hexhive

# Forgery-Resistant Touch-based Authentication on Mobile Devices


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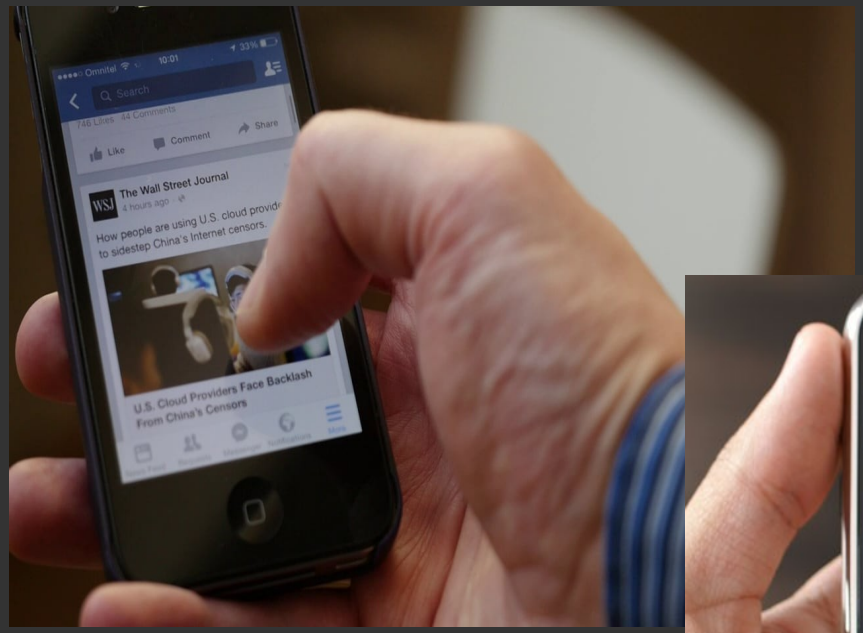
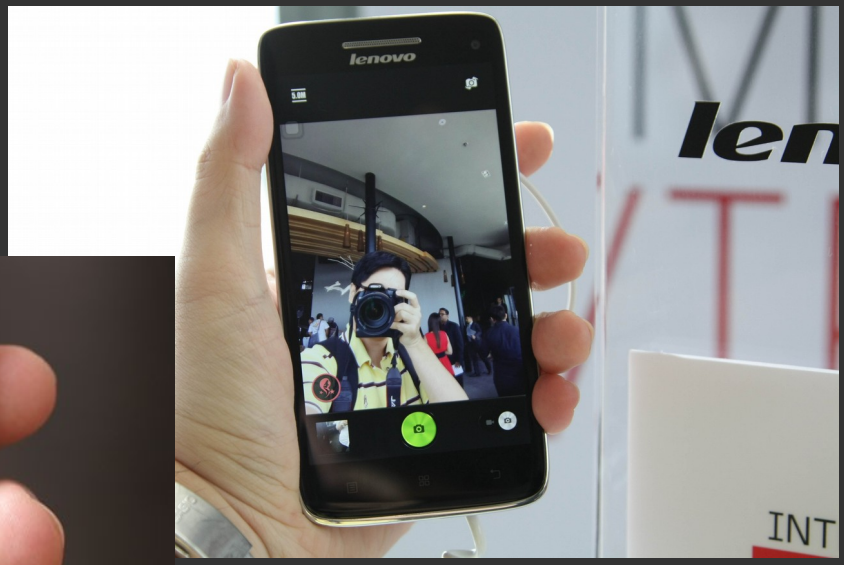
# Mobile access to private data

- Our mobile devices have access to private data
  - EMail, banking, pictures, social media, documents

