



Biometric Rich Gestures:

A novel approach to authentication on multi-touch devices

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The Netherlands

Kaspersky® **Academy**

IT Security

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Motivation

The number of privacy sensitive applications on iPhone and other computing devices has increased.

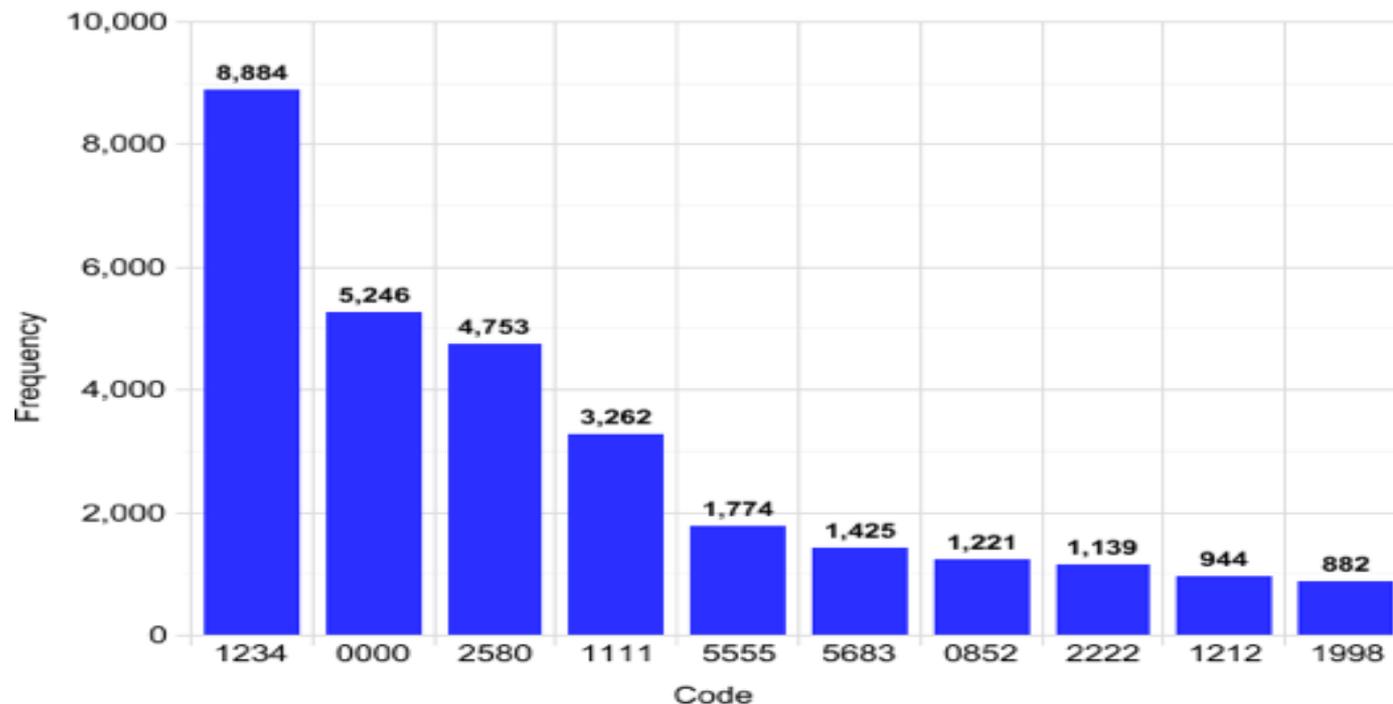


Text password

Problem: Weak passwords are being chosen by the users

(out of 204,508)

