

AMI RESEARCH & DEVELOPMENT, LLC

Neuromorphic Fast Pattern recognition for Kinematic and Finger Image Active Authentication

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Active Authentication

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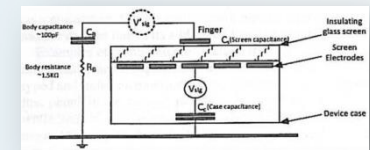
Neuromorphic Fast Pattern Recognition for Kinematic Gestures and Finger Image Authentication

The Active Monitoring of the User's Finger Image and Habitual Motion Securely Validate their Identity

Finger Image (physiological signature)

Detect Epidermal Characteristics "Finger Image"
WITHOUT additional hardware,
such as a Special Finger Print Reader Button

- Correlate Finger Image to user's fingerprint template
- Finger Image of the user is monitored as the user swipes across the touchscreen



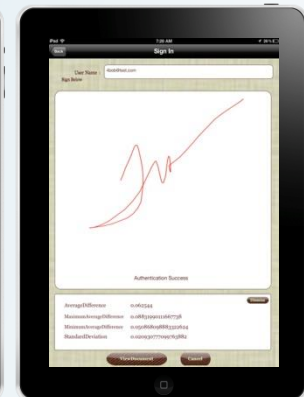
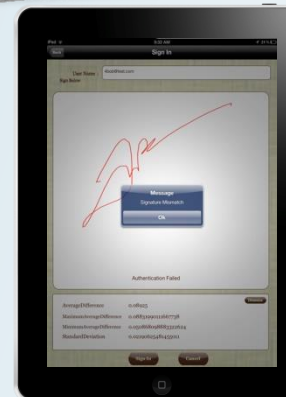
Touch Screen Schematic



Touchscreen Gestures (biometric behavior)

Exploit Habitual Touchscreen Gestures

- Habitual kinematic motion of the user is monitored based on the user's touchscreen gestures against learned template of user



TWO ORTHOGONAL BIOMETRICS
(Finger Image & Kinematic Gesture data)
fused for Active Authentication



Agenda

- Team
- Overview of Technology
- Technical Details
 - Kinematic Gestures
 - Finger Image
- Summary

Team



- Bill Mouyos – Principle Investigator, wmouyos@ami-rd.com



- Judy Feng – Co-Principle Investigator, jfeng@ami-rd.com



- Dr. John Apostolos – Chief Scientist, japostolos@ami-rd.com



- Lilliane Dobrowolski, Researcher, ldobrowolski@ami-rd.com



- Dwayne Jeffrey, Researcher, djeffrey@ami-rd.com



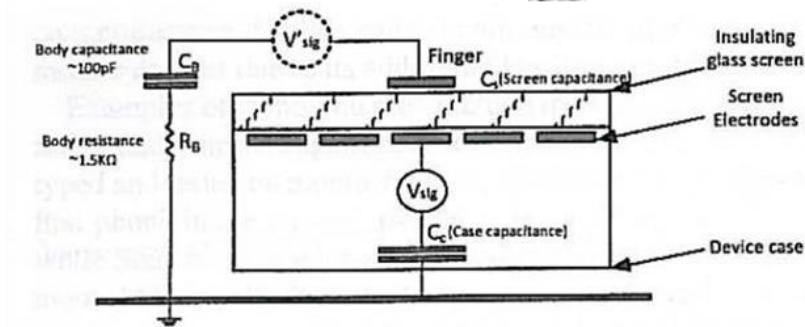
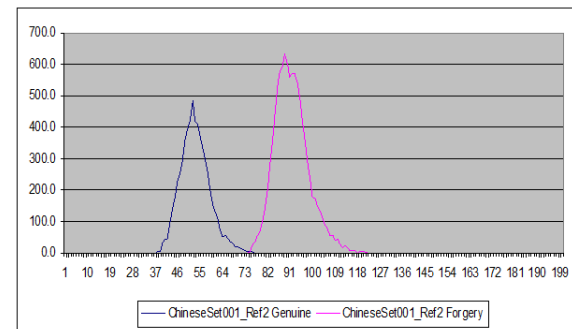
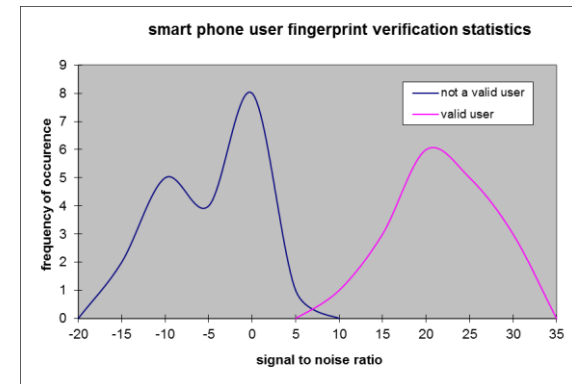
- Benjamin McMahon, Researcher, bmcMahon@ami-rd.com



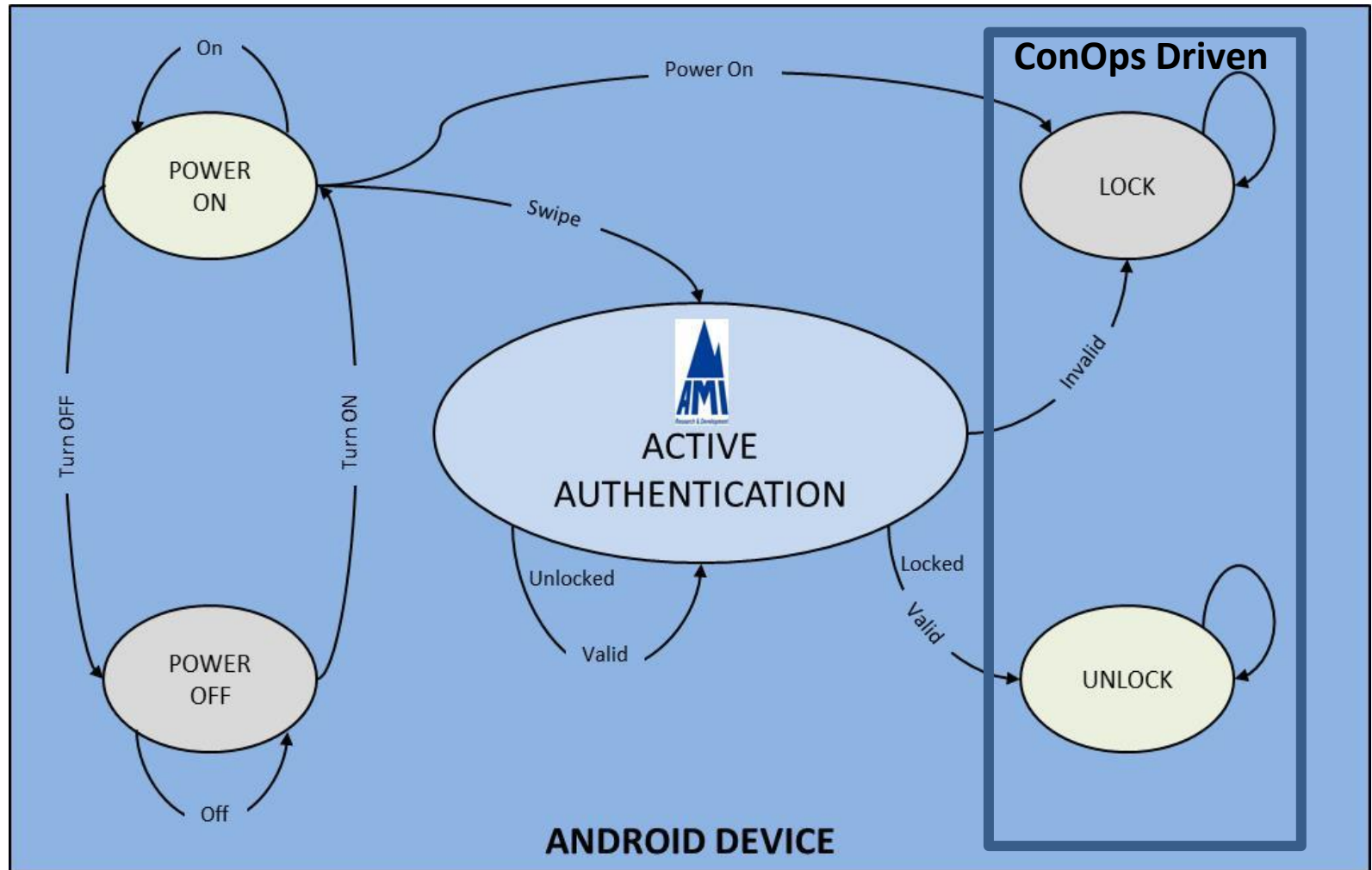
- Dr. Andrzej Rucinski, Professor (University of New Hampshire), Andrzej.Rucinski@unh.edu

