Continuous Biometric Authentication in Haptic Users

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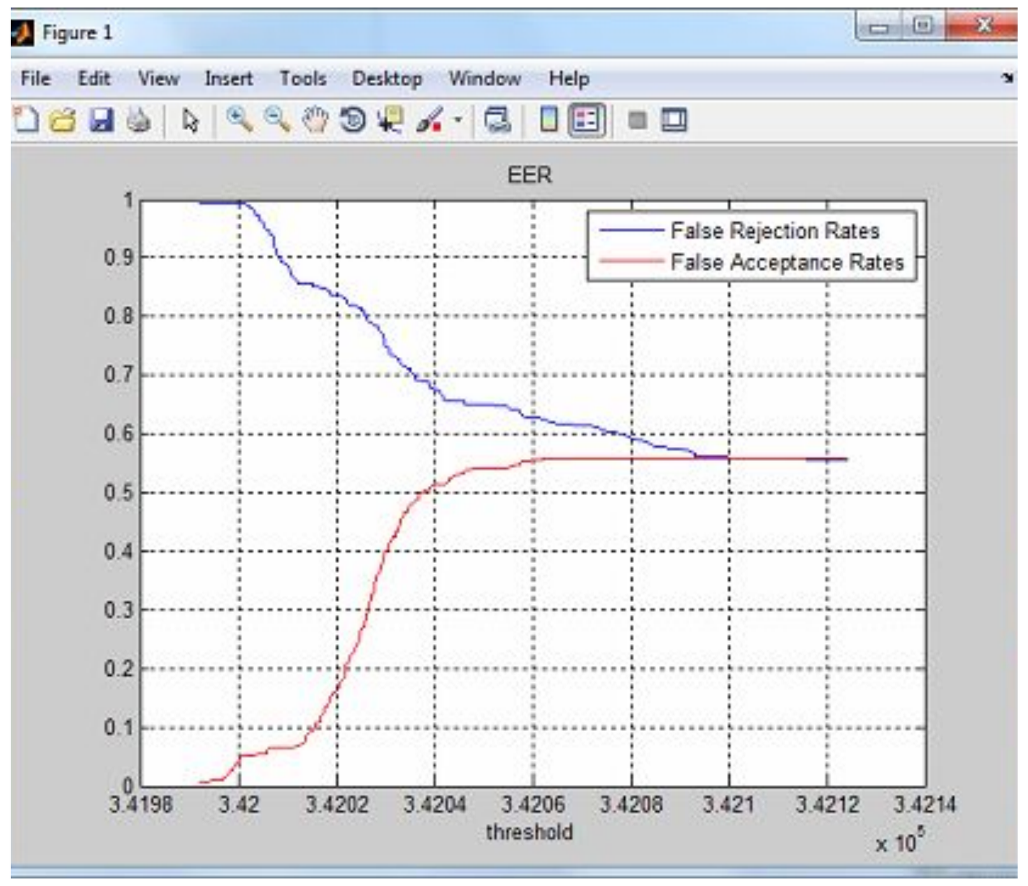
INTRODUCTION

Over the last few decades there has been an increase in the amount of companies using technology as a method to perform critical task. With that, comes a stronger push to have the best methods to authenticate users performing those critical task. Password authentication such as pins and alphanumerical are common methods of securing networks, but are more prone to fraudulent attacks. [3] Another method of authentication that is being seen more is using behavioral biometrics for user authentication.

Our research focuses on the type of behavioral characteristics that would be most beneficial to determine if a user is authentic or not. By using a GeoMagic Omni haptic device, we ran an experiment that extracted a set of features that are potentially unique to individuals and tested their equal error rate. Our goal is to get the EER as low as possible by removing and adding features based on their uniqueness, independence, and potential to reduce noise.

BACKGROUND

Graphing the equal error rate (EER) is commonly used in this field of research to quantify the accuracy of a given biometric authentication system. The graph plots the false rejection rate (FRR), against the false acceptance rate, (FAR). The intersection of those two curves is what is known as the equal error rate.
The closer the EER is to zero, the more accurate the system is when authenticating users. In order to reduce the EER, it is important to use features that are unique among users.