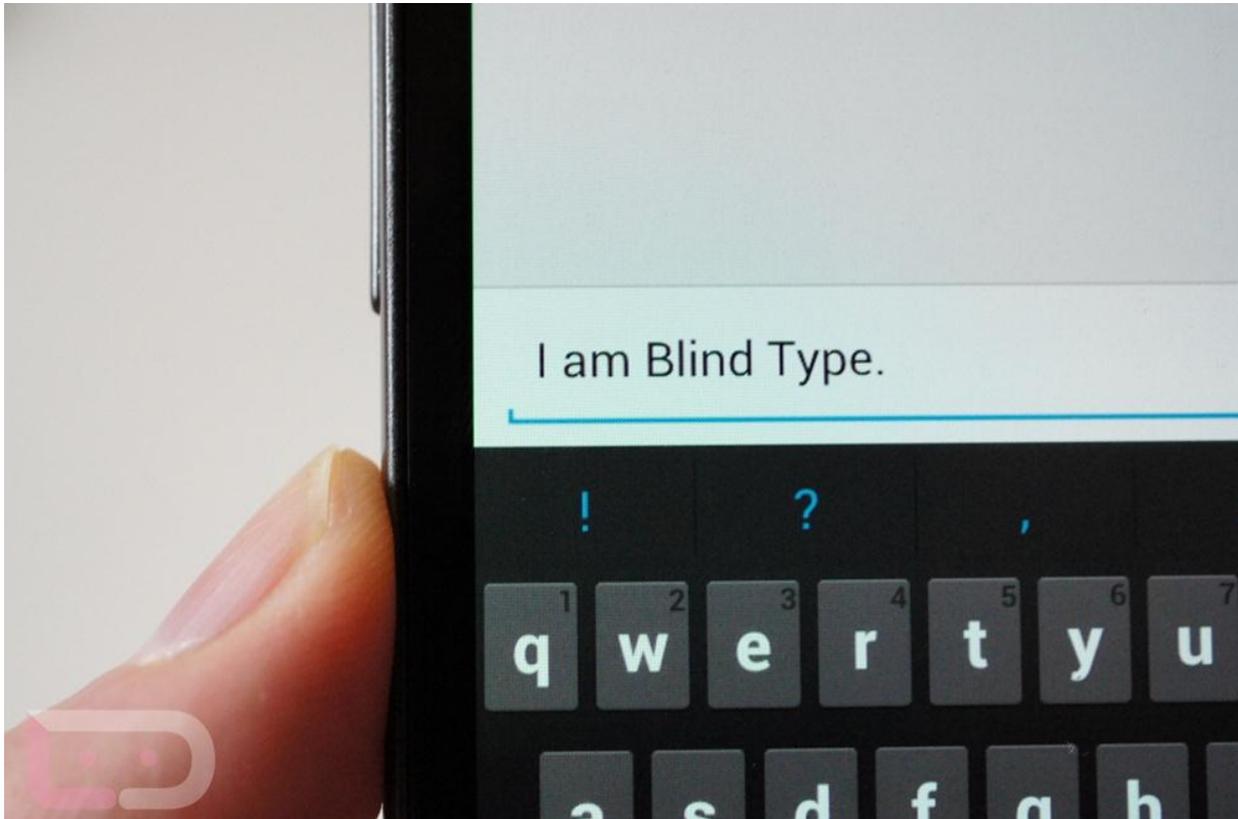
Most Common Passcodes



▶ Ref: <http://www.i-programmer.info/news/149-security/2668-passcodes.html>

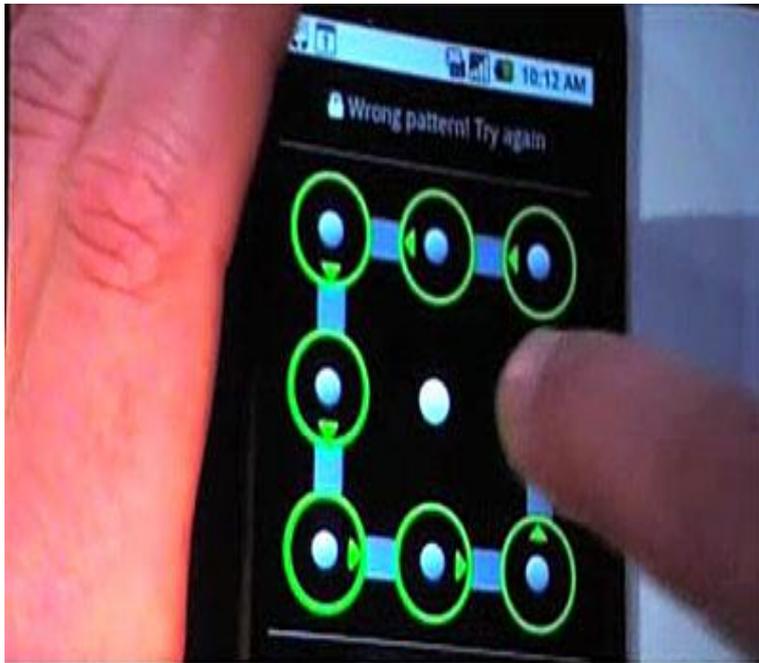
Text password on touch surface

Problem: Password is getting harder to enter on touch keyboard.



Password alternative on touch surface

Pattern Lock scheme by Android



Steve Horowitz, Engineering Director, Google
(c) 2008, UberPulse.com

Picture Password by Microsoft



Password on shared space



Ref: http://i4.asntown.net/Microsoft_Surface_displayinch_multi_touch_screen_w-tur9.jpg