Overview - Neuromorphic Processor

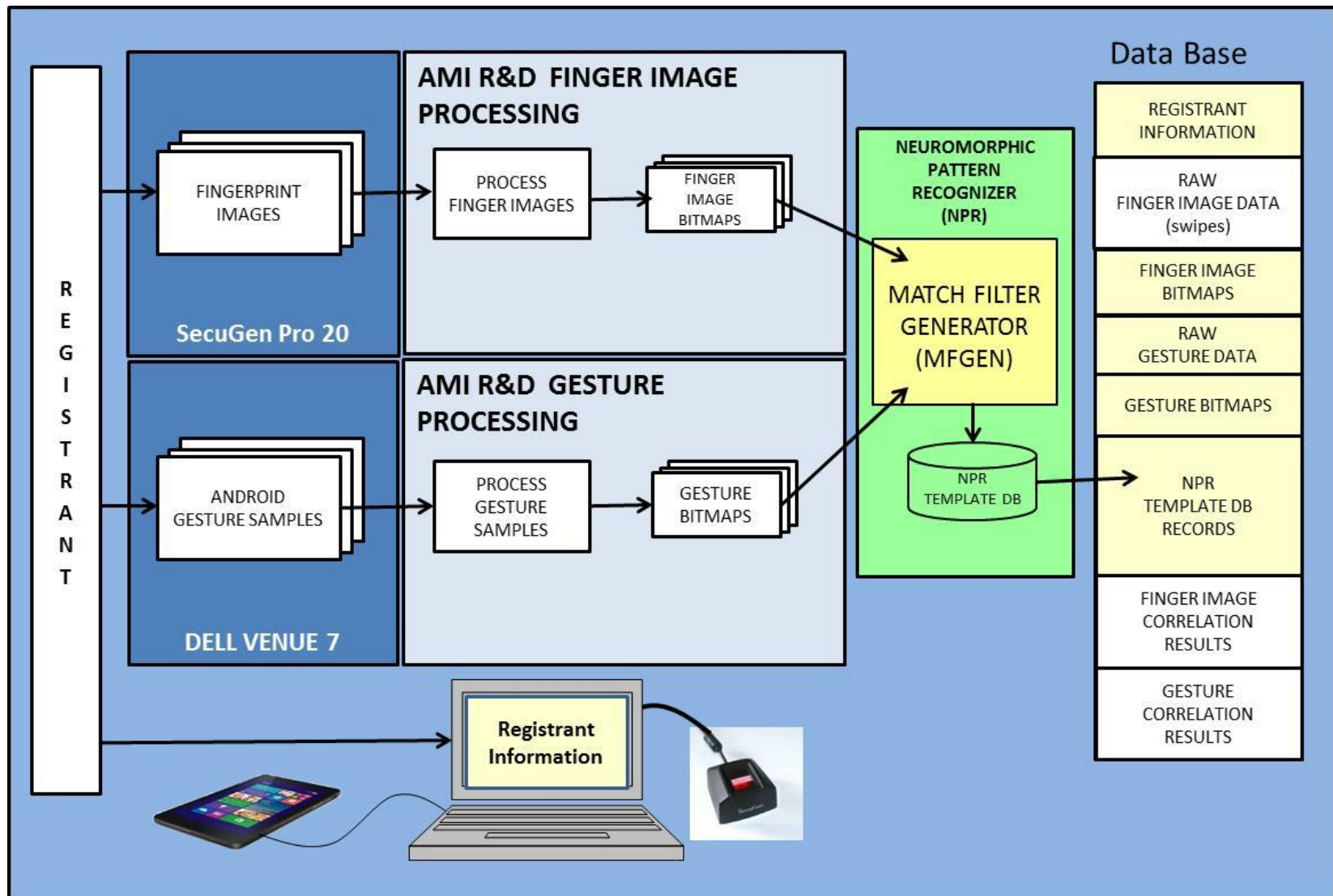
- By applying AMI R&D's Neuromorphic Pattern Recognition (NPR) Algorithms implemented in software two (2) biometric modalities are used to determine a user's authenticity
 - Habitual kinematic motion
 - Epidermal features