EXPERIMENT SET-UP

Experiment:

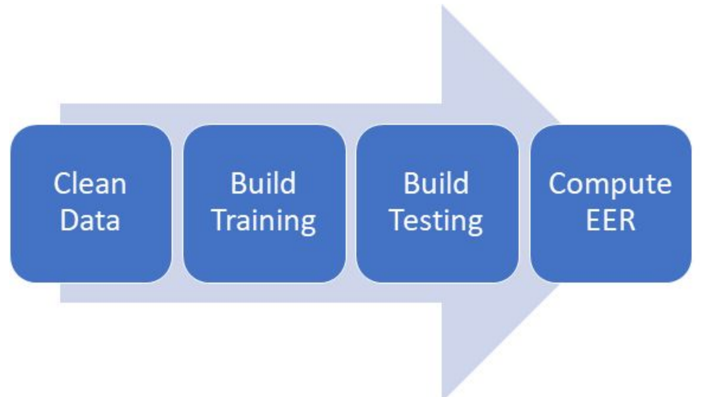
- Data collected from 32 users in 10 trials
- 5 tasks using a Omni haptic device [1]
  - Identify surface texture on plane
  - Identify surface texture on shape
  - Identify shape etched into plane
  - Stack blocks using one haptic pen
  - Stack blocks using two haptic pens
- Lowest EER was 43.08%

Training & Testing:

The training script imports processes from each defined session into a matrix. Based on a defined threshold it categorizes the haptic interaction between probe and stroke events. The testing script works an in the same fashion as the training. Additionally, the output file from the training script will have one row per user since all of their features are averaged out. The standard deviation is then calculated to obtain to false acceptance and false rejection rate.

Scripts:

These Four Scripts ran in a sequence to obtain the Equal Error Rate of the features.



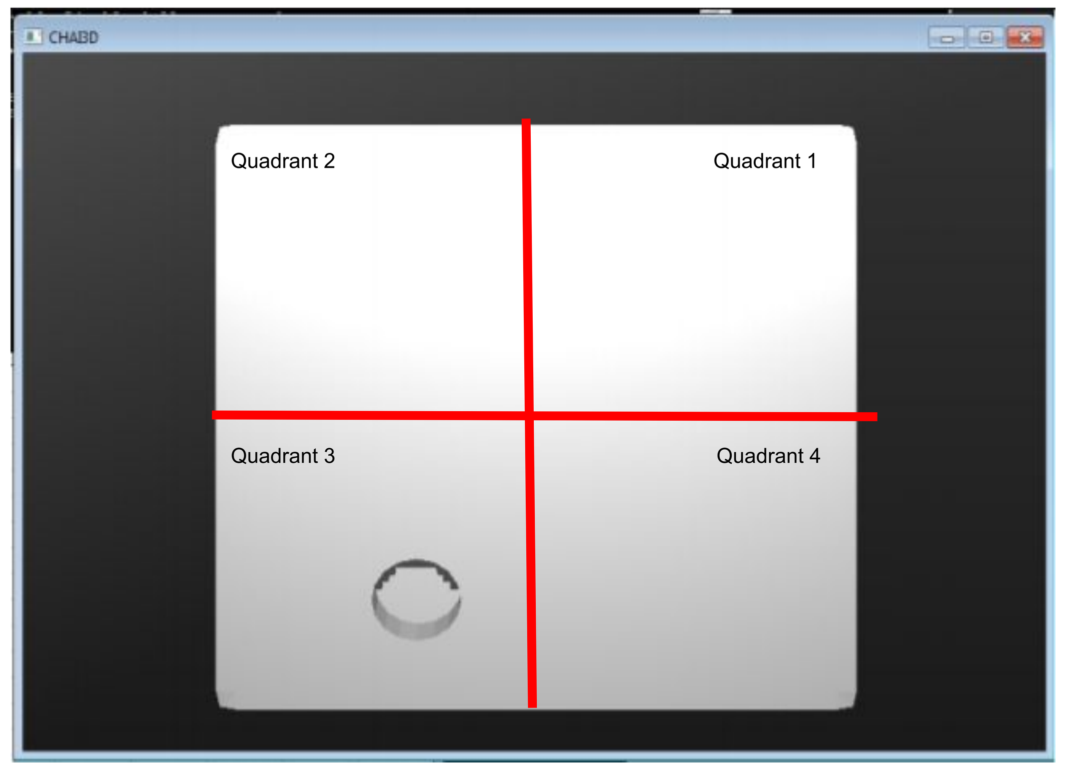


Fig. 1 Etched circle in a flat plane. This is the experiment the data was extracted from.

