Problem
Interaction with Smartwatches is Difficult due to Their Small Sizes

They Are...
Pairs of simultaneous or rapidly sequential touches (and optionally one or more releases) made by the index and middle finger of one hand.

Because They Wanted a Solution to Be...
- Easily integratable with the currently dominant touch screen paradigm.
- Large enough to register two adjacent touches
- Executable rapidly and eyes-free avoiding fat-finger problems
- More Hardware in constrained spaces of the watch form factor is a luxury.
- No need of new sensors standard touch-screen input
- Easy to implement and use

Preliminary Study
Capture, analyze and understand how users perform beating gestures.

- Establish parameters such as appropriate timing thresholds to distinguish between the different touch and release beating sequences.
- Determine whether the gestures would interfere with existing input paradigms and measure the reliability and consistency.

What was captured?
User Performance
- Reliability

What are the modifiable variables?
- Placement of the Fingers
- Release of the Fingers

Important Results - Timing
- The overlap between Dual-Tap and LR/RL data was a total of 27 trials (4.1%).
- The overlap between Dual and LR/RL of 14 trials (4.3%).

This suggests that practice rapidly increased users' fluency with beating.

Results - Errors
- Extra - Those involve making additional undesired input
- Incorrect - Making the wrong input
Important Results - Errors

Majority of extra errors were due to early release of the sensors; however, these errors were occurring around 500ms suggesting that many of these extra errors represent experimental artifacts due participants anticipating when to release the screen to continue to the next trial.

Considering incorrect errors occurring in trials featured a specific combination RL followed by RL-Release. This suggests this particular beating gesture is challenging for users.

Discussion

Majority of users performed the beating gestures rapidly (300-400ms) and reliably approximately with a 5.5% overall error rate.

Cutoff values do not interfere with single taps, and beating gestures always require starting with two simultaneous on screen touches thus regular tapping input is not disturbed and accidentally triggers are reduced.

Cutoff values should be customizable to accommodate outlying users especially between Dual-Tap and LR/RL movements or be limited to either Dual-Tap or LR/RL gestures but not both.

Combining RL with RL-Release should be avoided since spikes the error rate LR-Release and RL-Release account for substantial amount of errors.

Conclusion

Beats are rich, rapid and reliable form of input for small screens, they do not require additional sensors, support existing interaction styles, minimizes the need for on-screen feedback and increases the expressivity of touch.

Introduction Cont.

Touch Screen Input

Simple - Single input detection eg. Stylus, finger, or knuckle.

Multi - Multiple input detection eg. Pinch gesture

Duet - Software
Duet - Study

Accuracy

Ten-Fold Cross Validation

Per User Classification

General Classifiers

Several Online Maps Services

Google Maps
Open Street Maps
Bing Maps
ArcGis
etc.

6 Traditional Gestures

1. Pinch
2. Drag
3. Tap-and-Hold
4. Double-Tap
5. Double-Tap-and-Hold + Drag
6. Two Finger Tap

Two New Gestures to Zoom

Tap&Tap for Smartphones

Two New Gestures to Zoom

Two Finger Tap for Tablets
Why new gestures?
Added to traditional gestures with no major conflict, good to have.
More freedom to control the maps.
Easy to implement.
30% of time saved on tablets.
14% of time save on smartphones.

References