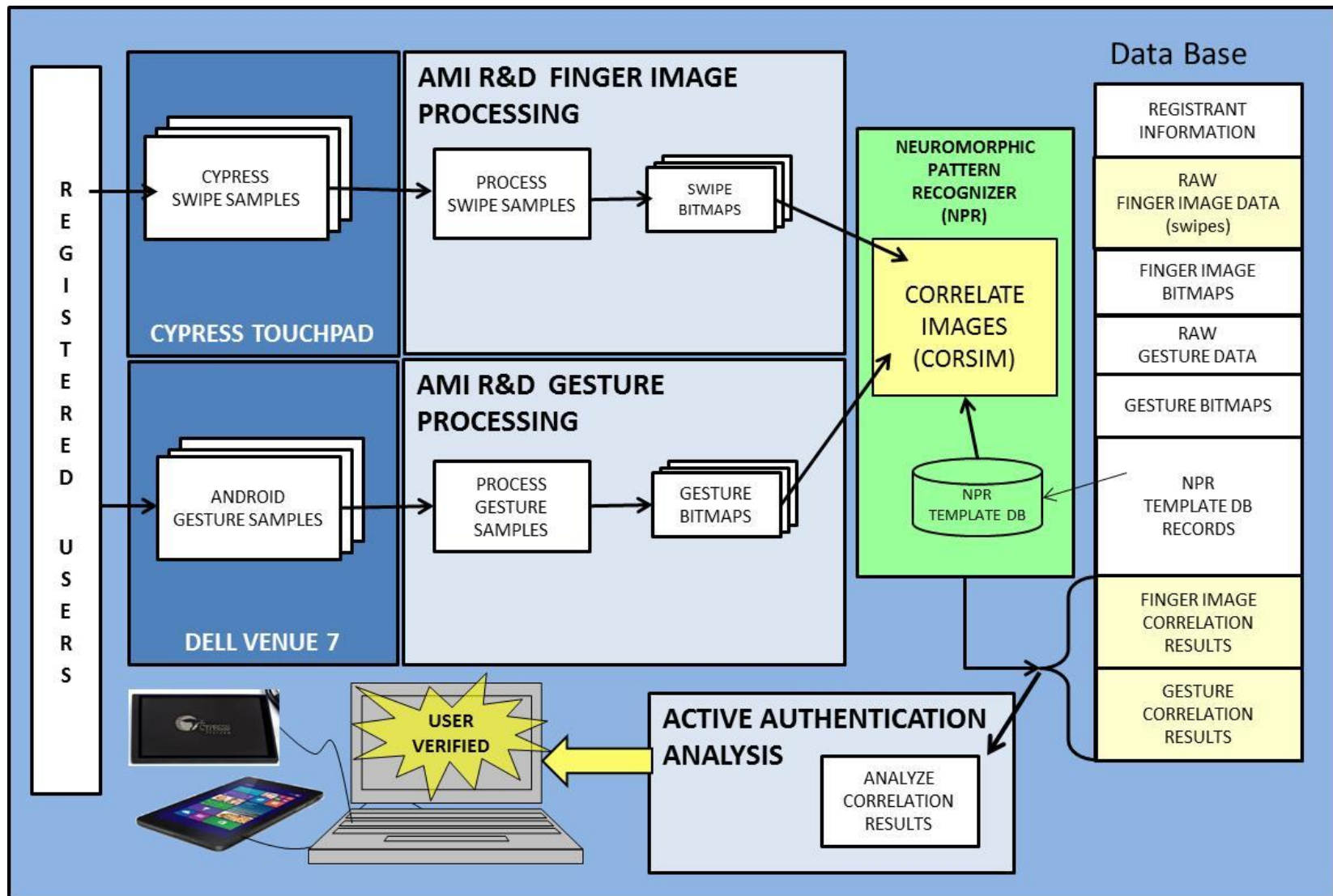
Active Authentication State Diagram



Touchscreen Gestures & Finger Image Registration



Touchscreen Gestures & Finger Image Verification

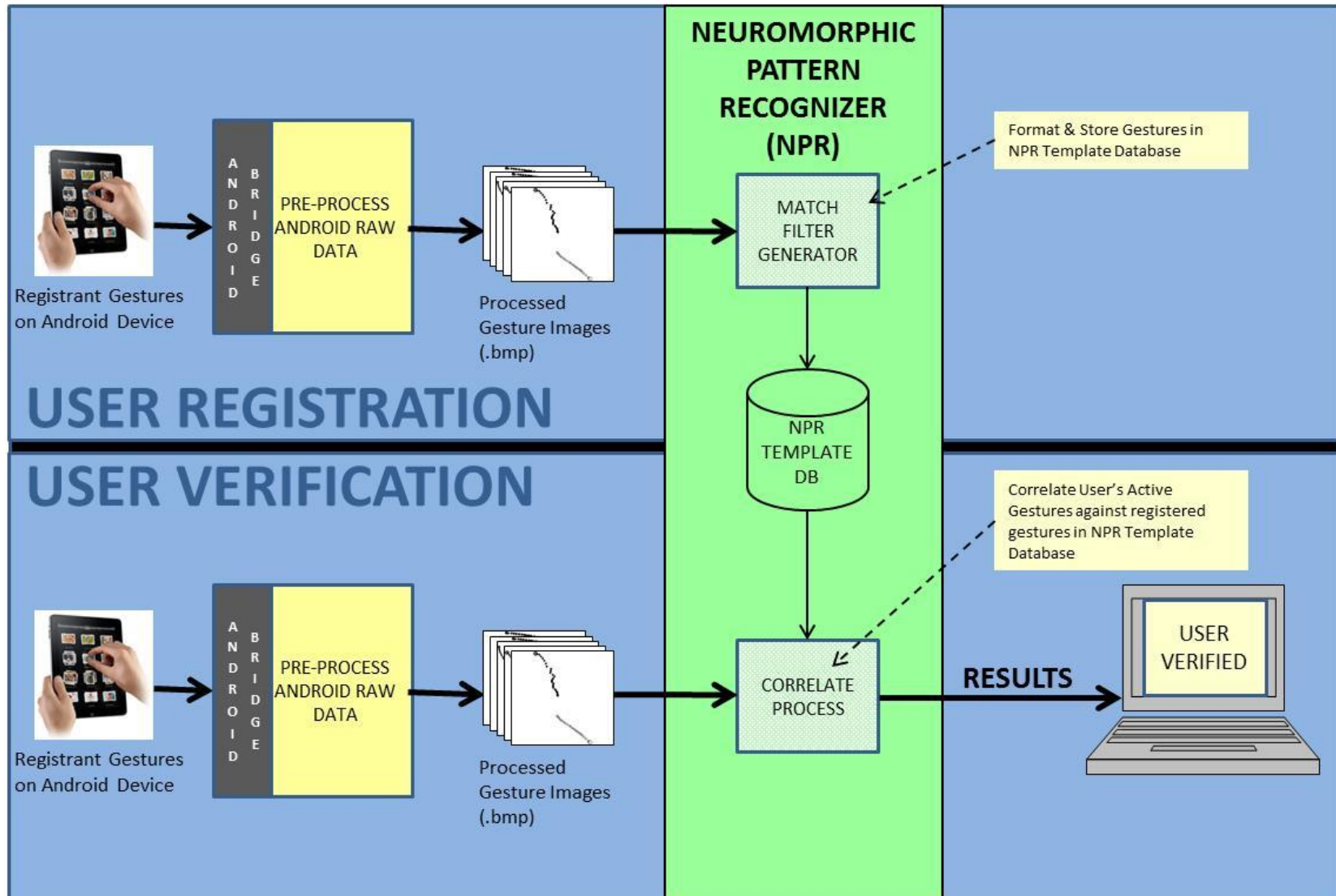


KINEMATIC GESTURES

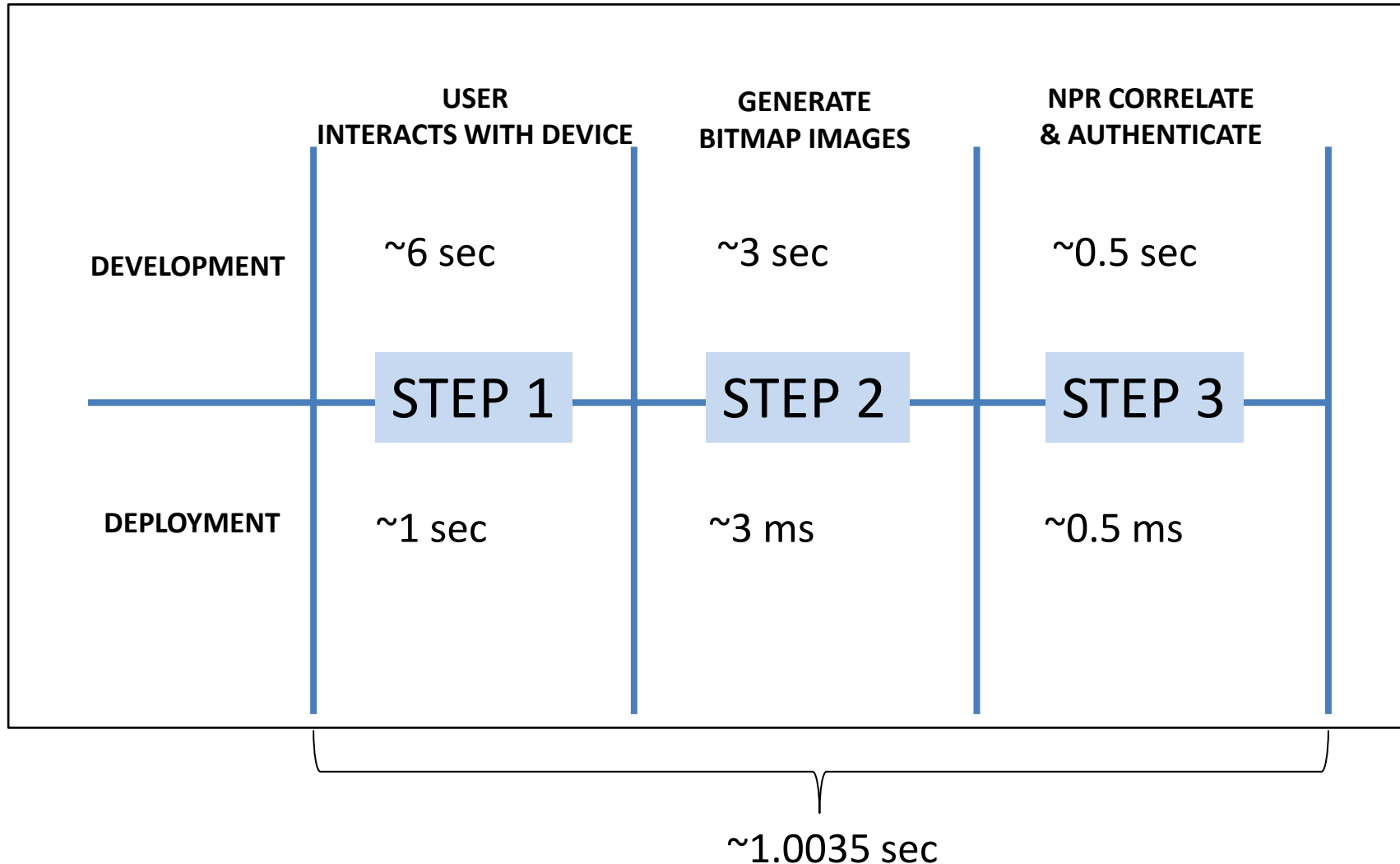
Touchscreen Gestures– Behavioral Biometric

- **Approach**
 - Match specific user's habitual touchscreen kinematic gestures on an Android device to the user's registered gestures utilizing the AMI Neuromorphic Pattern Recognizer (NPR) to continuously verify active users of the device.
- **Implementation**
 - **Registration:** User gesture data are obtained using a predefined script consisting of various device activities. The data are separated into individual gestures, categorized and processed into NPR formatted bitmap images and entered into a template database.
 - **Device Operation:** User interactions with the device are processed into NPR formatted bitmap images representing unique gestures.
 - **User Verification:** Each active unique gesture NPR formatted bitmap image is passed to the AMI NPR and correlated against the registered images in the user's template database.