Multi-touch gestures

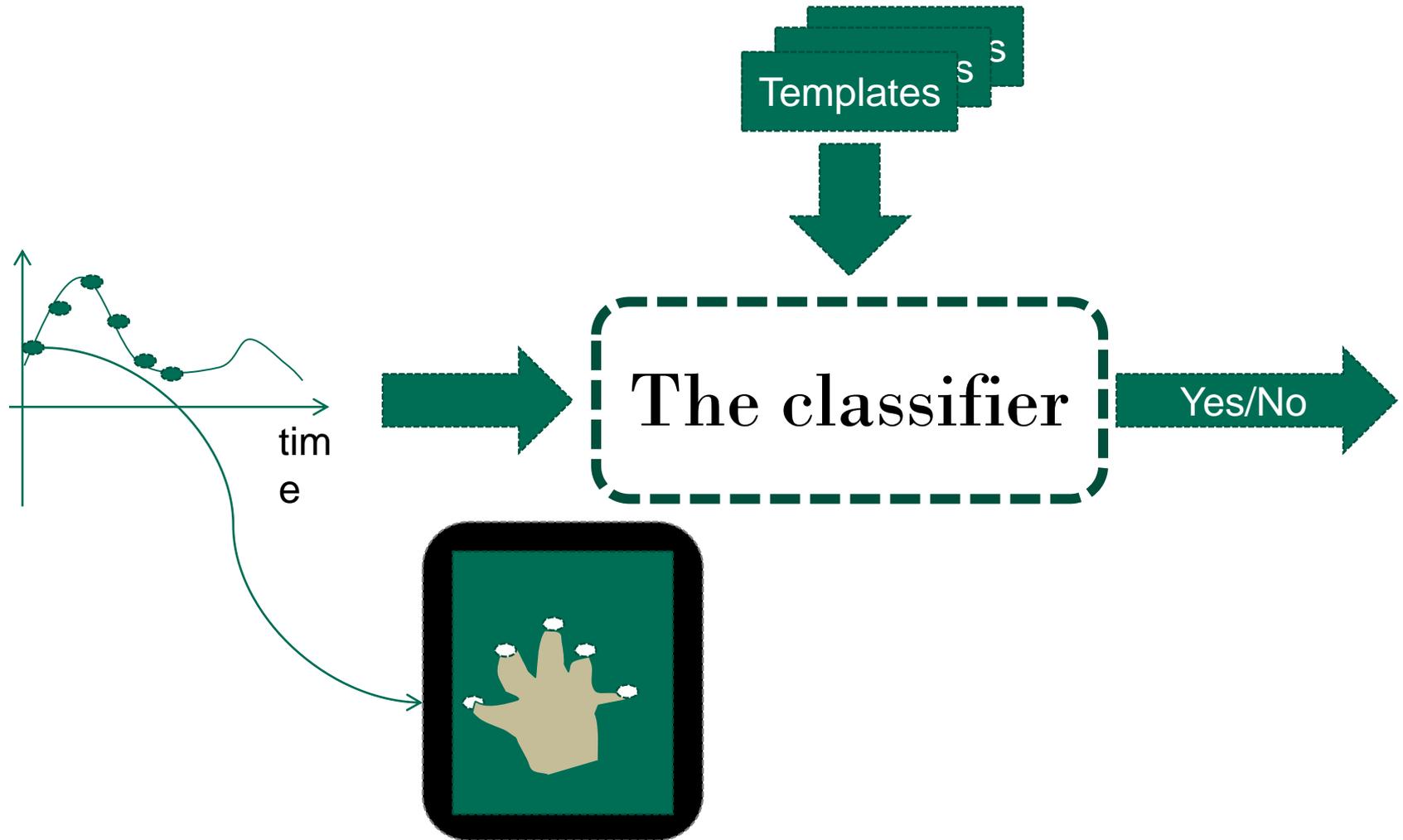


Multi-touch gestures

Q: How much biometric information can we derive from this modality?

Q: How do users feel about this modality? How does the security align with the usability?

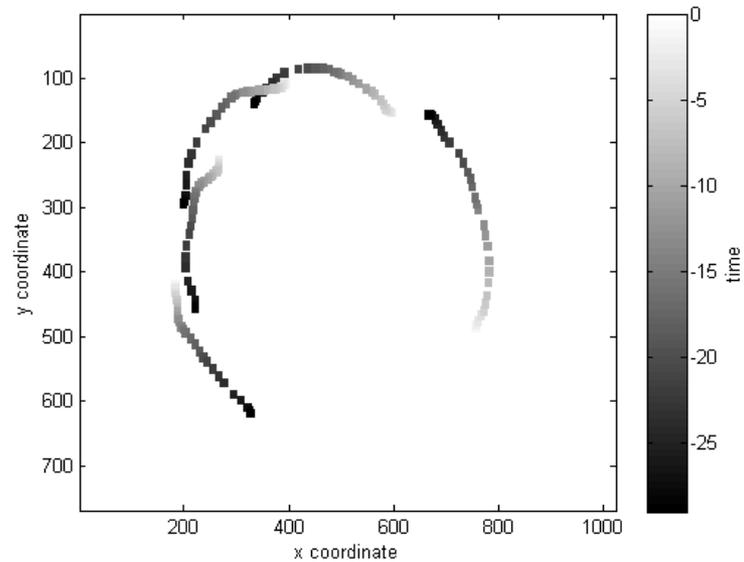
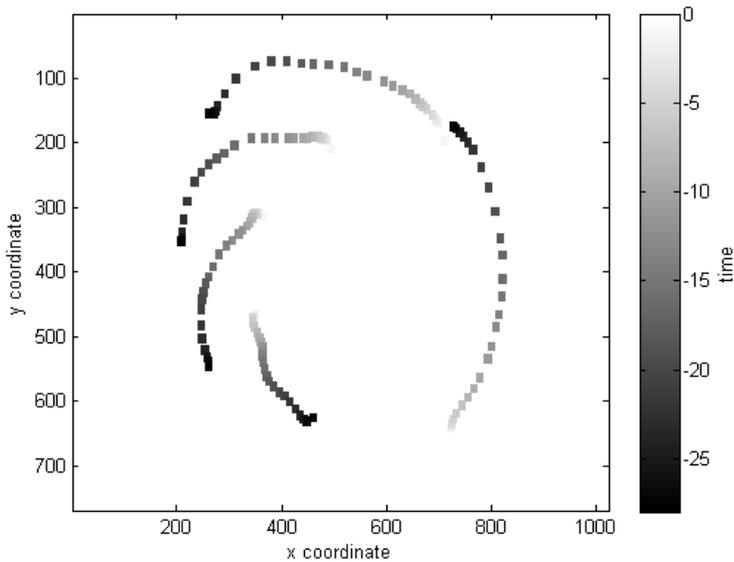
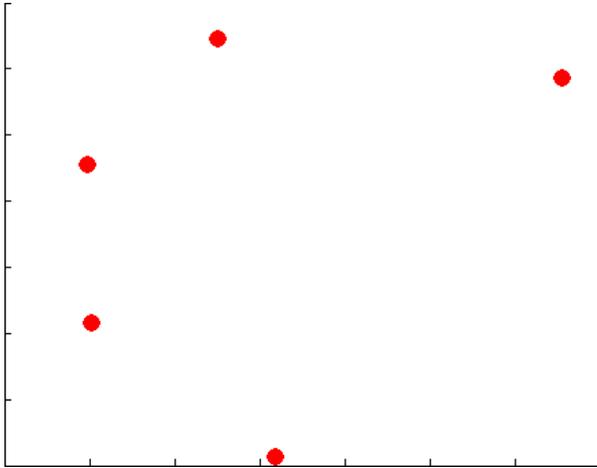
A multi-touch verification system



Biometric Distance

High Level Features:

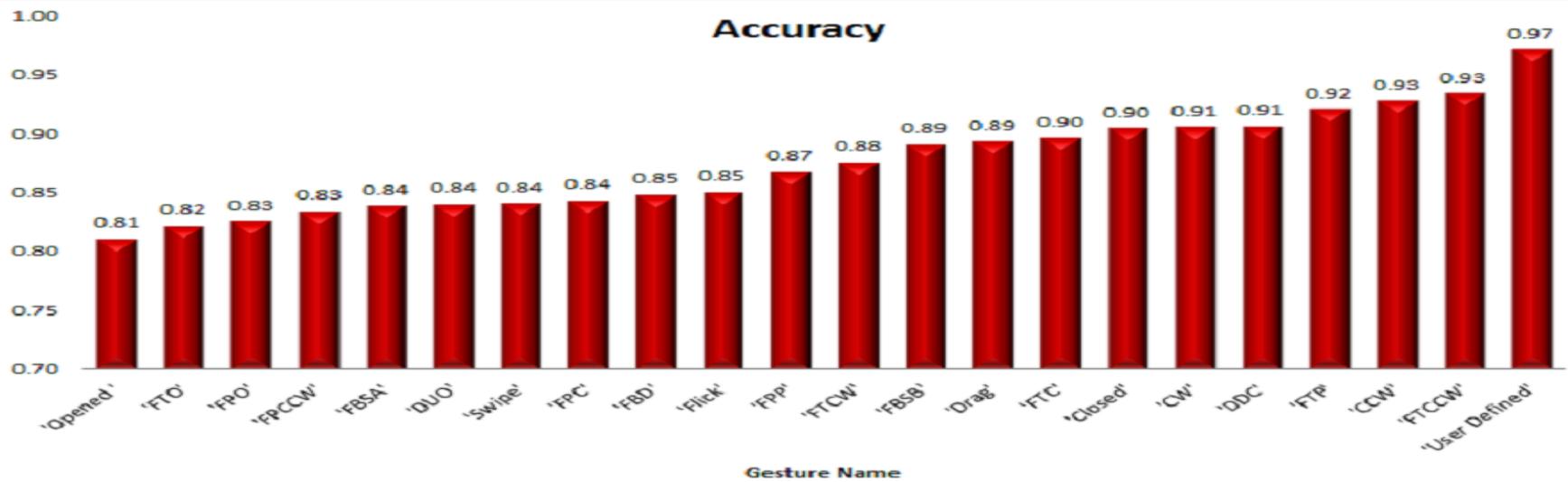
1. Speed
2. Hand size
3. Distances between the finger
4. Path vector
5. Relative path vector



The set of multi-touch gesture

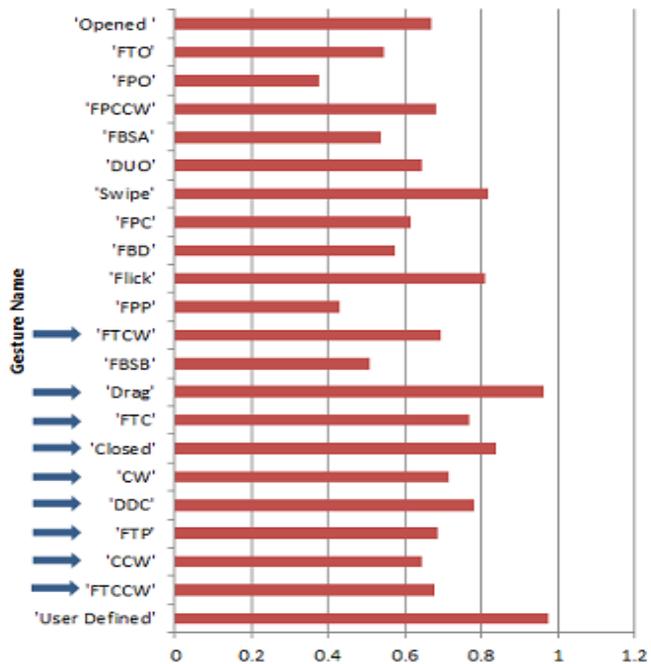
| Annotation | Palm movement | Fingertip movement | Dynamic fingertips | # of subjects |
|------------|---------------------|--------------------|-----------------------|---------------|
| 'CCR' | Static | Circular(CCW) | All | 32 |
| 'CR' | Static | Circular(CW) | All | 33 |
| 'Closed' | Static | Close | All | 34 |
| 'Drag' | Dynamic(↓) | Parallel | All | 33 |
| 'DDC' | Dynamic(↘) | Close | All | 33 |
| 'DUO' | Dynamic(↖) | Open | All | 30 |
| 'FBD' | Static | Parallel(↓) | Fixed thumb and pinky | 30 |
| 'FBSB' | Static | Parallel(⟨ shape) | Fixed thumb and pinky | 26 |
| 'FBSA' | Static | Parallel(⟩ shape) | Fixed thumb and pinky | 27 |
| 'FPCCR' | Static | Circular(CCW) | Fixed pinky | 28 |
| 'FPC' | Static | Close | Fixed pinky | 31 |
| 'FPO' | Static | open | Fixed pinky | 26 |
| 'FPP' | Static | Parallel(↓) | Fixed pinky | 28 |
| 'FTCCR' | Static | Circular(CCW) | Fixed thumb | 30 |
| 'FTCR' | Static | Circular(CW) | Fixed thumb | 30 |
| 'FTC' | Static | Close | Fixed thumb | 31 |
| 'FTO' | Static | Open | Fixed thumb | 30 |
| 'FTP' | Static | Parallel(↓) | Fixed thumb | 30 |
| 'Flick' | Dynamic(↘) | Parallel | All(Quick) | 33 |
| 'Opened' | Static | Open | All | 34 |
| 'Scrawl' | Dynamic(Customized) | Parallel | All | 30 |
| 'Swipe' | Dynamic(→) | Parallel | All | 34 |