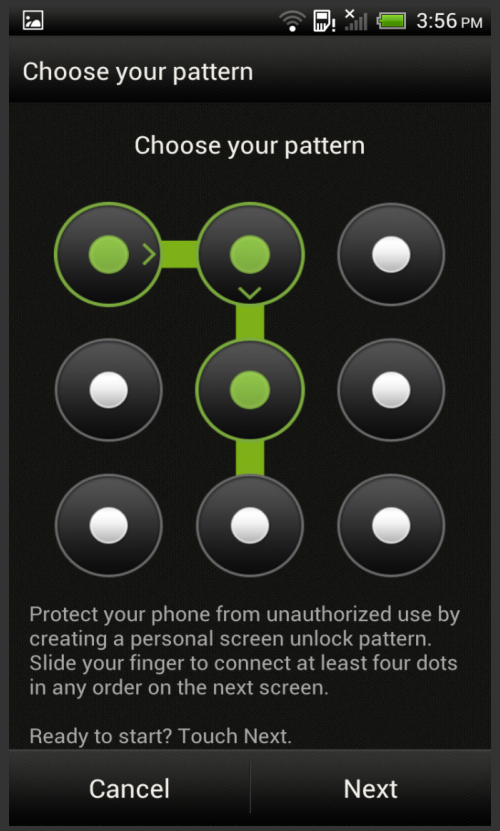


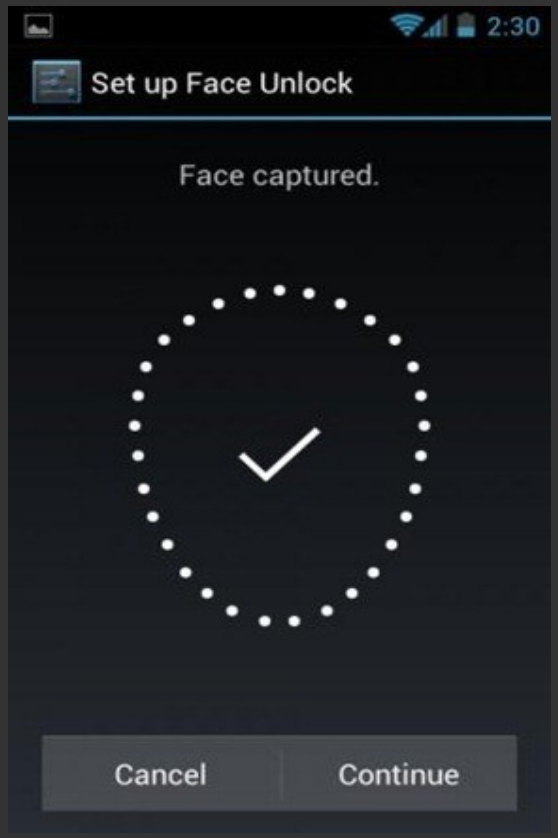


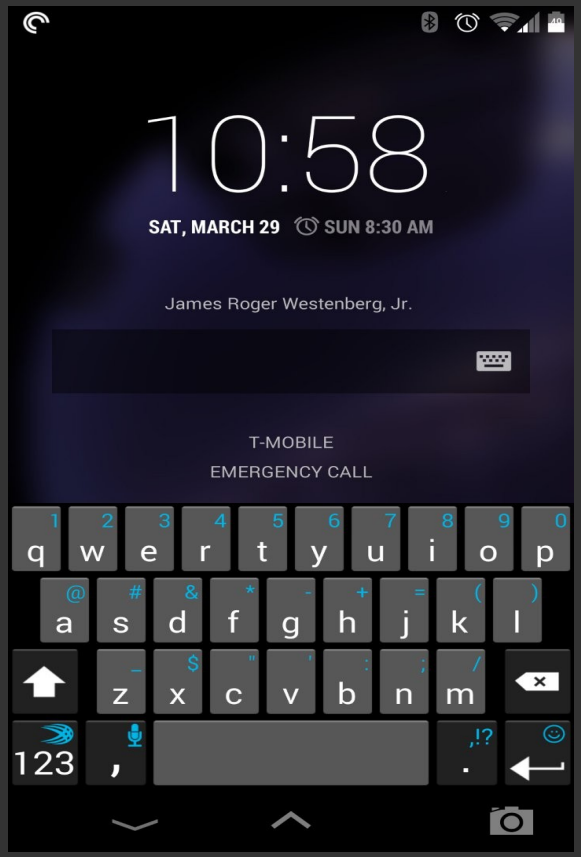


# Mobile authentication is tedious

- Authentication is often disabled (42%)
- Biometrics (fingerprint, face) prone to replay