Touchscreen Gestures Overview

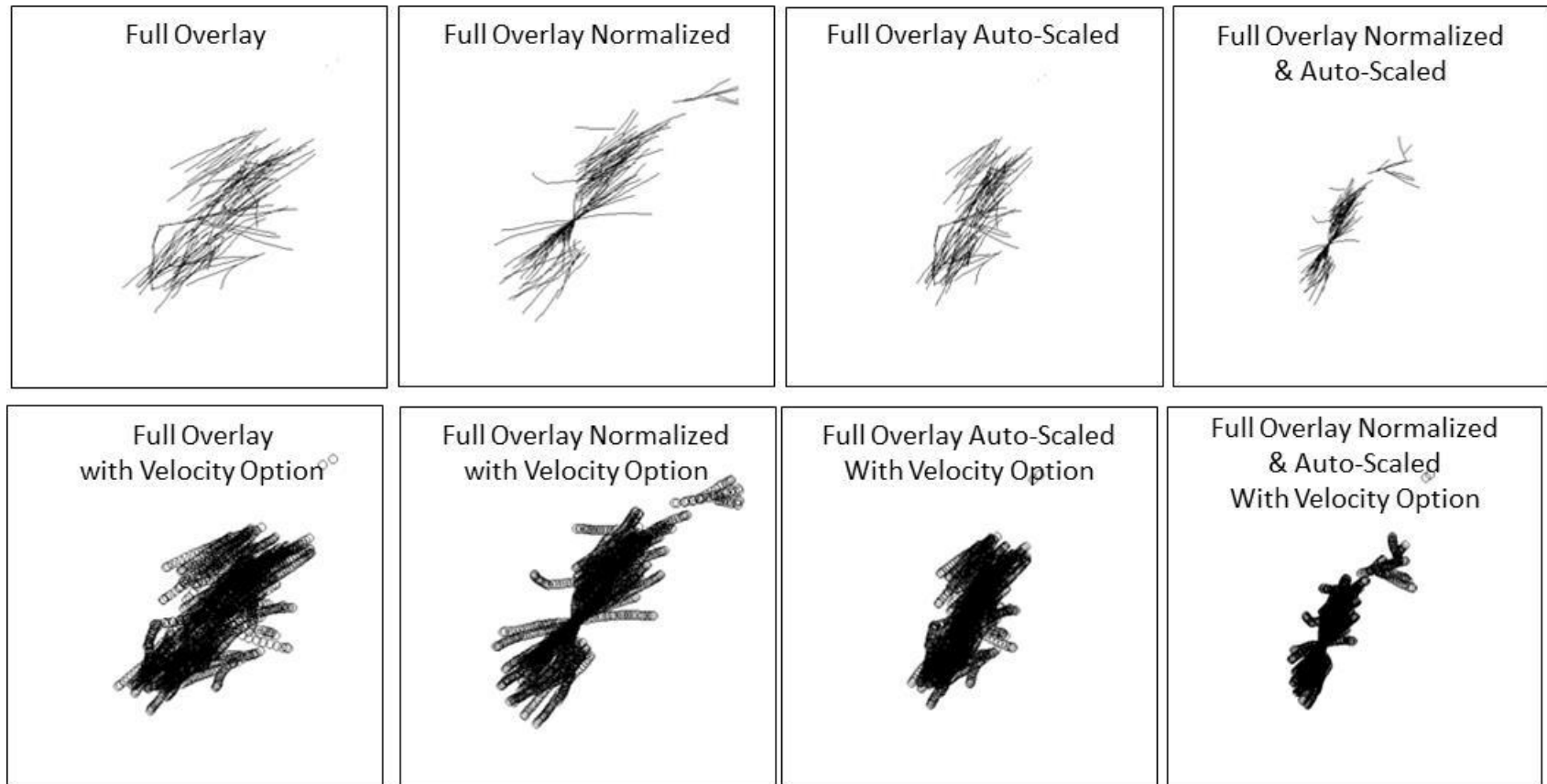


Touchscreen Gestures Timing –Single Gesture Verify



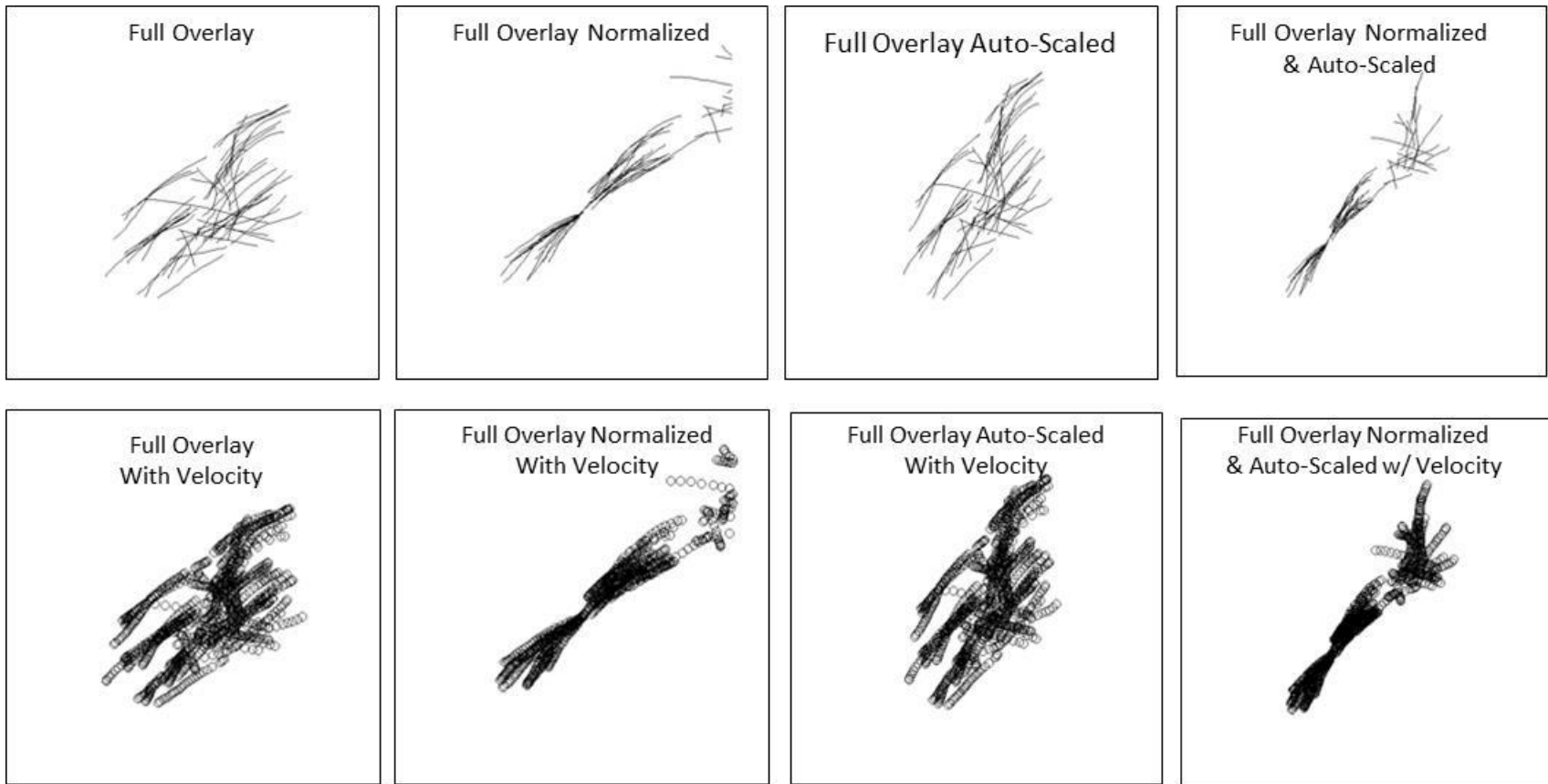
Touchscreen Gestures - Sample Gesture Images

- These images depict various overlay views of USER 018 gestures for Activity #1.