Accuracy

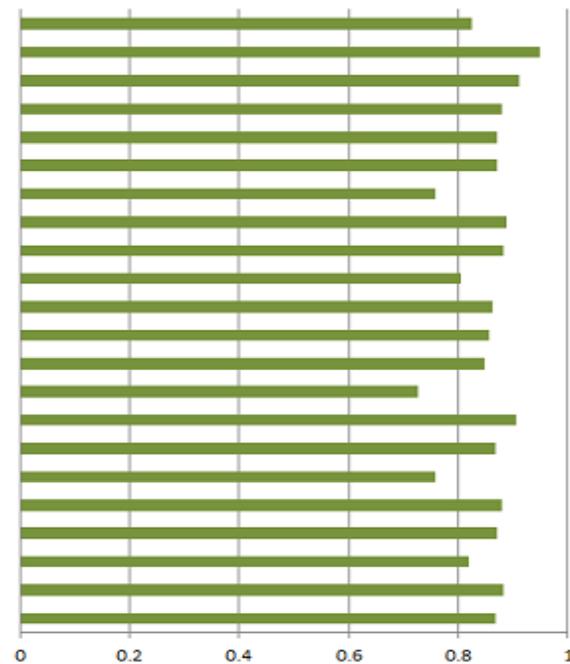


(a) Gesture Accuracy

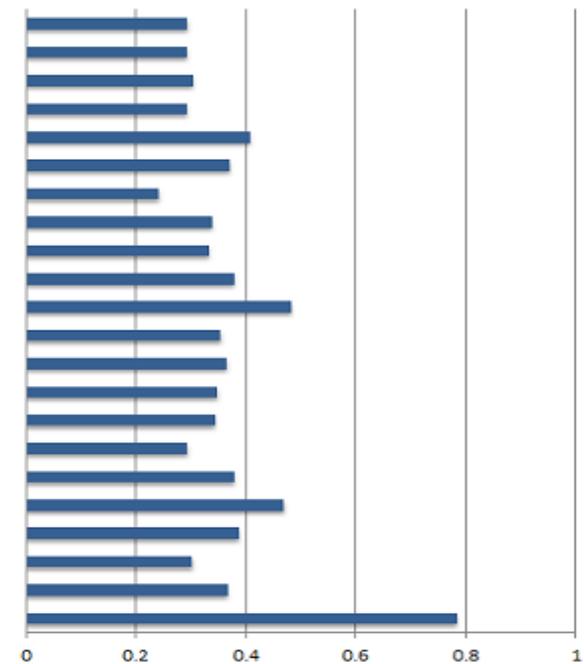
Ease of Use



Pleasure



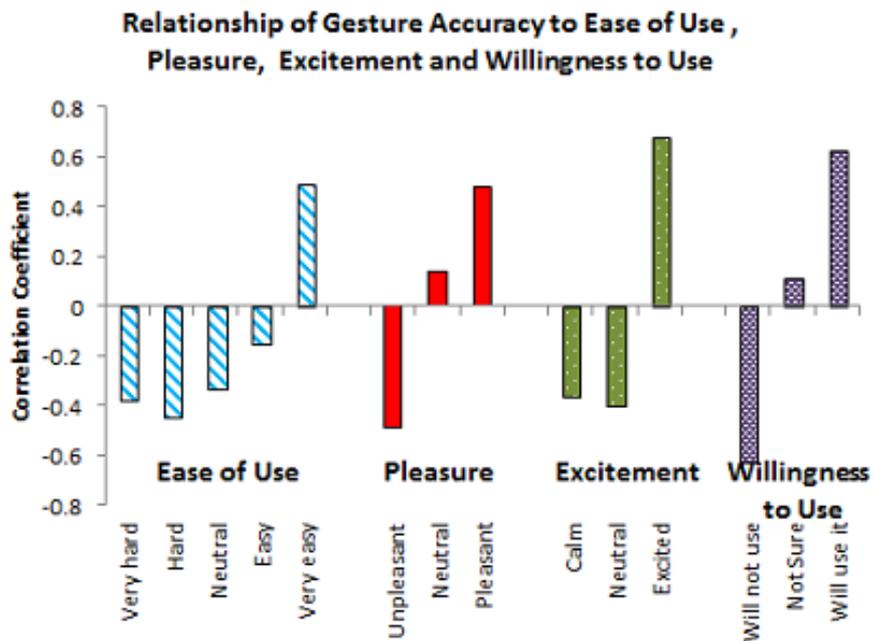
Excitement



(b) Self-reported user experience

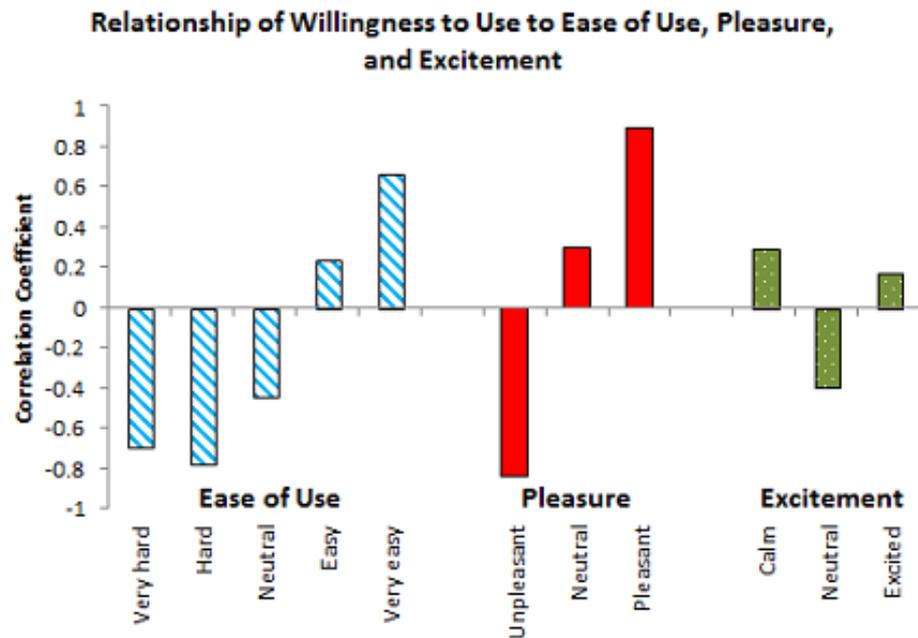
Gesture Response

Accuracy domain



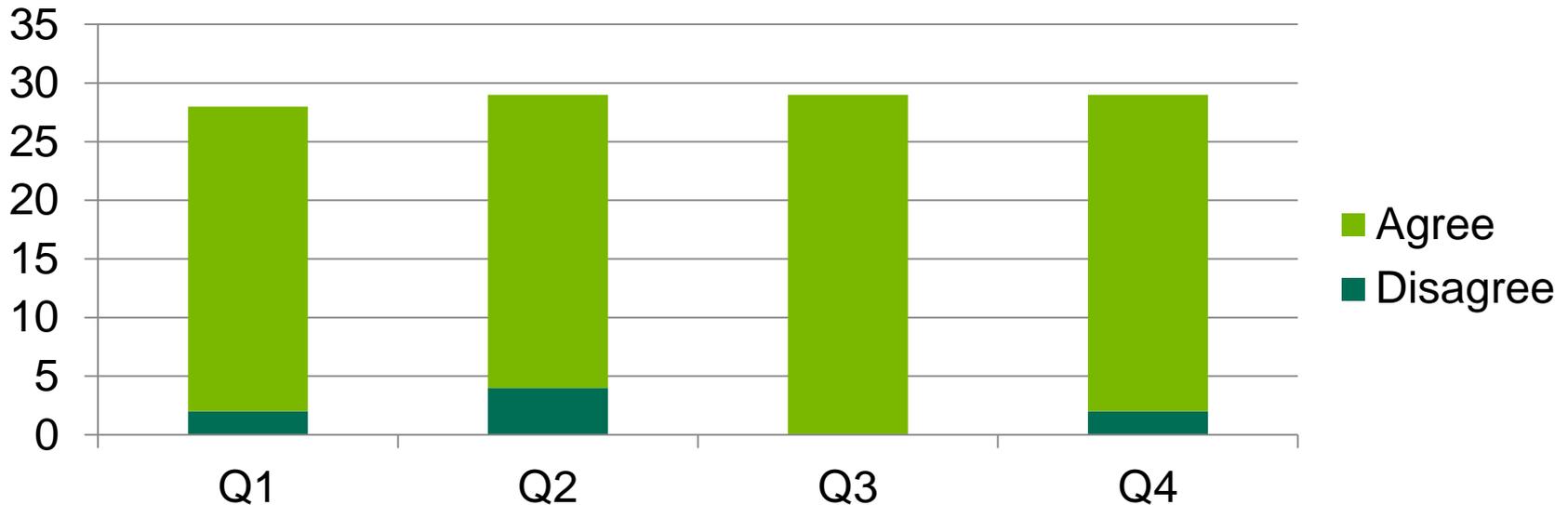
(a) Biometric Accuracy

Usability domain



(b) User Experience

Approach Response



Q1: 'Is gesture password easy to memorize?'

Q2: 'Would you prefer gesture password over text password?'

Q3: 'Would gesture password would be faster for you to use?'

Q4: 'With practice the gesture password would get easier to perform?'

Interesting Findings:

- **Individuals have their unique patterns of a multi-touch gesture that are algorithmically separable.**
- **The usability of a multi-touch gesture aligns well with its uniqueness.**
- **This result highlights the potential of the approach and encourages more researches to explore and expand the concept idea.**

Thank You

Napa Sae-Bae, Polytechnic Institute of NYU

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Scheme Response

'Why would you prefer it?'

'Because no one would be able to copy it and it would be natural. '

'No typing and easy to perform.', 'I don't like typing. '

'Its quicker and much cooler. '

'I will use both because it will be more secure. '

'Its simpler than text password. '

'Its faster. And it is also easy to forget text password. '

'Its more secure. I think gestures can also be copied easily like finger prints. '

'Its fast and cooler. ', 'Its cool and new.'

'That's what I am used to. And you have more possibilities for text password. '

'Because it can be customized and would be hard to copy. '

'Its easier to perform and harder to forget. '

'I have big fingers, so its hard for me to perform the gestures. '

'Its easy to memorize and hard to copy. '

'I don't have to write anything. '

'I think it would have better protection. '

'Its more secure. 'Harder to copy. '

'I don't wanna type on a tablet where there is no keyboard. '

'It would be more convenient. Its more advanced and I liked the technology. '

'If I share my tablet with someone else then I will use text password, if not then gesture password. '

'I have too many passwords to remember. So, I would prefer gesture password. '

'More complex. '

'I love to dance and this involves movements. So, I would like gestures password. And its not boring. '

'Do you have any other comments about gesture authentication?'