# Continuous Touch-Based Authentication

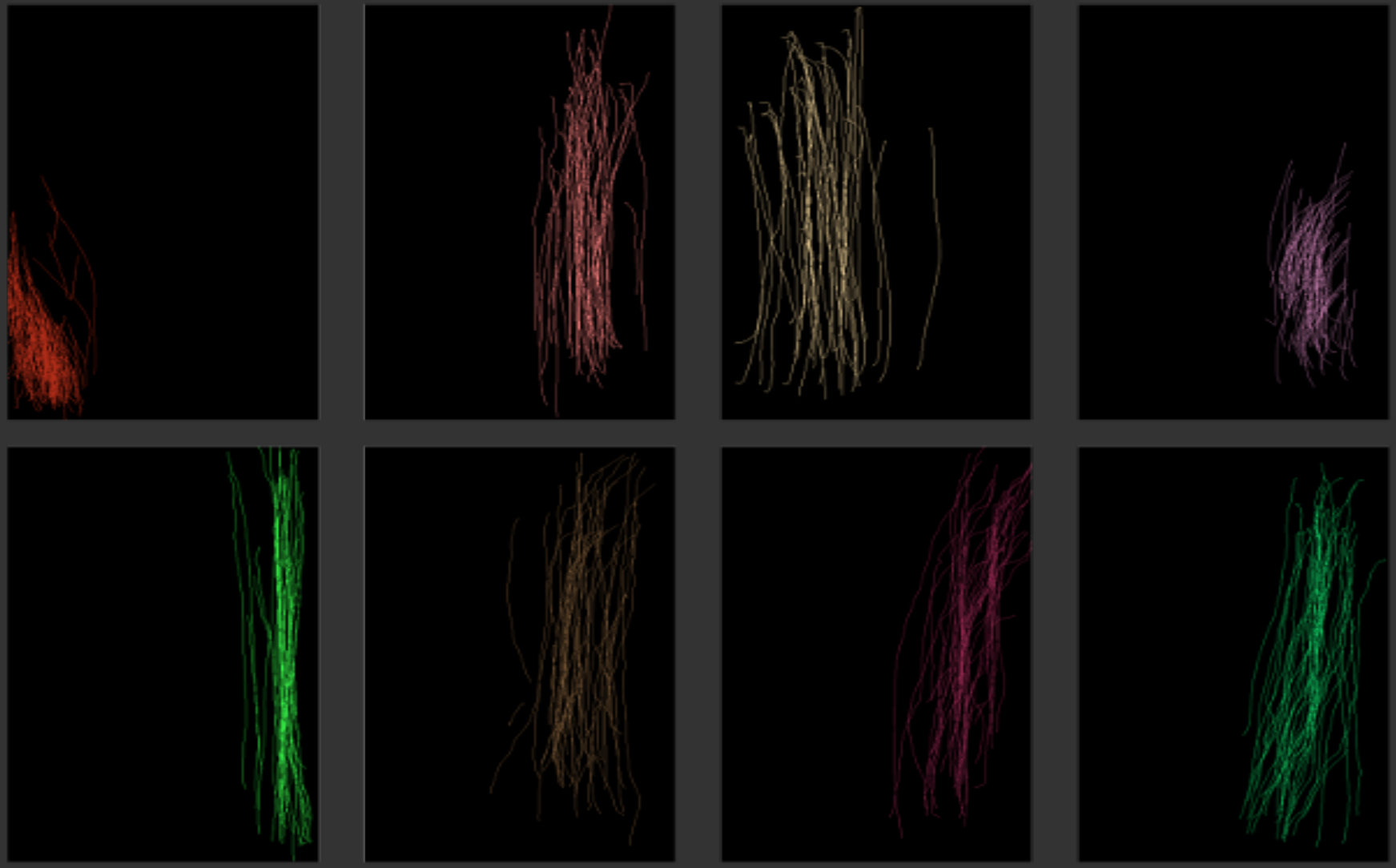
# Continuous authentication

- Users continuously interact with the device
- Leverage these interactions to authenticate

- Assumption: each user interacts differently
  - Collect touch strokes
  - Train model
  - Use model to authenticate

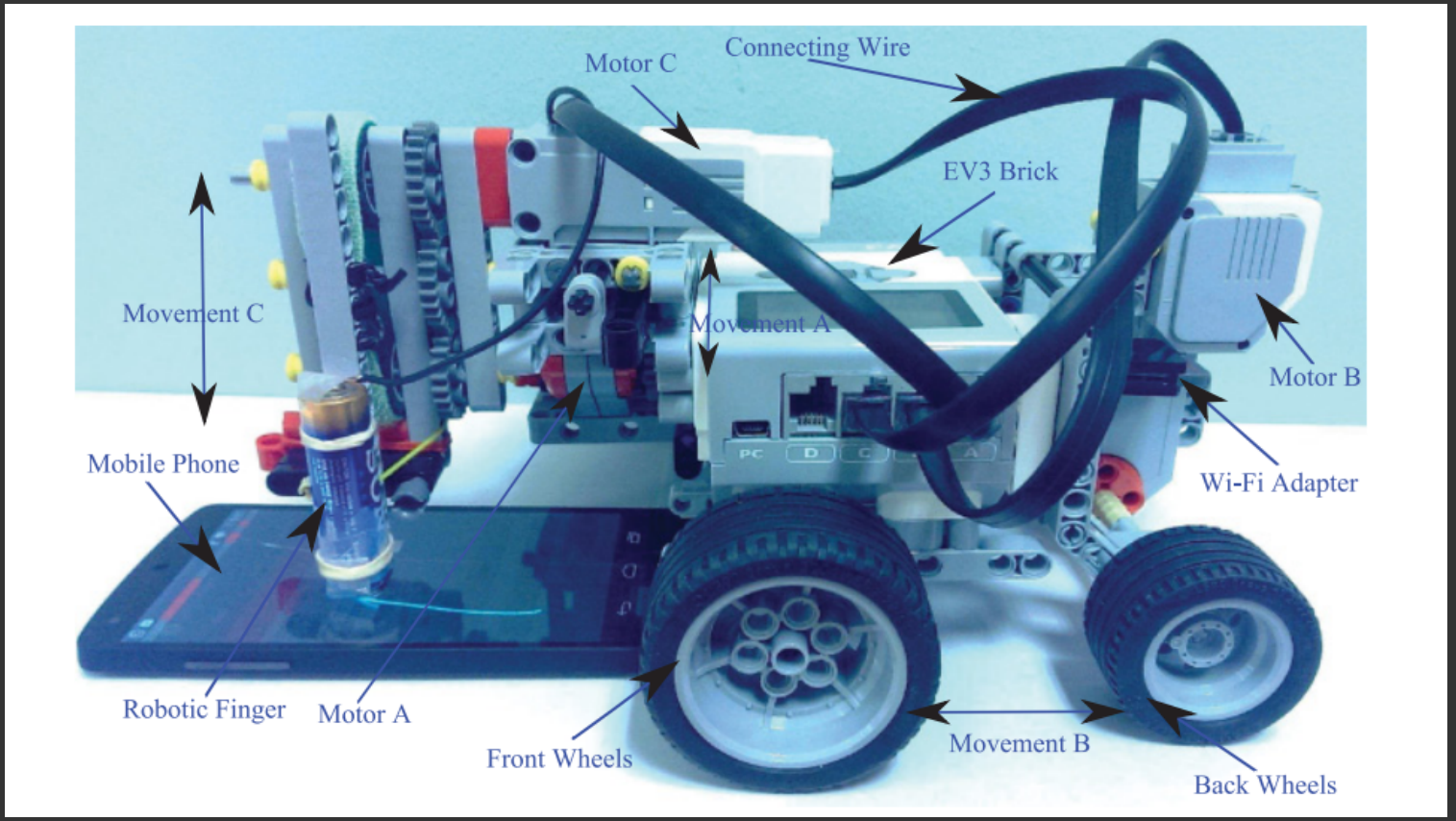
Mario Frank, Ralf Biedert, Eugene Ma, Ivan Martinovic, and Dawn Song "Touchalytics: On the Applicability of Touchscreen Input as a Behavioral Biometric for Continuous Authentication". TIFS '13