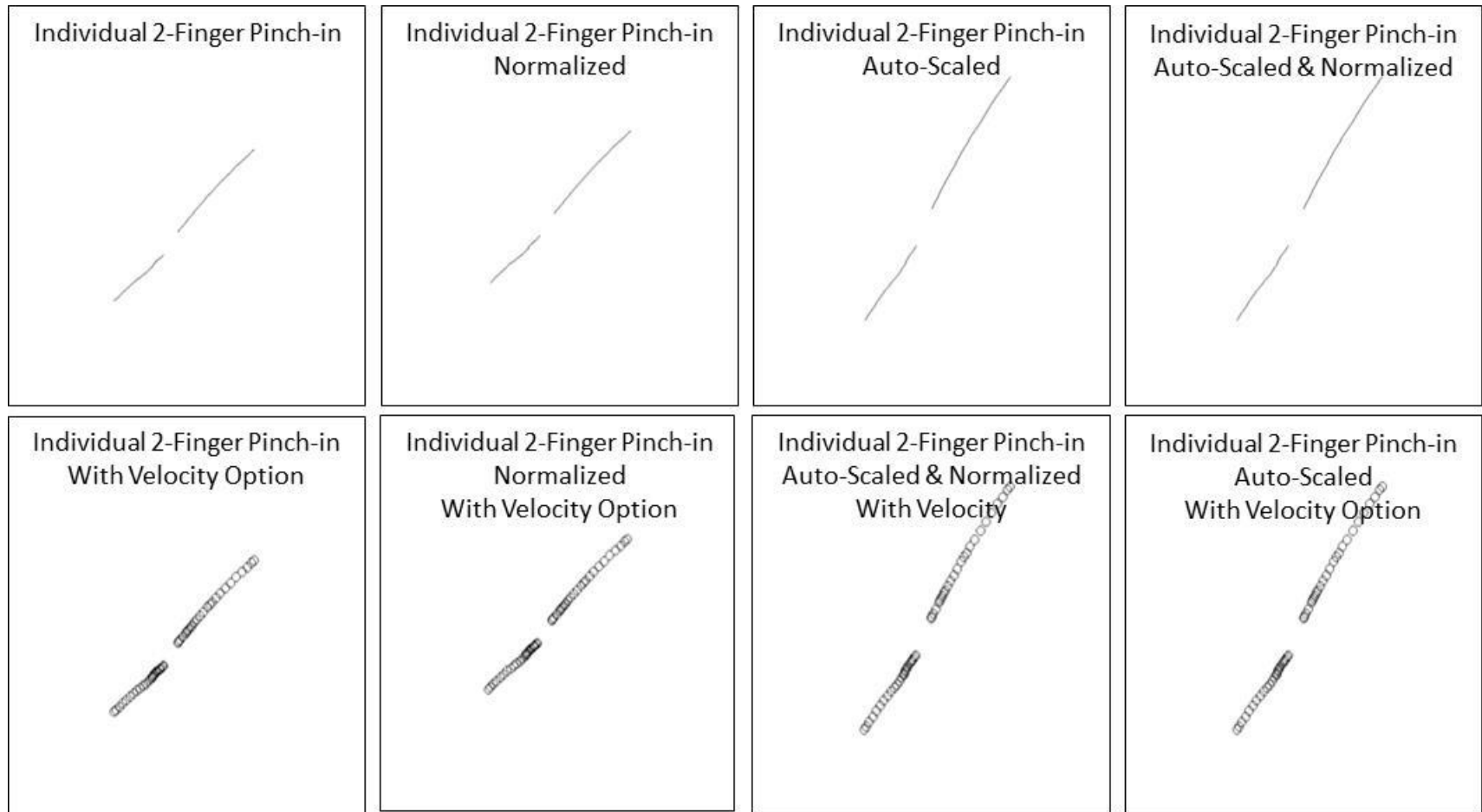
Touchscreen Gestures - Sample Gesture Images

- These images depict various overlay views of USER 011 gestures for Activity #1

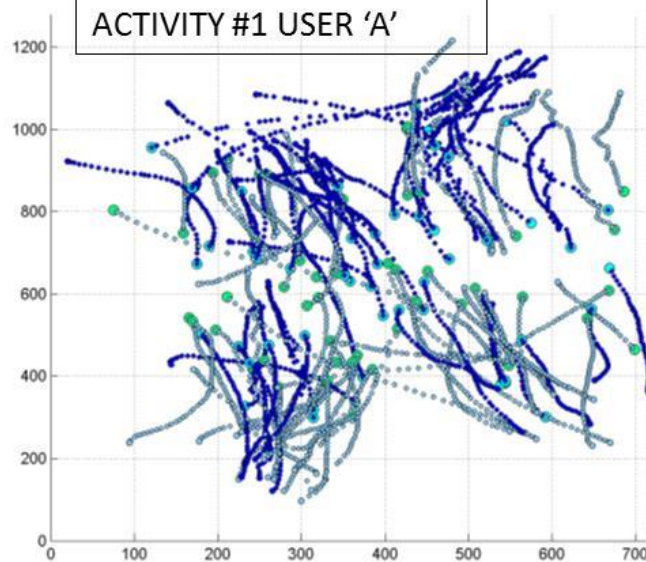


Touchscreen Gestures - Sample Gesture Images

- These images depict various views of a single swipe used during development/analysis.

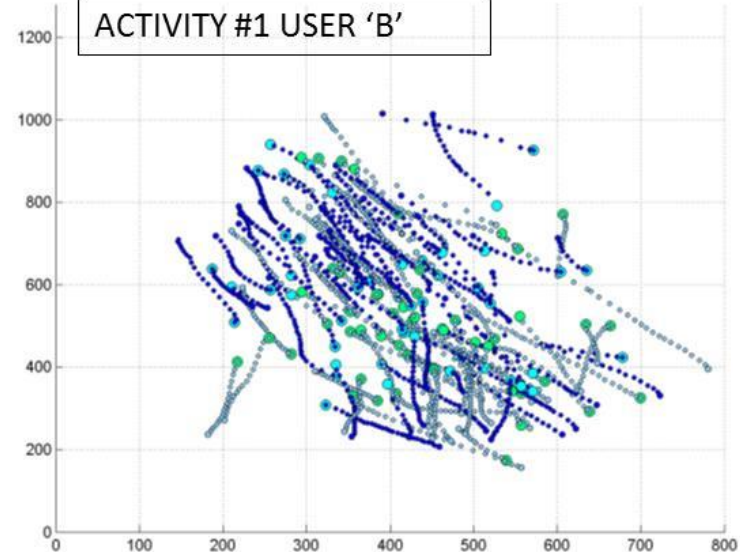
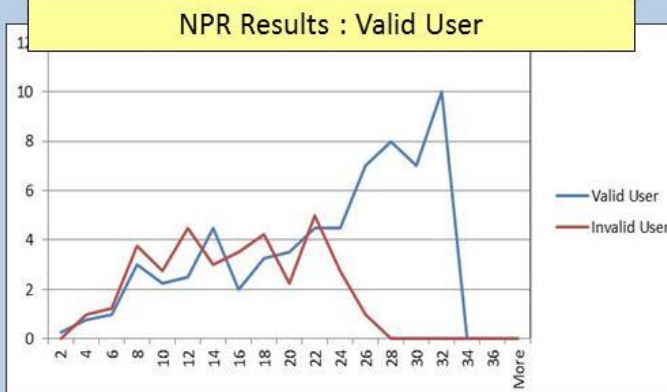


Touchscreen Gestures - Sample Data & Results



User 'A' and User 'B' have noticeably different gesture patterns for the same activity.

This demonstrates that gesture differences exist and can be separated.



FINGER IMAGE

Finger Image – Physiological Biometric

- **Approach**

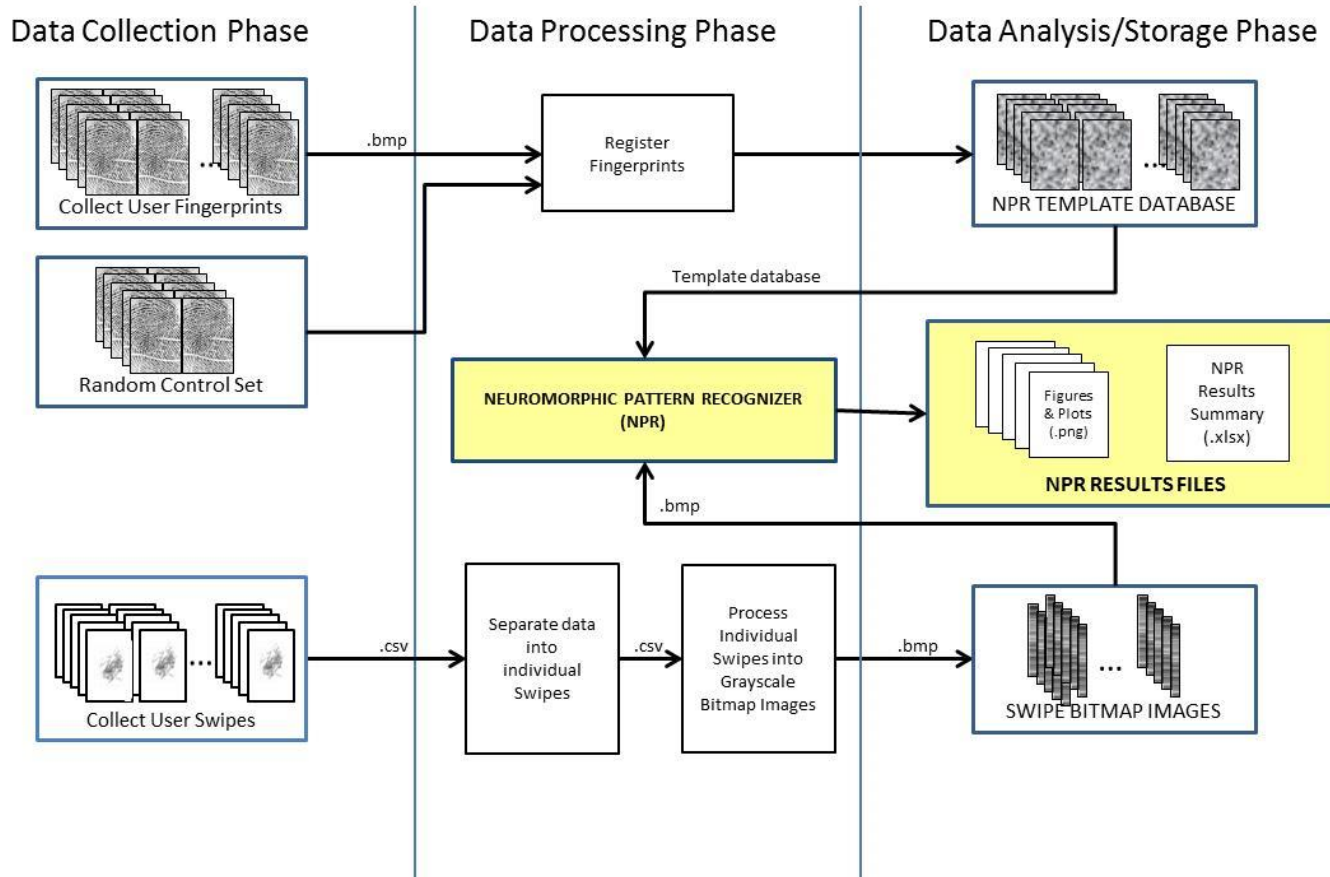
- Match Cypress CYTK58 device touch interactions of specific users to their actual fingerprint images utilizing the AMI Neuromorphic Pattern Recognizer (NPR) to continuously verify active users of the device.