'I would like to see it happen. '

'**Note - He thinks this technology won't be good enough for authentication. '

'Good technology. Very practical. '

'Its interesting. Good technology. '

'Its good and new. '

'Its pretty cool. '

'I think its a good idea. The application should indicate on the screen if the user is performing the gesture correctly or not. '

'**Note - She thinks that some gestures won't be easy to perform even with more practice. Her age is above 60 years. '

'**Note - She liked CCW gesture the most. '

User Response

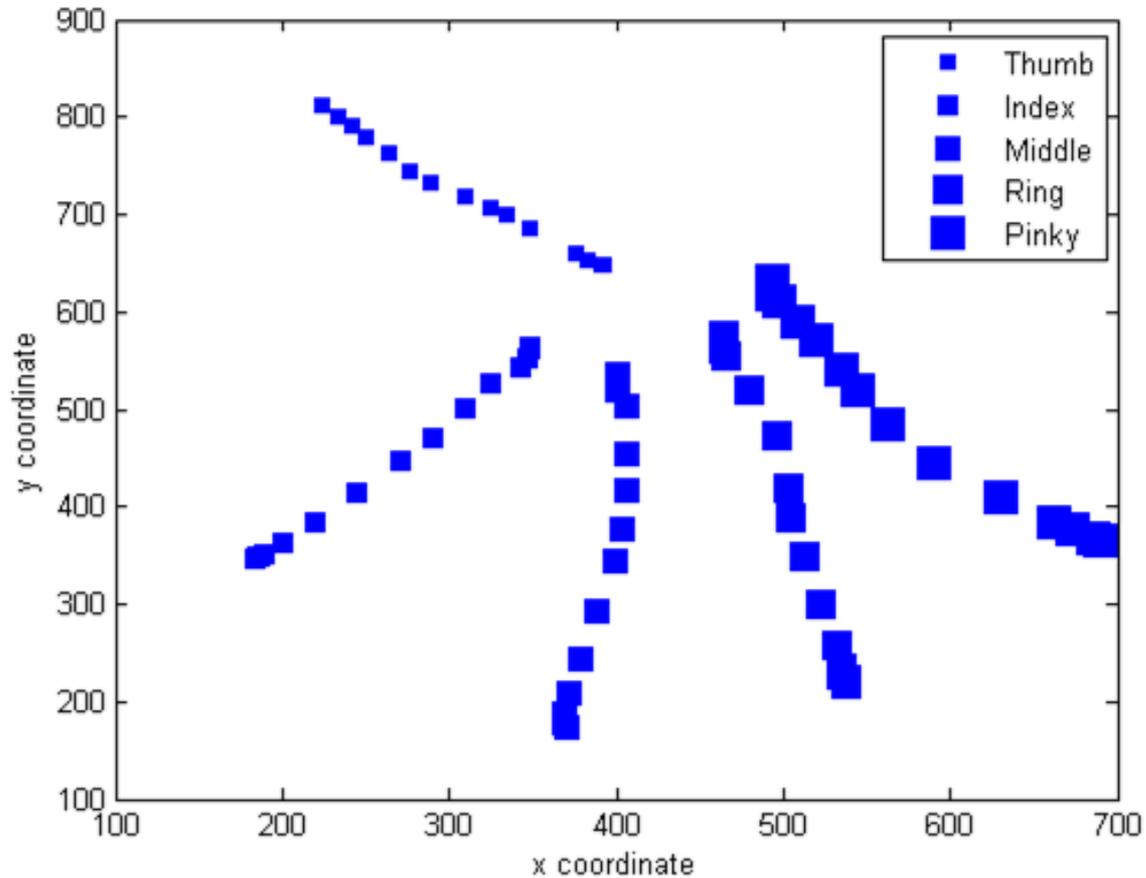
Gesture Response

- Accuracy domain
- Usability domain

Scheme Response

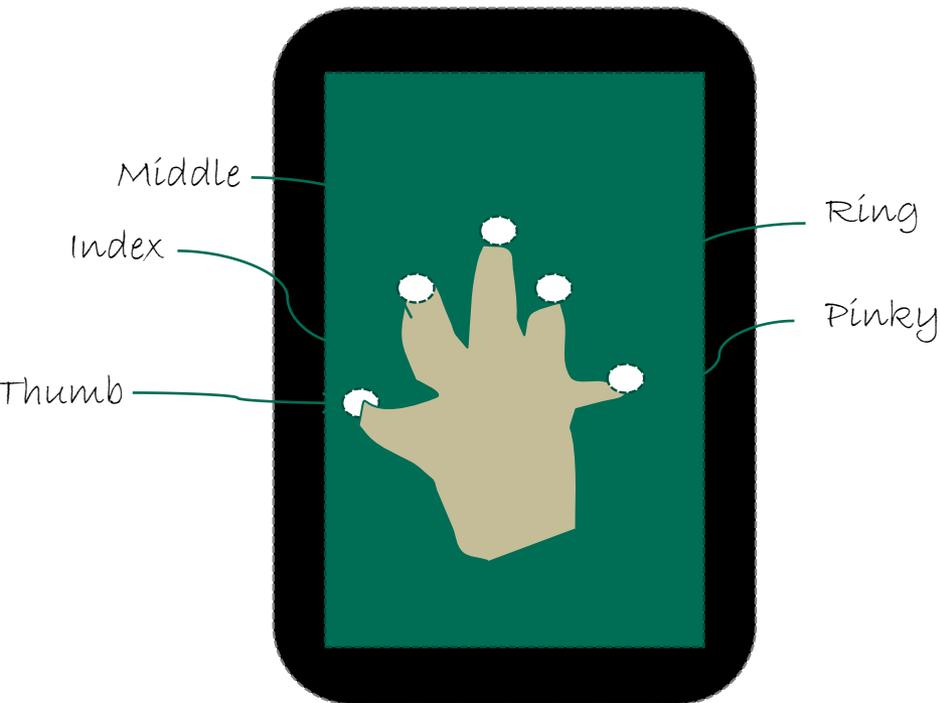
A multi-touch verification system

Pre-processing



A multi-touch verification system

Pre-processing



- Uniquely assign the set of IDs (1 to 5) to the 5-touch point set according to the fingertip used to generate.