# Continuous authentication



# Biometrics pitfall: replay attacks

- Loosing trained model or touch data is fatal
- Automated replay attacks are possible

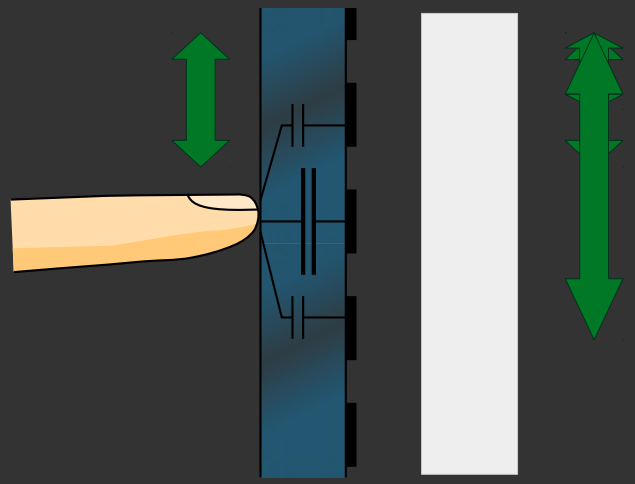



A. Serwadda and V. V. Phoha. “When kids' toys breach mobile phone security.” In CCS'13

# Forgery-Resistant Touch-based Authentication

# TouchAlytics 2.0: diversity

- Assumption: slight variances in screen settings influence touch behavior
  - Introduce a (flexible) layer of indirection between the user and the authentication system
  - Constantly vary the screen settings



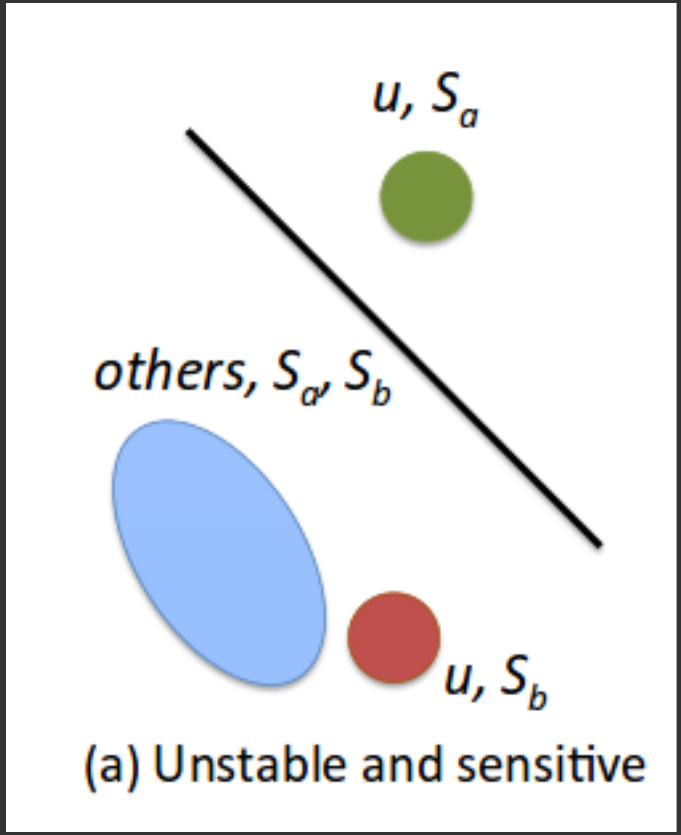
# TouchAlytics 2.0: indirection

- Sensor records x, y, pressure, area
- Control transformation of raw data to primitives

