"Just Like Launching Fireworks, And Match With Function Perfectly": Explore and Evaluate User-Defined One-Handed Gestures of Smartwatch



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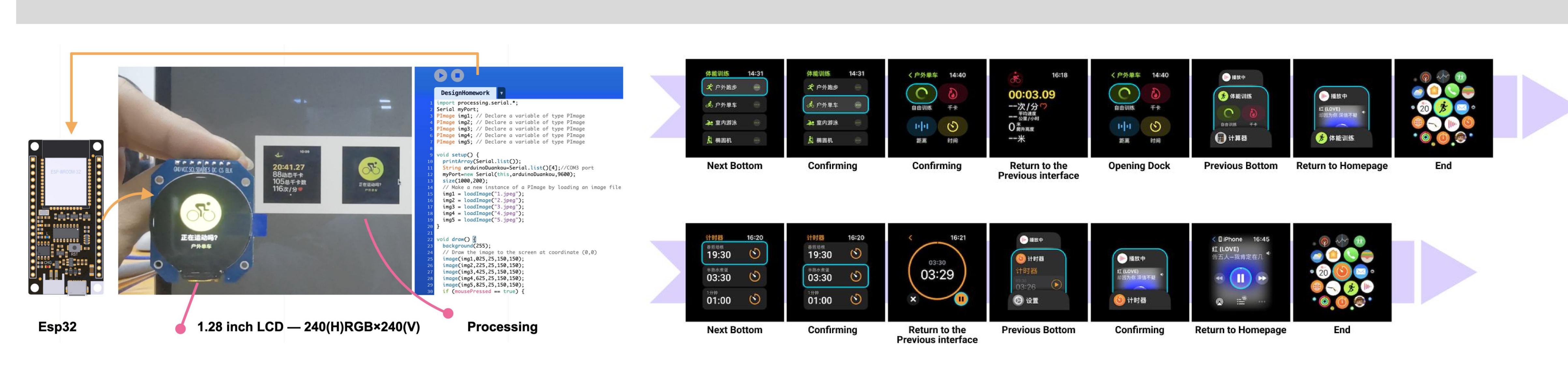
STAGE 1 Generated Gesture Self Evaluation



Background

With the popularity of mobile Internet and smart devices, wearable products (e.g., smartwatches, smart bands) are becoming more and more mainstream. One-handed gesture interaction is a more convenient input interaction method on smartwatches for some special scenarios, e.g. wearing a smartwatch when running or biking. There have been many previous studies proposing various techniques for recognizing one-handed gestures, but few studies have focused on the user perspective of one-handed gestures. To explore user-friendly one-handed gestures, what users are thinking when using the gesture, and what characteristic would make the user feel this one-handed gesture is friendly, we developed a series of one-handed gestures for 6 basic functions of the smartwatch.