- **Implementation**

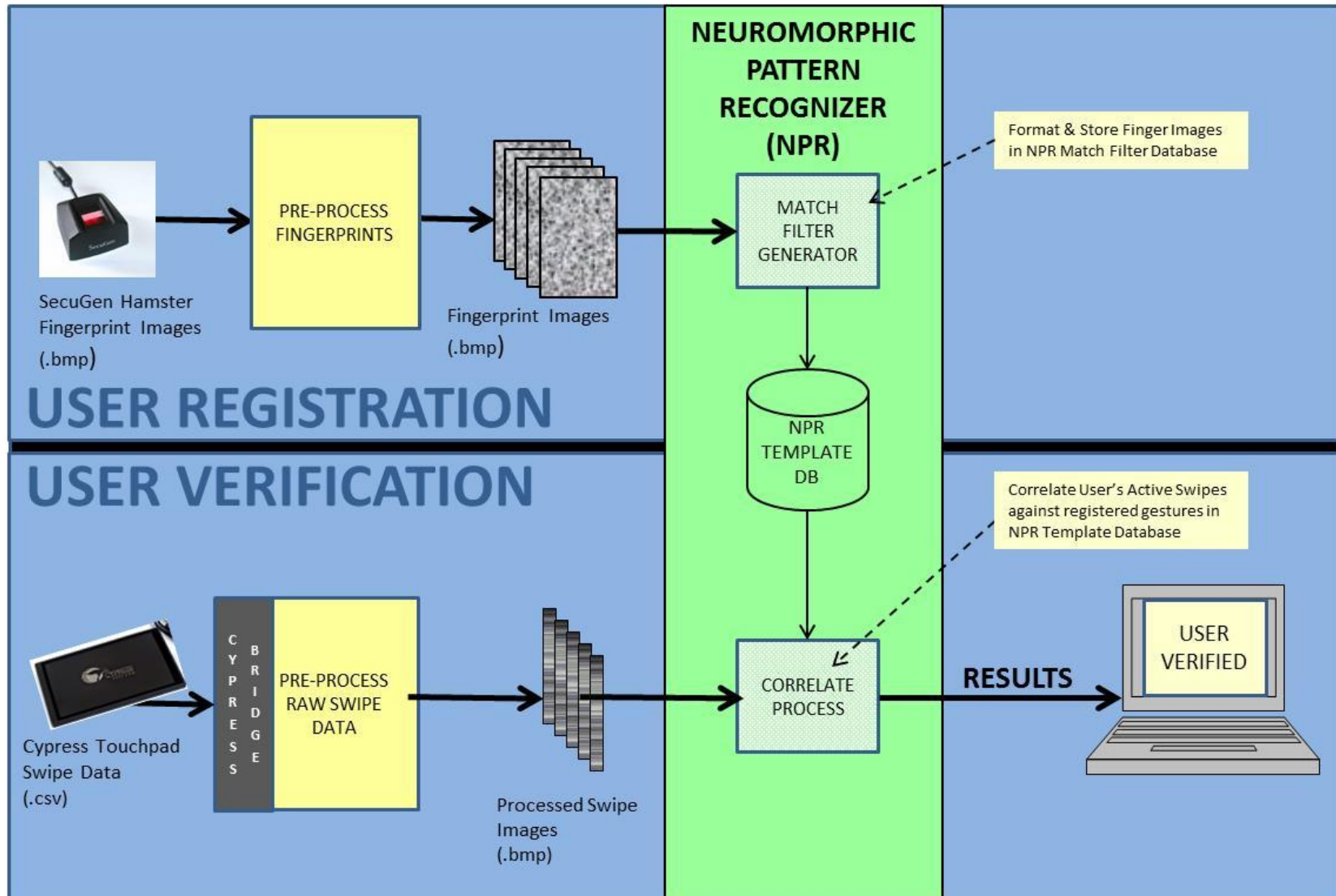
- **Registration:** User fingerprint images are collected utilizing an off-the-shelf fingerprint reader. Fingerprint images are processed into a template database in NPR format for use in the user verification process.
- **Device Operation:** Each user interaction with the device is processed into individual bitmap images representing the user's fingerprint ridges as the user's fingers pass over the device sensors.
- **User Verification:** The fingerprint ridge bitmap images obtained during device operation are passed to the AMI Neuromorphic Pattern Recognizer (NPR) and correlated against the registered images in the user's template database.