- Indirection for raw touch data interpretation
  - X-Distortion: stretch strokes along x-axis
  - Y-Distortion: stretch strokes along y-axis

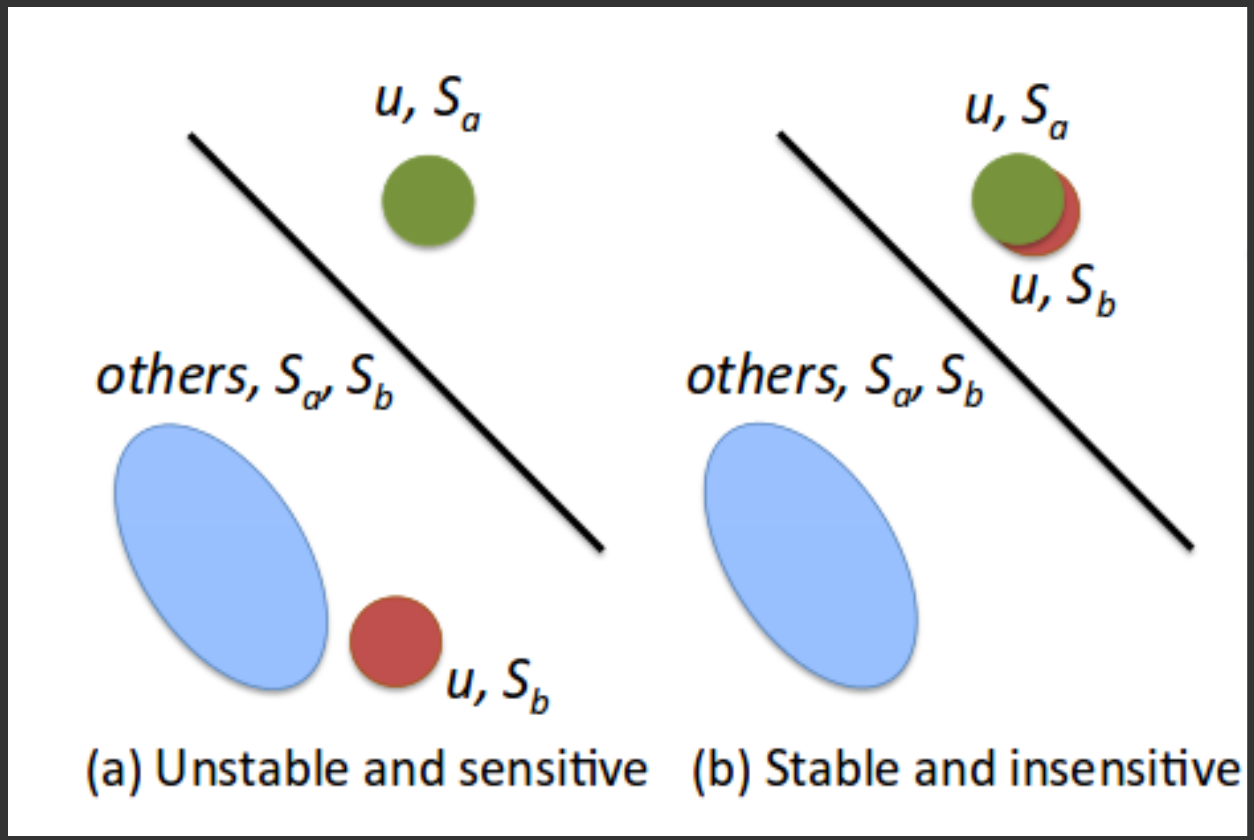
- Application acts relative to current setting
  - Users change behavior to compensate