- Bijective Mapping from $I = \{1,2,3,4,5\}$ to

$$P = \{p_i = (x_i, y_i) \mid i = 1, \dots, 5\}$$

- Objective Function

$$f_t = \operatorname{argmin}_f \sum_{i=1}^5 \|f_{t-1}^{-1}(i) - f^{-1}(i)\|$$

- Constraint

- The sorted set forms a simple polygon

The full description of techniques can be found at:

“Investigating Multi-touch Gestures as a Novel Biometric Modality” (submitted to BTAS 2012)

Multi-touch gesture taxonomy

Palm movement

- Static
- Dynamic

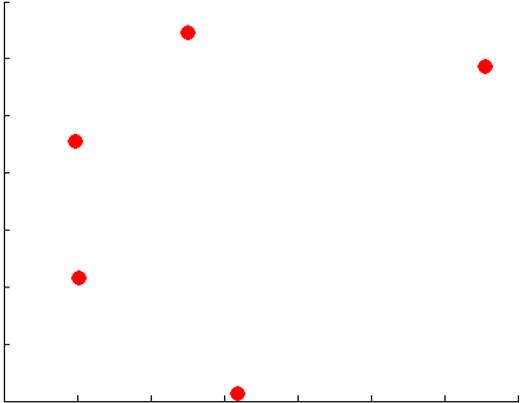
Fingertips motion

- Parallel
- Close
- Open
- Circular
 - CW,CCW

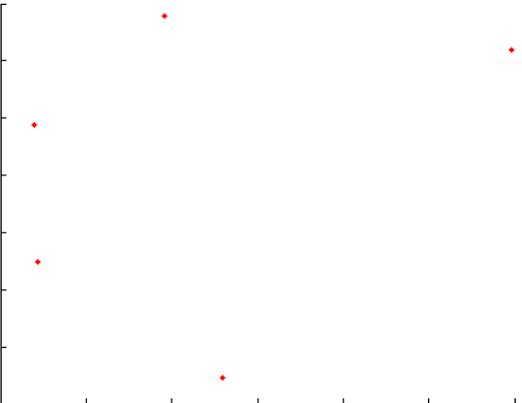
The set of dynamic fingertips

- All
- Partial

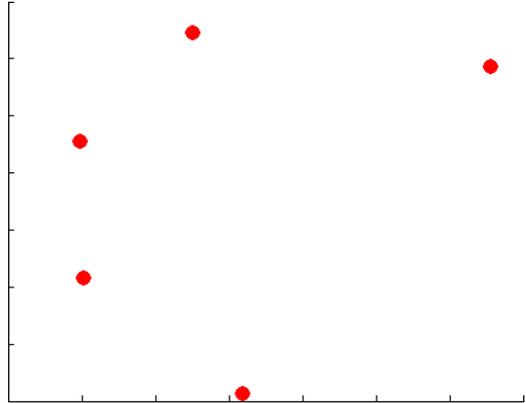
Examples:



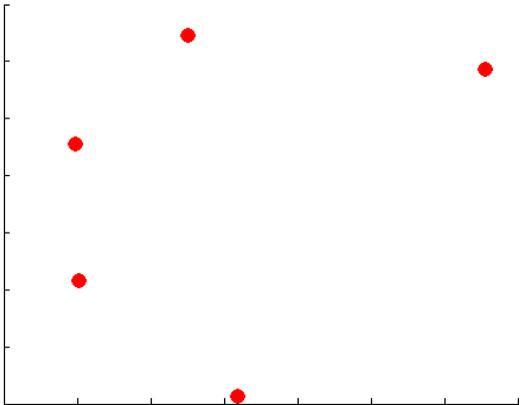
Parallel



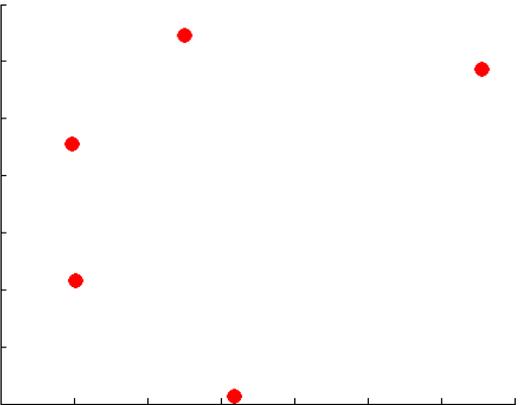
Opened



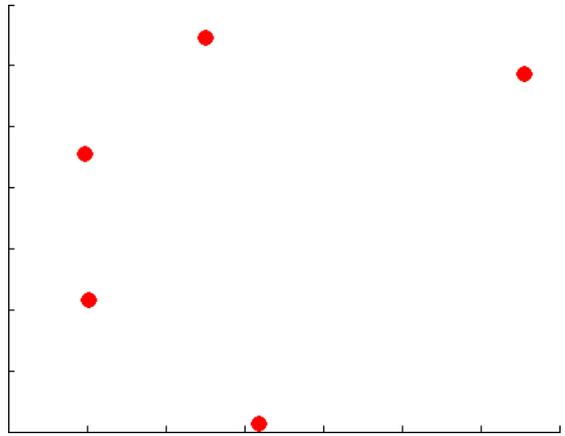
All



Closed



Circulated :
CW and CCW



Partial:
Fixed thumb