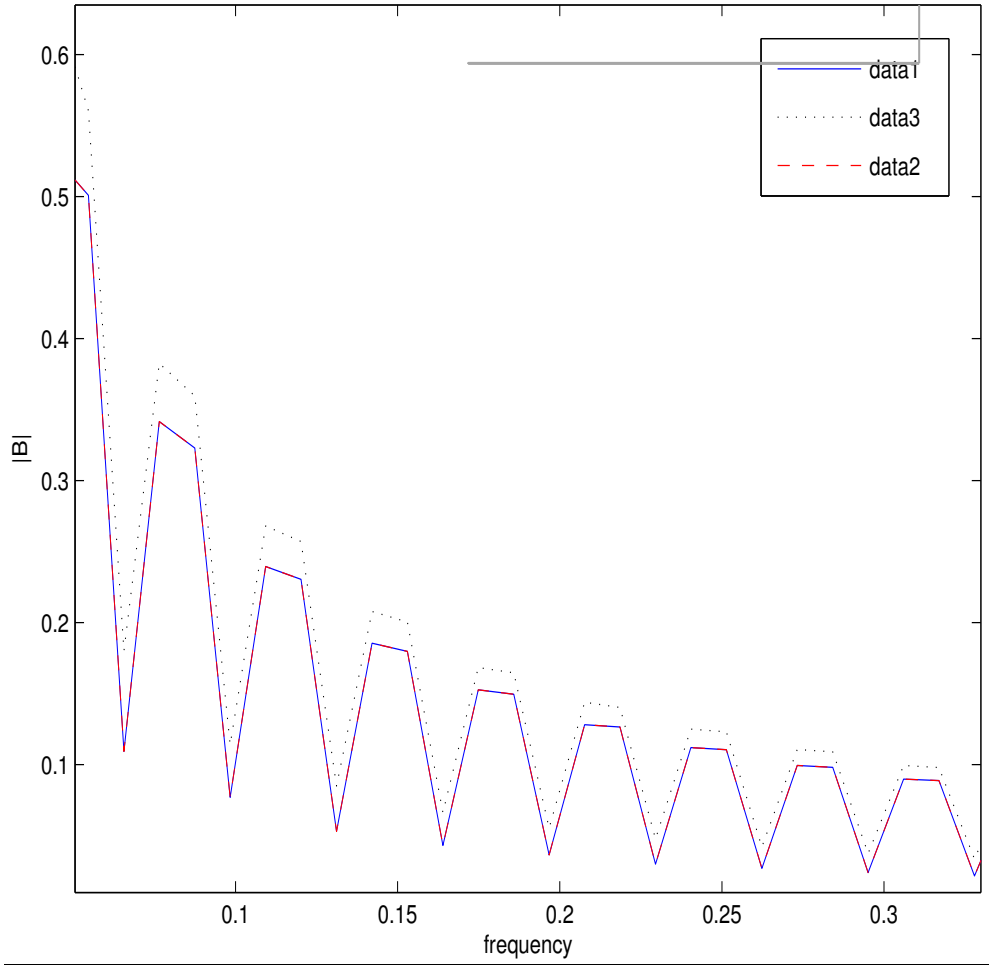


Analysis : Dynamic Time Warping

- Dynamic time warping analysis creates a match score (MS) of two data sets d^1 and d^2
- Comparing their respective strokes; i.e. changes in direction on the 2D plane.
- This technique is used for false rejection rate and false accept rate (FRR/FAR) calculations

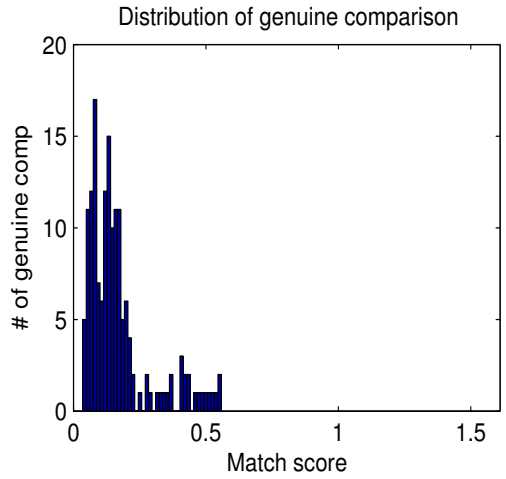
Spectral Analysis

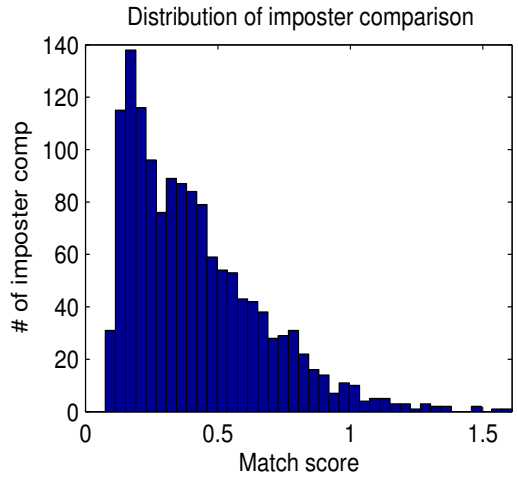
- The frequency spectrum of the 3D position data is analyzed
- Based on windowed discrete time Fourier transform.
- $data_1$ and $data_2$ are from the same user and $data_3$ from different user

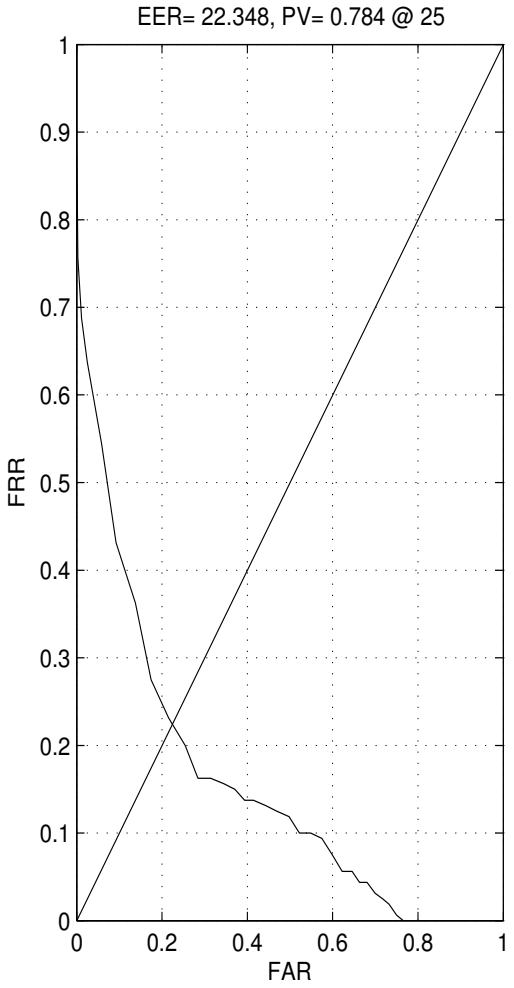


Results

- To quantify the performance of the proposed algorithms:
  - Standard verification analysis was applied
- A Probability Verification(PV) of 78.8% at 25% FAR
- Equal Error Rate (EER) stands at 22.3% with a threshold MS of 0.195







Conclusions and Further Work

PV	Training Effect	
	With	Without
Time Warping	49.0%	60.1%
Spectral Analysis	67.6%	78.8%

- We have investigated the possibility of automatic identification in Haptic systems
- Results are mixed. Basic analysis appears to show a relatively low PV.
- On the other hand further analysis appears to show improvements in