# Required: stability and sensitivity

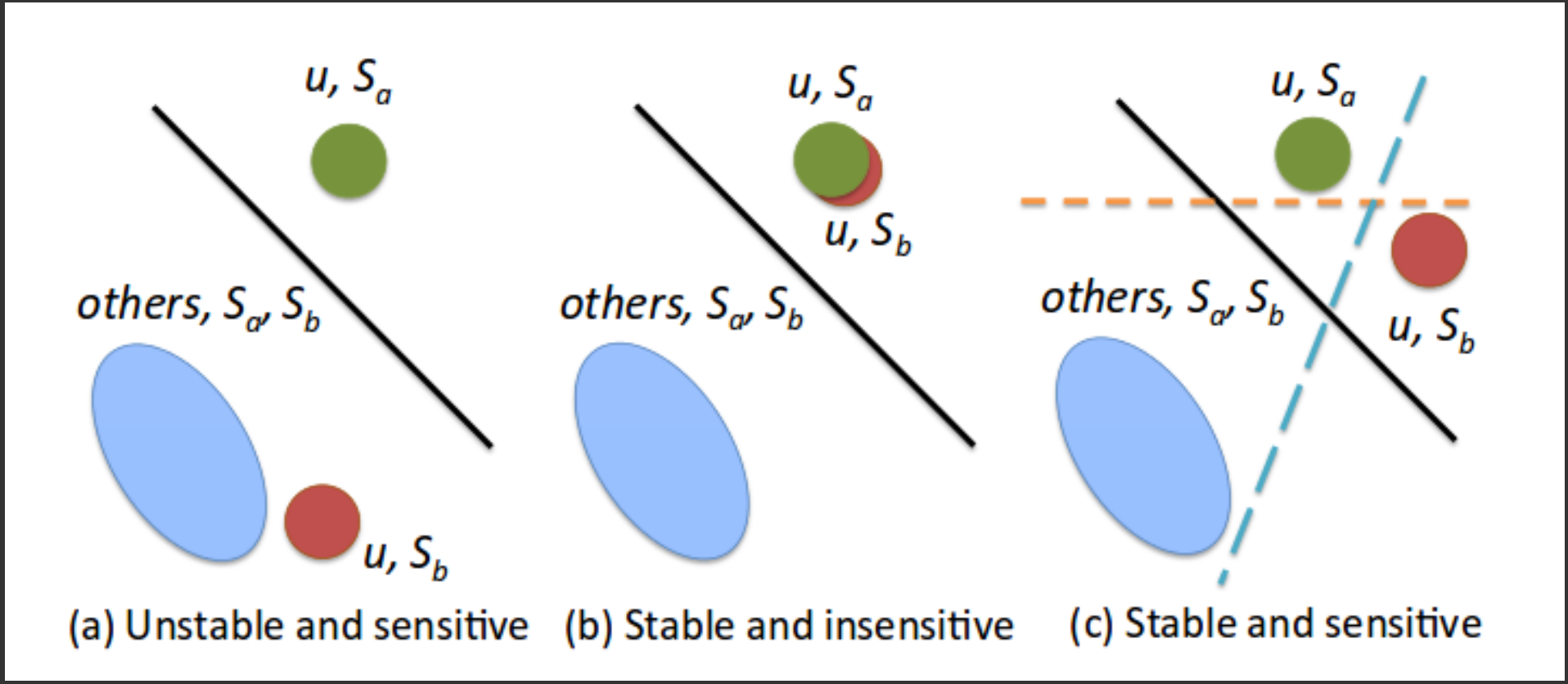


(a) Unstable and sensitive

# Required: stability and sensitivity



# Required: stability and sensitivity



# Adaptive Authentication

- Registration phase
  - Collect models for different screen settings
  - Train authentication classifiers (SVM)
- Authentication phase
  - Switch screen settings randomly
  - Match touch behavior against trained profile
  - Trigger hard authentication on mismatch

# Evaluation

# User study

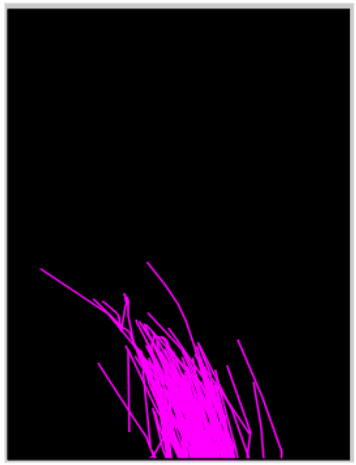
- Two “comparison” games,
  - Swipe horizontally to find errors in 2 images
  - Scroll vertically to compare geometric shapes

# User study

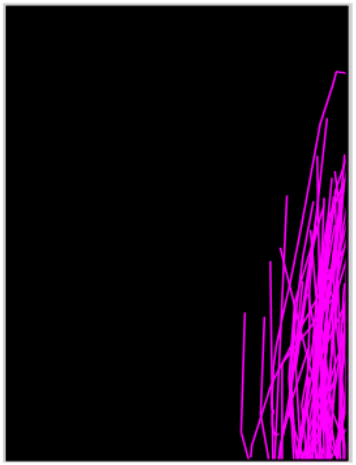
- Two “comparison” games,
  - Swipe horizontally to find errors in 2 images
  - Scroll vertically to compare geometric shapes
- 25 users evaluated in study
  - Measure touch interactions with different distortion settings
  - 0.8, 0.9, 1.0, 1.1, 1.2 along X and Y axis