Finger Image Development Process Overview

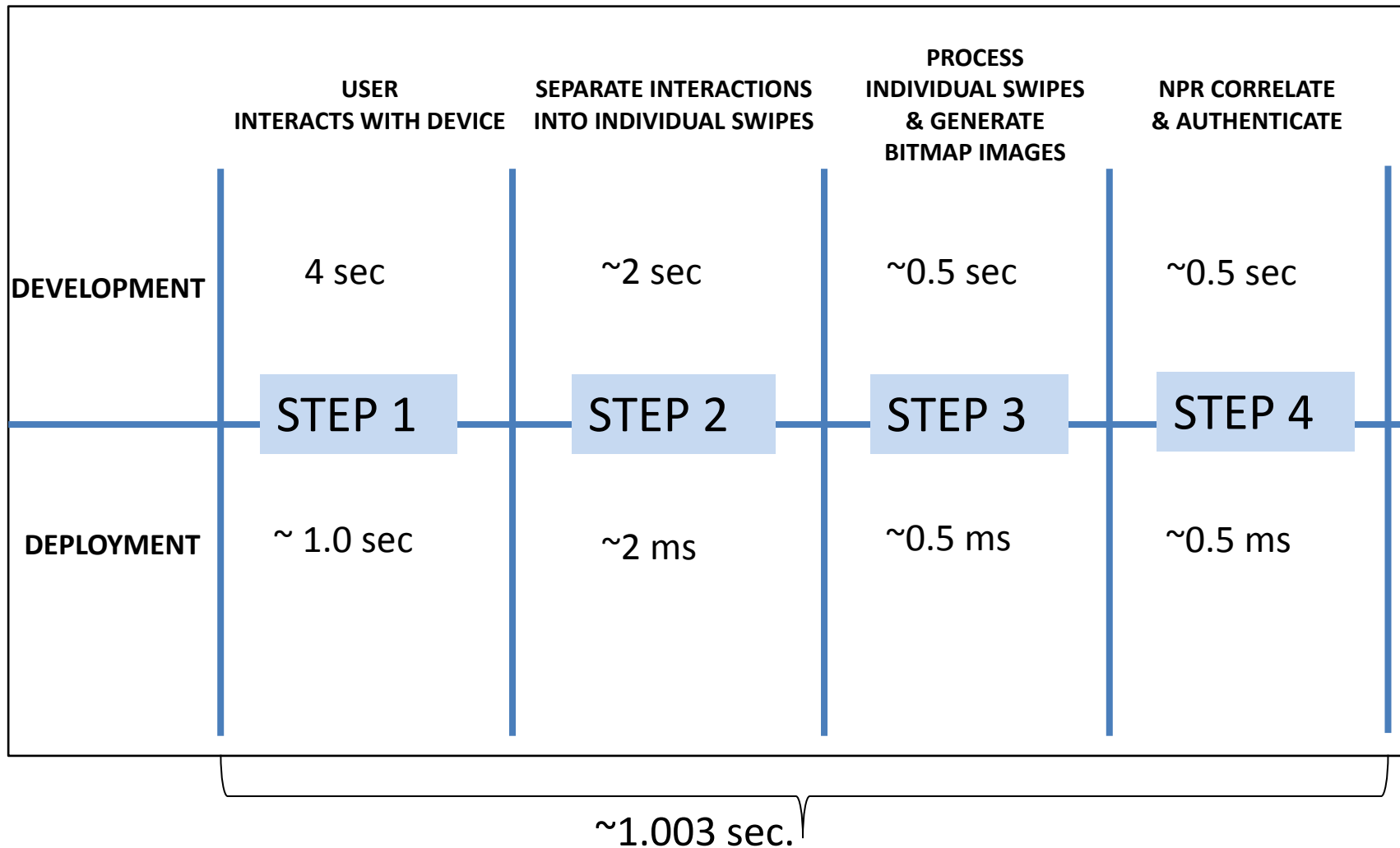
Finger Image Development Process



Finger Image Overview



Finger Image Timing

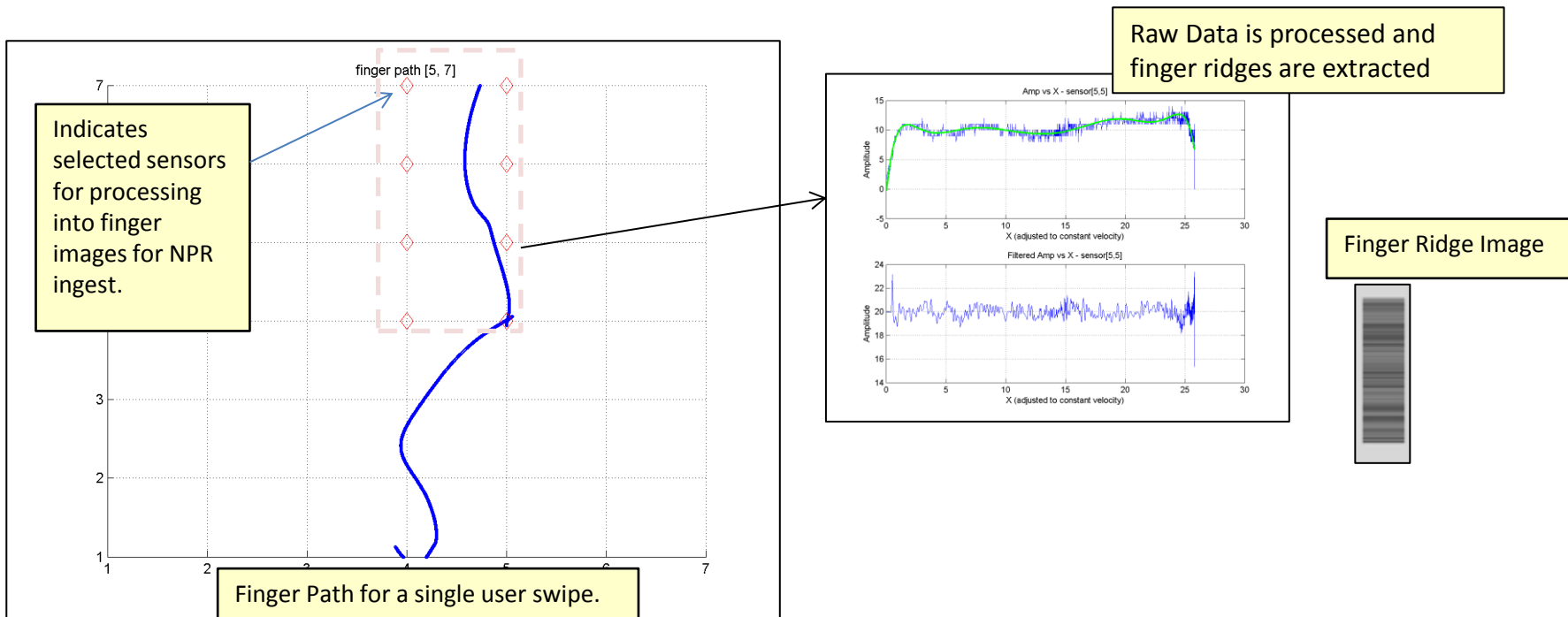


Finger Image – Sample Rate Analysis

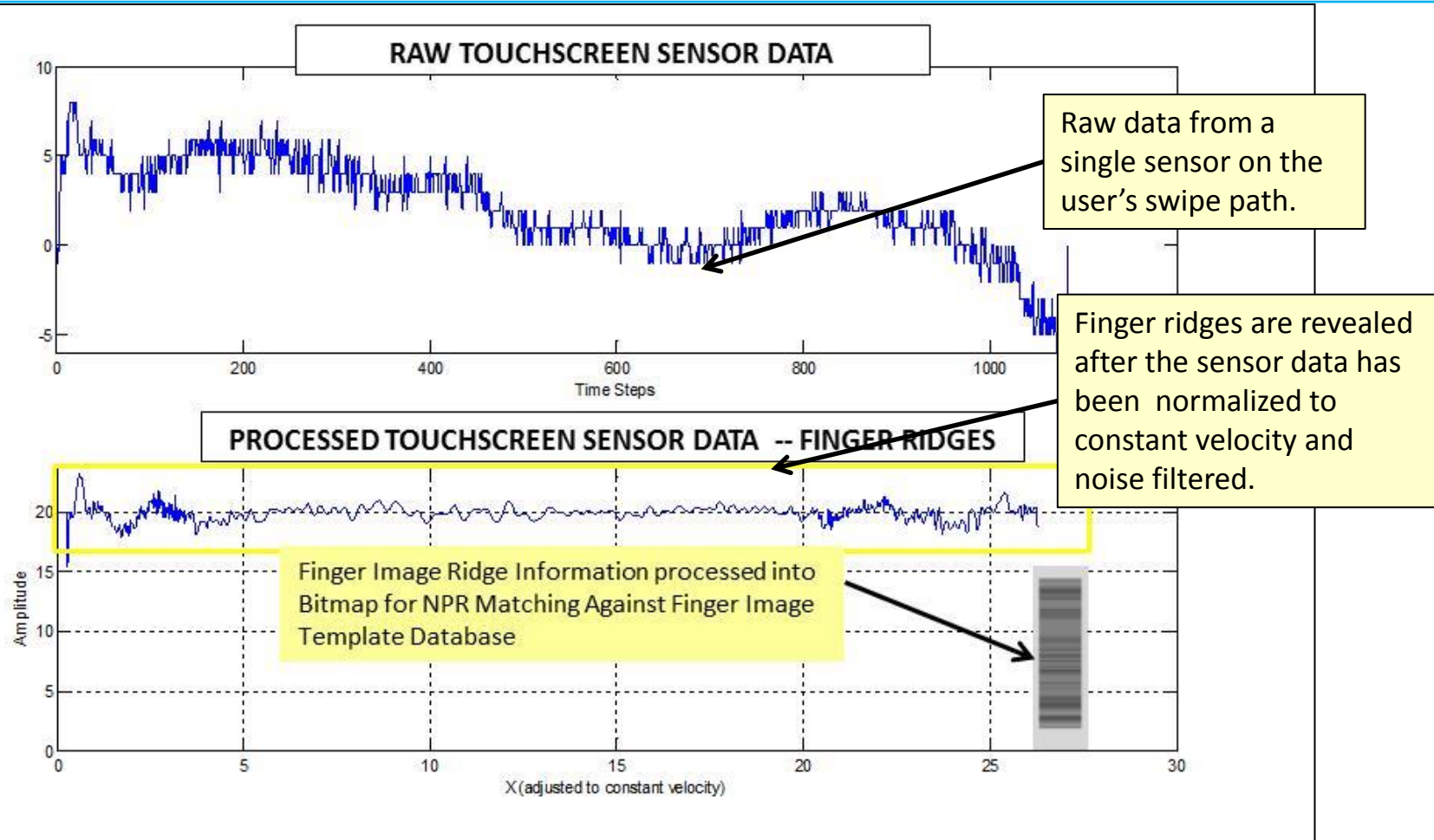
- **Development platform sample rate**
 - 250 Hz
- **Device Operation/Deployment Sample Rate**
 - 14.2 kHz
- **Algorithm Deployment Requirements Analysis**
 - The average swipe rate was 92.0 inches/second
 - It was determined to accurately sample a finger image at this rate of speed, a sample rate of 14.2 kHz is optimal
 - Because this rate was calculated using the fast swipes, it is also appropriate with any slower speed interaction with the device, which may be more common than a fast swipe

