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CSR: Small: Surviving Cybersecurity and Privacy Threats in Wearable Mobile Cyber-Physical Systems

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Introduction & Motivation

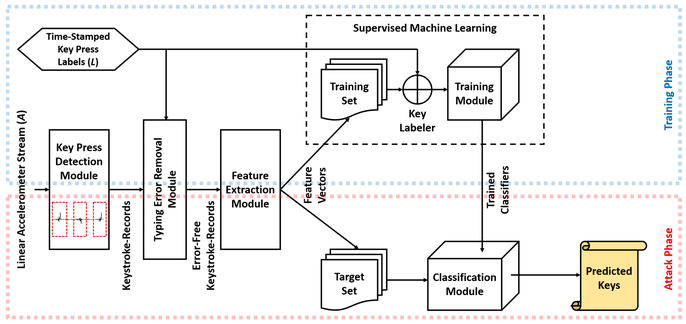
- Smart wearable devices, such as smartwatches, are becoming mainstream and fast replacing their traditional non-smart counterparts.
- However, there is inadequate understanding and awareness of the various ***side-channel security vulnerabilities*** that are enabled by these wearable devices, and how to ***protect*** users against them.

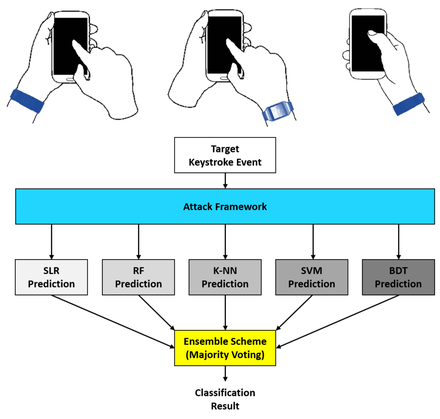
Side-Channel Attacks

We demonstrate that wearable devices enable novel side-channel security and privacy threats:

- ***Mobile keystroke inference [1,6]:***

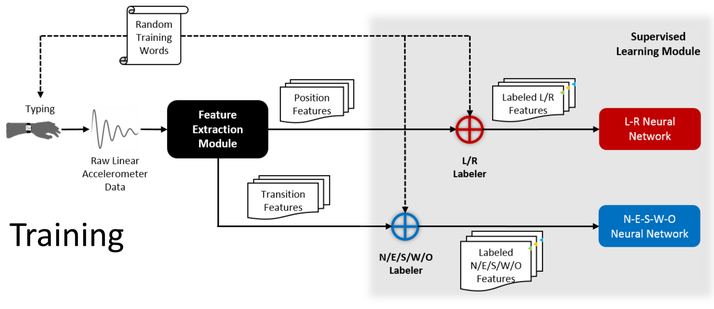
Key tap inference attacks on handheld numeric touchpads by using *zero-permission* smartwatch motion sensors as a side-channel.

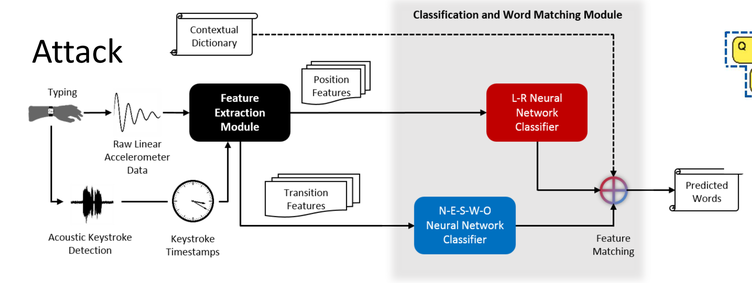


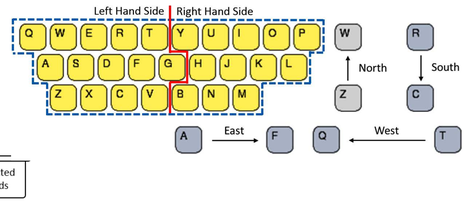


- ***External Keyboard keystroke inference [2]:***

Keystroke inference attacks on external QWERTY keyboards using smartwatch motion sensors as side-channel. We characterize wrist movements based on the *relative physical position of keys* and the *direction of transition* between pairs of keys. Keystroke characteristics are then matched to candidate dictionary words.







- ***Location tracking (in progress):***

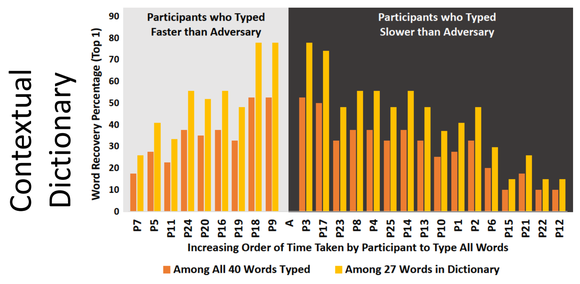
Tracking automobile drivers using inertial information computed from driver's smartwatch.