# User study: stability

(a) User A, 0.8 Y-distortion

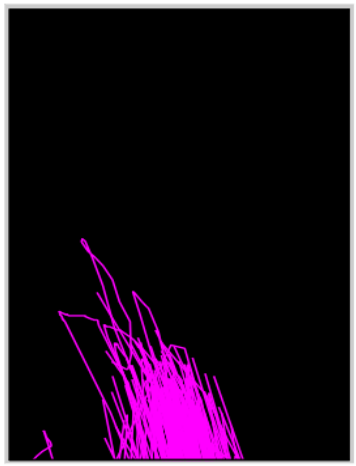


(b) User B, 0.8 Y-distortion

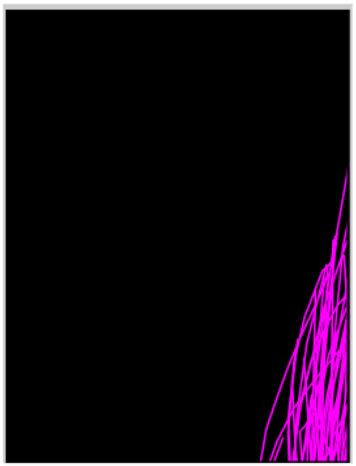


(c) User C, 0.8 Y-distortion

(d) User A, 1.2 Y-distortion



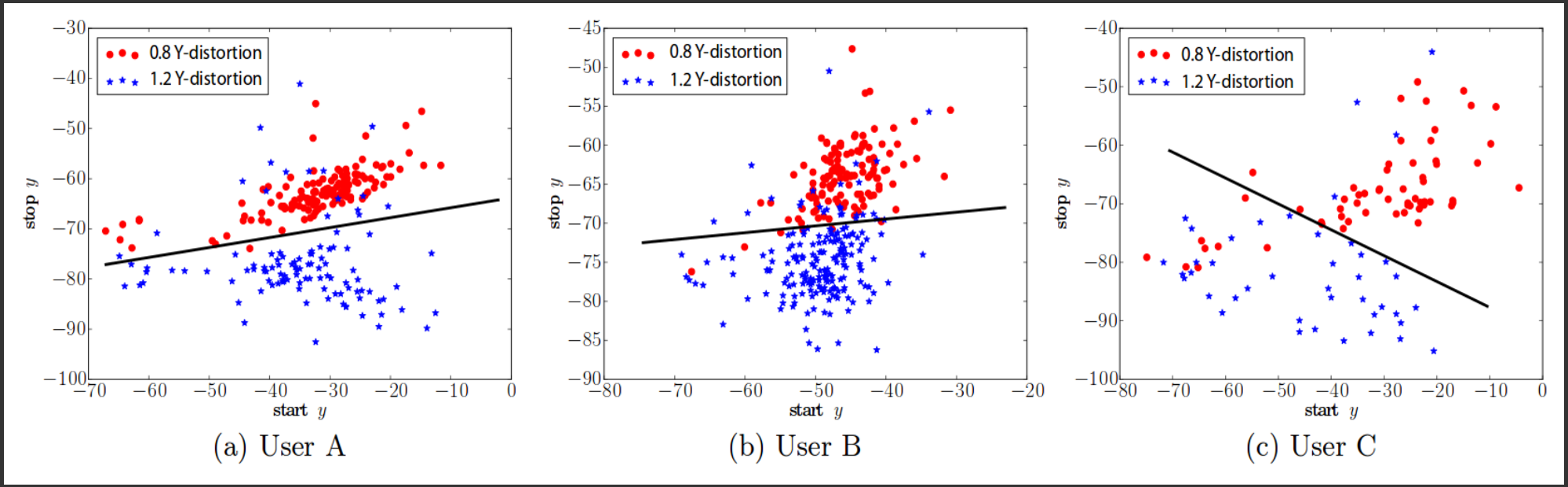
(e) User B, 1.2 Y-distortion



(f) User C, 1.2 Y-distortion

Touch behaviors of a user in one setting are closer to those of the user in another setting than those of other users.

# User study: sensitivity




A user's touch strokes in different settings have a high degree of separability in the feature space.