Finger Image – Sample Raw Data

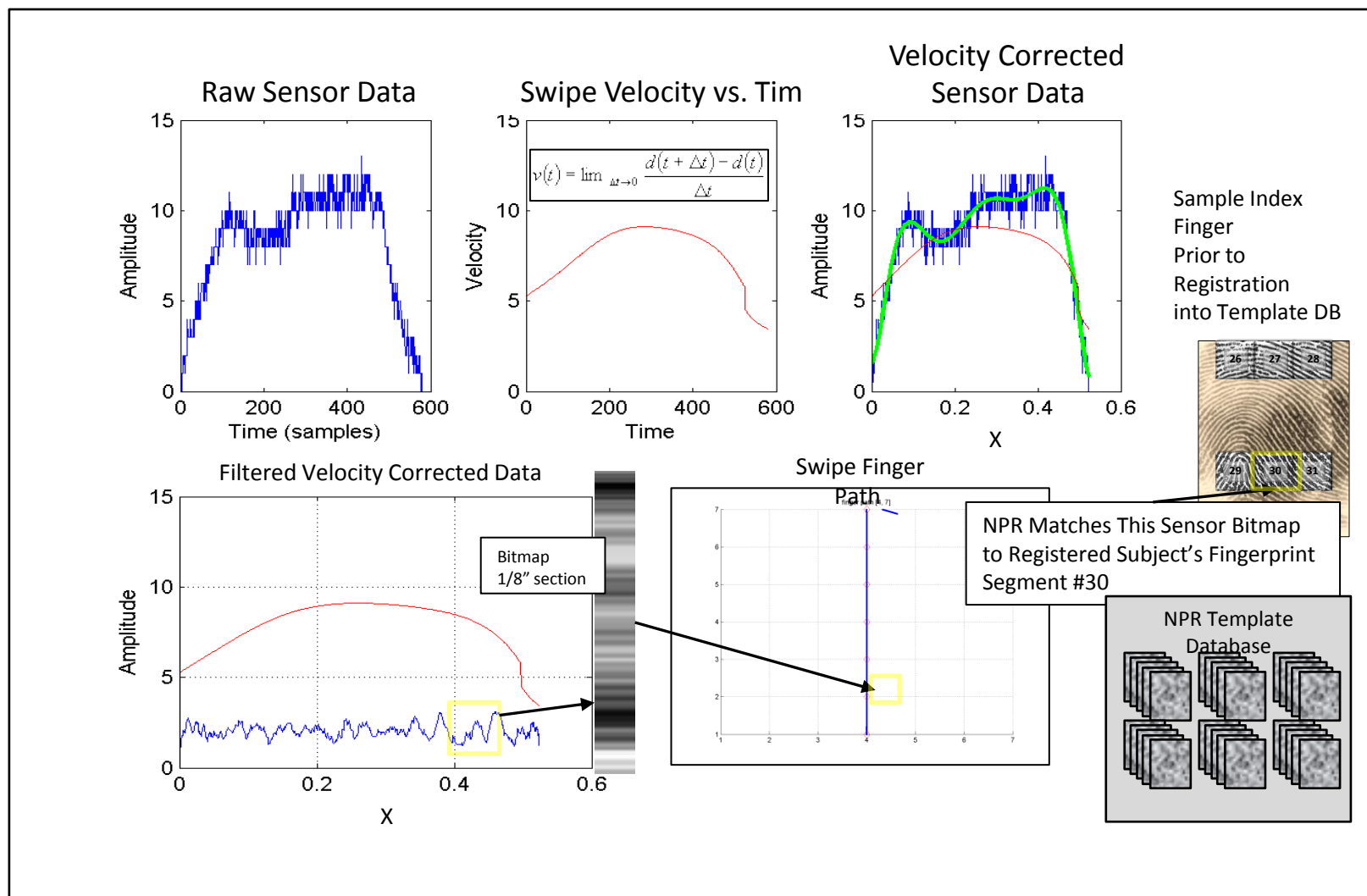
- The Finger Swipe Path over the sensors is plotted from the raw data
- Sensors along the Finger Swipe Path are selected for processing into finger ridge bitmap images. (indicated by red diamond shapes)



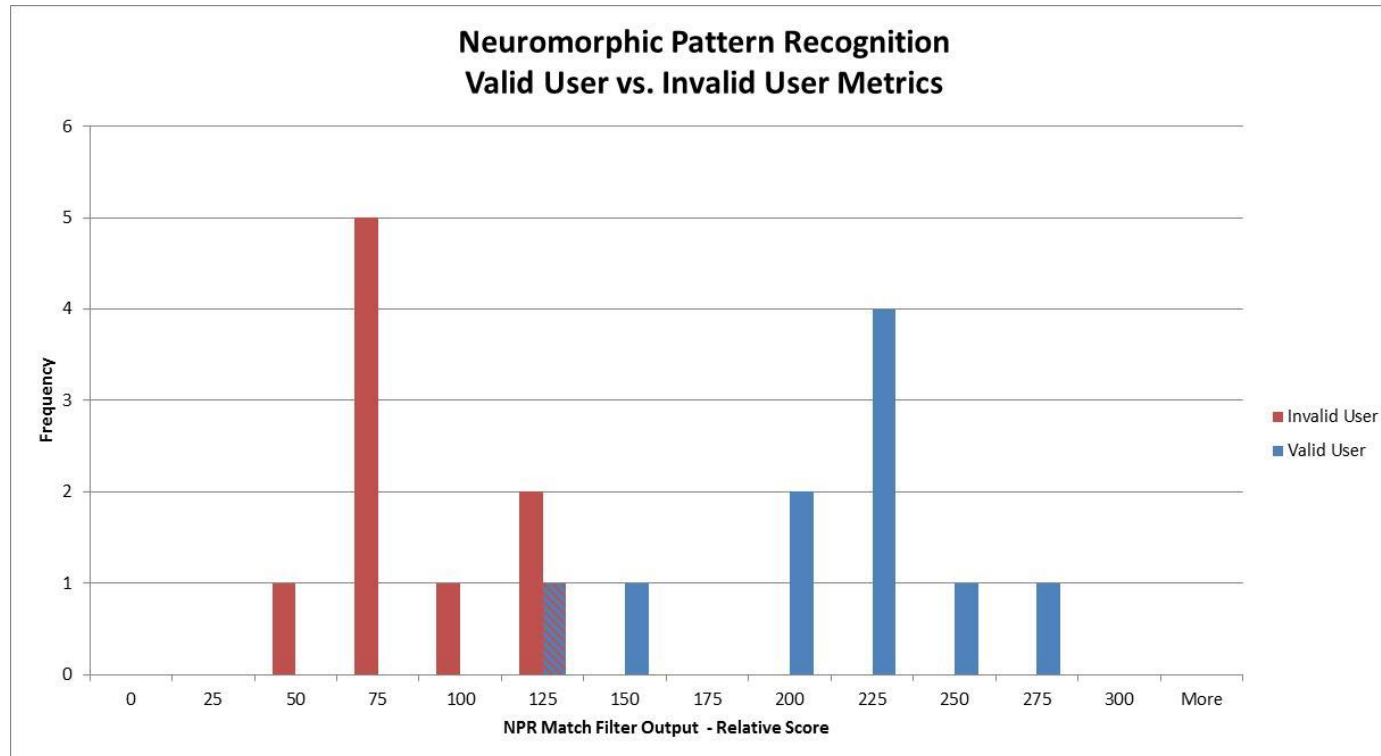
Finger Image – Sample Processed Cypress Data



Sample Raw Sensor Data Processing



NPR Finger Image Metrics



Sample Data for Metrics: 11 Users/ 10 Swipe Bitmaps Each (out of a database of 100 Collected Users)

True/False Positive Rate: 10% at the Equal Error Rate (EER)

False Acceptance Rate: 10% at the Equal Error Rate (EER)

Time Before Decision: ~ 1 minute

Platform: Windows 8.1 64-bit OS, Intel® Core™ i5-4200U CPU @ 1.60GHz 2.30GHz with 8GB RAM

Summary

- AMI has proven that a finger image can be captured using the existing touchscreen hardware and can correlate this image to a finger print template
- AMI has shown that habitual gestures are unique to a user and we are able to distinguish between users
- AMI has applied our NPR algorithm to habitual gestures Finger swipe sample rate needs to be increased from the development platform to make system real-time
- Working to incorporate into either the touchscreen controller firmware or Android kernel