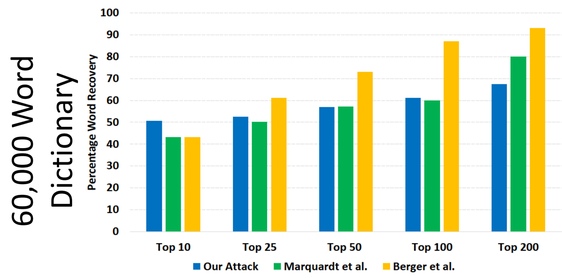
Evaluation Results

- *Mobile keystroke inference:*

Experimental evaluation using commercial off-the-shelf smartwatches show that key tap inference using smartwatch motion sensors is not only fairly accurate (more than 90% in certain scenarios), but also comparable to (and better than) similar attacks using smartphone motion sensors.

- *External Keyboard keystroke inference:*



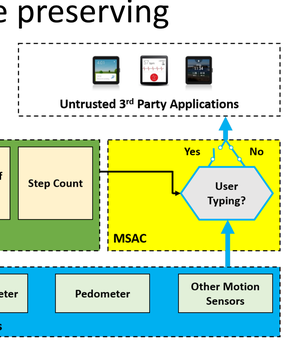


Protection Measures

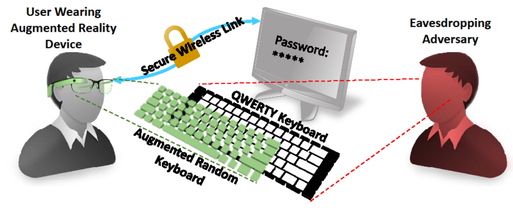
We developed ***design-time*** and ***run-time protection*** mechanisms to protect against some of the demonstrated side-channel attacks, while preserving ***acceptable usability/utility*** of the wearable devices:

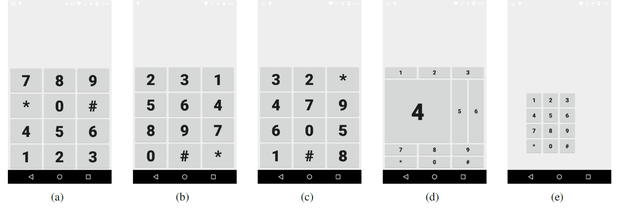
- ***Context-aware sensor access control [2]:***

Untrusted applications get access to motion sensors only when rTAD reports that the user is not typing at the moment.



- ***Randomized mobile keypads [3] and augmented reality keyboards [4]:***





- ***Studying and increasing security awareness among users [5].***

Publications Till Date

[1] Maiti, Anindya, Murtuza Jadliwala, Jibo He, and Igor Bilogrevic., "(Smart) watch your taps: side-channel keystroke inference attacks using smartwatches", In Proceedings of the 2015 ACM International Symposium on Wearable Computers (ISWC), 2015.

[2] Maiti, Anindya, Oscar Armbruster, Murtuza Jadliwala, and Jibo He., "Smartwatch-Based Keystroke Inference Attacks and Context-Aware Protection Mechanisms", In Proceedings of the 11th ACM on Asia Conference on Computer and Communications Security (ASIACCS), 2016.

[3] Maiti, Anindya, Kirsten Crager, Murtuza Jadliwala, Jibo He, Kevin Kwiat, and Charles Kamhoua., "RandomPad: Usability of Randomized Mobile Keypads for Defeating Inference Attacks", In Innovations in Mobile Privacy & Security (IMPS) Workshop, 2017.

[4] Maiti, Anindya, Murtuza Jadliwala, and Chase Weber., "Preventing shoulder surfing using randomized augmented reality keyboards", In Pervasive Computing and Communications (PERCOM) Workshop on Security and Privacy in Internet of Things (SPT-IOT), 2017.

[5] Crager, Kirsten, Anindya Maiti, Murtuza Jadliwala, and Jibo He. "Information Leakage through Mobile Motion Sensors: User Awareness and Concerns", In European Workshop on Usable Security (EuroUSEC), 2017.

[6] Maiti, Anindya, Murtuza Jadliwala, Jibo He, and Igor Bilogrevic., "Side-Channel Inference Attacks on Mobile Keypads using Smartwatches ", Under revision in the IEEE Transactions on Mobile Computing.