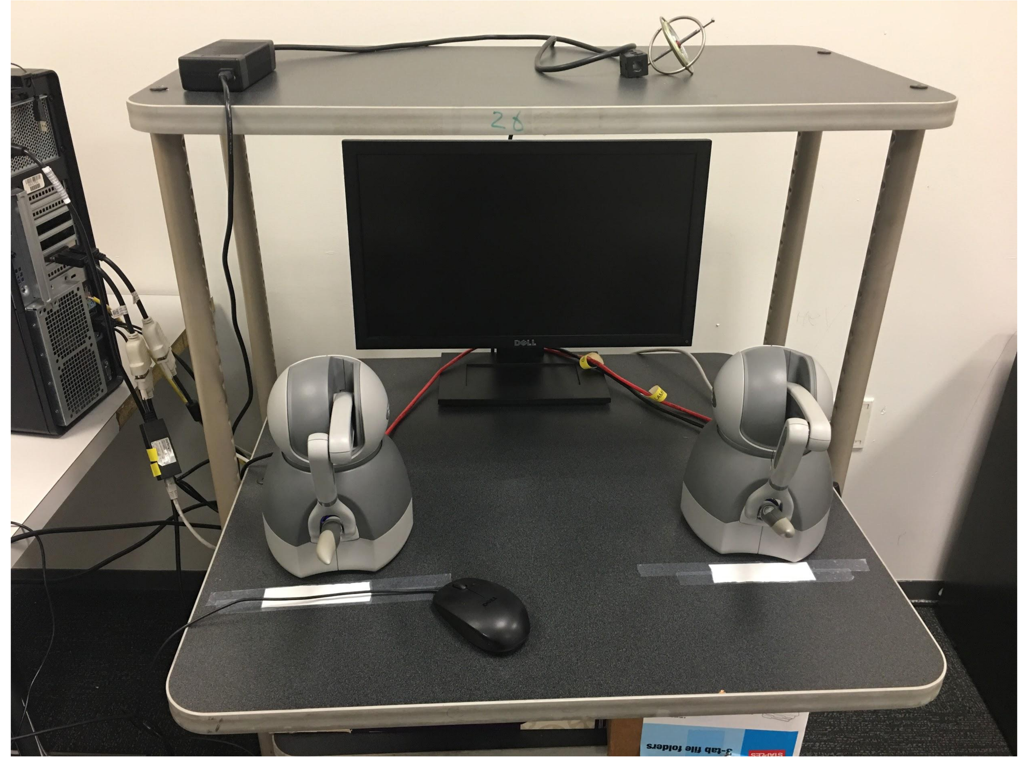


Fig. 2 GeoMagic Omni Haptic Device

RESULTS

The standard deviations of each feature represent how much the values of each feature vary. We believe that the higher the variance of a given feature, the more helpful it may be in the authentication process. Thus, we propose the following changes to the weights of the features used: increase the weights of mean angular velocity in the Z plane, mean time, and mean stroke length. We also propose decreasing the weights of the following features: mean stroke proxy, mean velocity, and starting and ending position. Furthermore, we optimized the training script and reduced the runtime by 1.8%, or 8 minutes.

Feature	Standard Deviation
Mean Angular Velocity Stroke 3 Z	8506.185
Mean Time Stroke 4	8173.805
Mean Time Stroke	6830.935
Mean Time Stroke 3	5407.829
Mean Time Stroke 2	5083.779
Mean Angular Velocity Stroke 4 Z	4765.666
Mean Stroke Length 2	3545.826
Mean Angular Velocity Stroke Z	2700.853
Mean Angular Velocity Stroke 2 Z	2124.393
Mean Stroke Length	1721.402

Table 1: Top 10 Standard Deviations of Features

CONTINUOUS AUTHENTICATION

Continuous Authentication:

- Continuous Authentication allows for a user to be authenticated consistently throughout a session. It can be accomplished in both physical and behavioral biometrics, but the latter has been the focus of this research. [4]

Qualifications of a Biometric Feature:

- The four core qualifications needed for a feature to be regarded as a biometric are: universality, distinctiveness, permanence, and collectability [2]
- In addition to the four core qualifications, a biometric feature is regarded as practical if it contains these additional qualifications: performance, acceptability, and circumvention

Potential Features: Position, force, angular and linear velocity, gripper angle, and torque.

- The weights established for each of these features lowered the EER to 43.08%. By understanding which characteristics are most unique, we could potentially lower the EER more and extract those unique characteristic as additional features.

FUTURE WORK

- Adjust the weights of different characteristics to obtain a lower equal error rate
- Determine which characteristics would potentially be good features based on uniqueness, independence and other factors
- Further optimization of existing scripts and functions to decrease the time needed to run the pipeline

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