# Two (robot-based) attacks

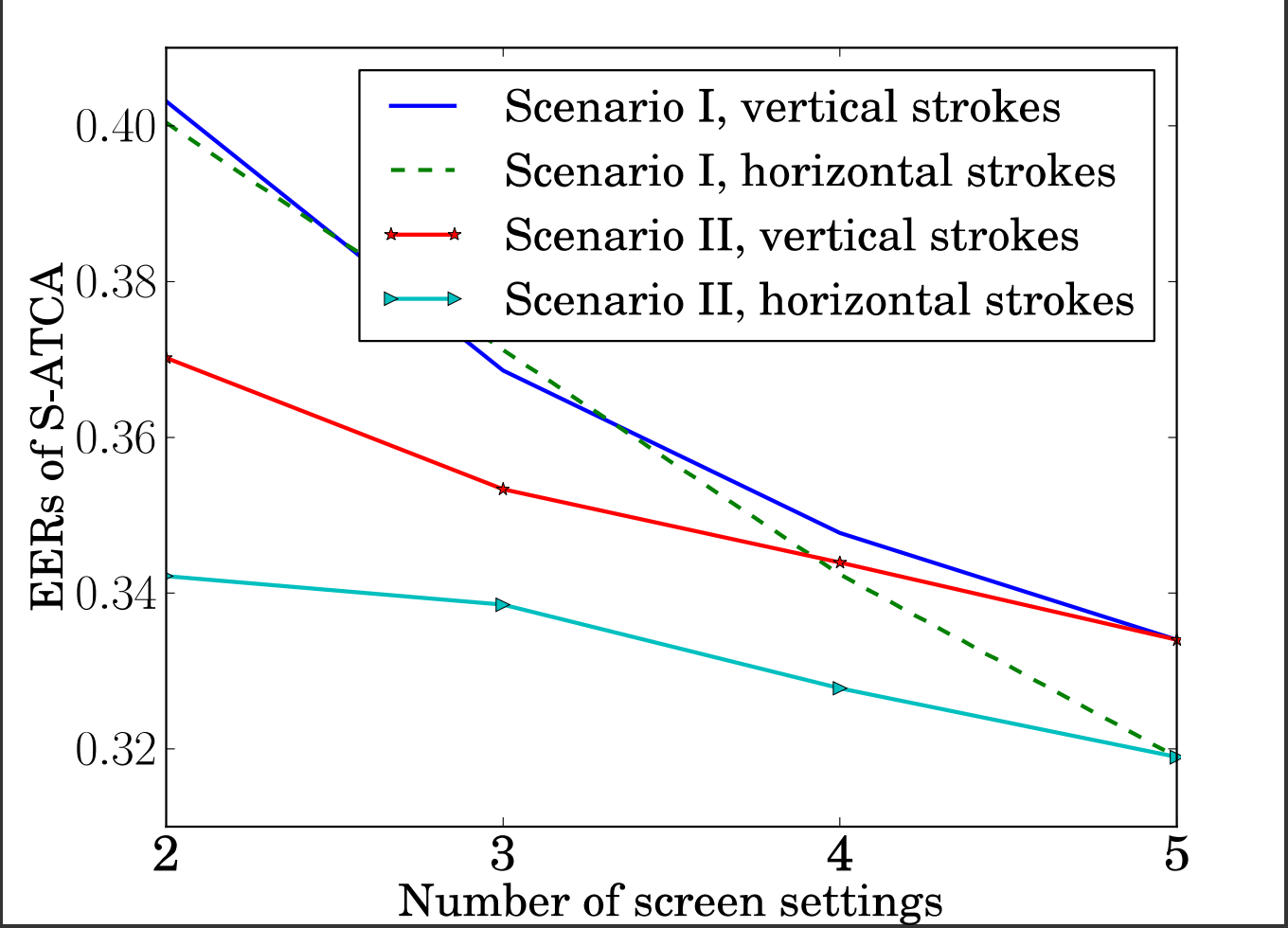
- Random attack: an attacker replays a random user's touch data (i.e., the naïve attack)
- Targeted attack: an attacker replays the targeted user's touch data (i.e., attacker has access to full training data)

# EER*s in different settings

| | Random attacks | Targeted attacks |
|---|---|---|
| S-Baseline-a | 0.12(0.1067) | 0.50(0.0000) |
| S-Baseline-b | 0.11(0.0819) | 0.50(0.0000) |
| S-Baseline-c | 0.14(0.1111) | 0.50(0.0000) |
| S-Baseline-d | 0.14(0.1051) | 0.50(0.0000) |
| S-Baseline-e | 0.17(0.1187) | 0.50(0.0000) |
| S-Baseline-improved | 0.12(0.0777) | 0.45(0.0364) |
| S-ATCA | **0.08(0.0542)** | **0.33(0.0502)** |

* EER: Equal Error Rate, equilibrium of false acceptance and false rejection rates
* ATCA: Adaptive Touch-based Continuous Authentication

# More screen settings help



# Attacking TouchAlytics

- Detect screen setting
  - Measure “swipe” distance and leak screen setting
  - Still leaves some strokes unprotected

# Conclusion

# Conclusion

- Users subconsciously adapt behavior, different screen settings do not affect user experience
- Adaptive touch-based continuous authentication randomly changes screen settings to fool attacks
- (Small) user study shows promising results
- Touch behavior is both stable and sensitive
- Future work: larger study, more screen settings, leverage sloppiness and jitter

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# Thank you!

# Questions?

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