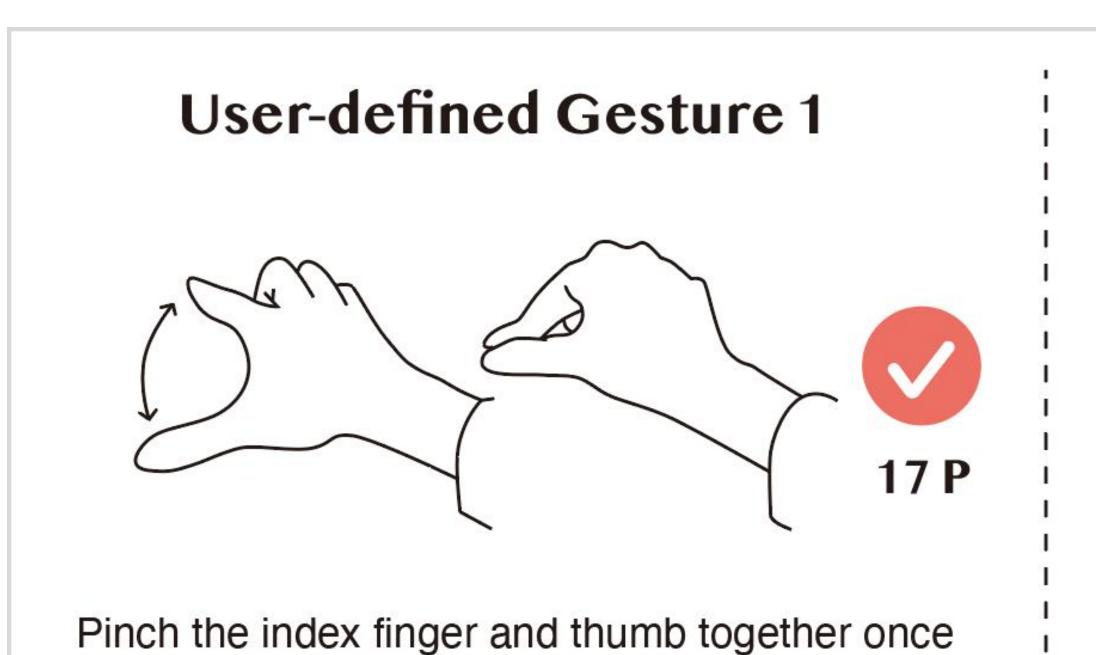
Aim & Methods

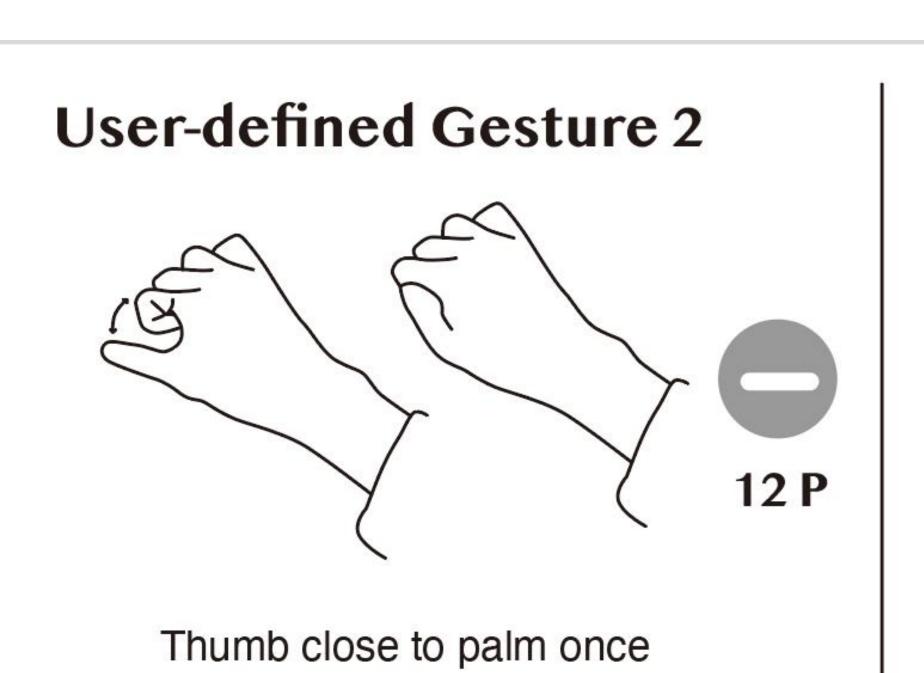


The experiment included two stages. In stage 1, we used an elicitation study to generate and filtrate gestures. In stage 2, in order to help users experience the real feeling of gesture interaction, we use the experimental method of the Wizard of Oz and build a set of a prototype that can simulate the effect of gesture interaction. Another group of participants evaluated these gestures by using a prototype, quantitative surveys, and scales. Participants in stage 1 (gestures generation) and stage 2 (gestures evaluation) did not overlap.

Results

"Previous Button" Function



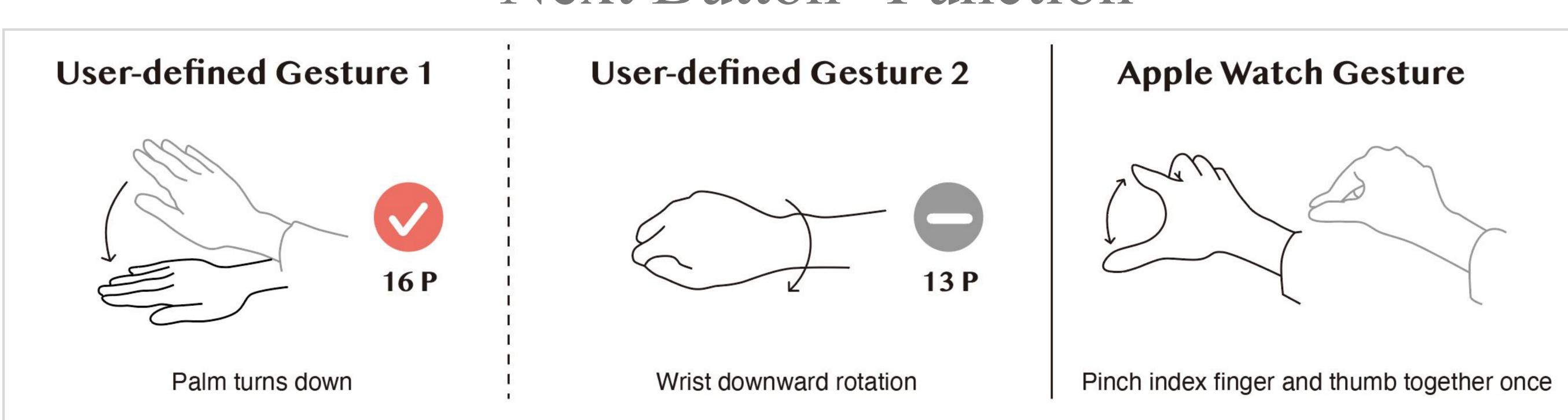




Among the two user-defined gestures, 15 participants preferred gesture 1, more than the 14 participants who chose gesture 2. The average score of user-defined gesture 1 performs better than the Apple Watch gestures on all four dimensions. There is a significant difference between the scores of user-defined gesture 1 and Apple Watch gesture on semantics.

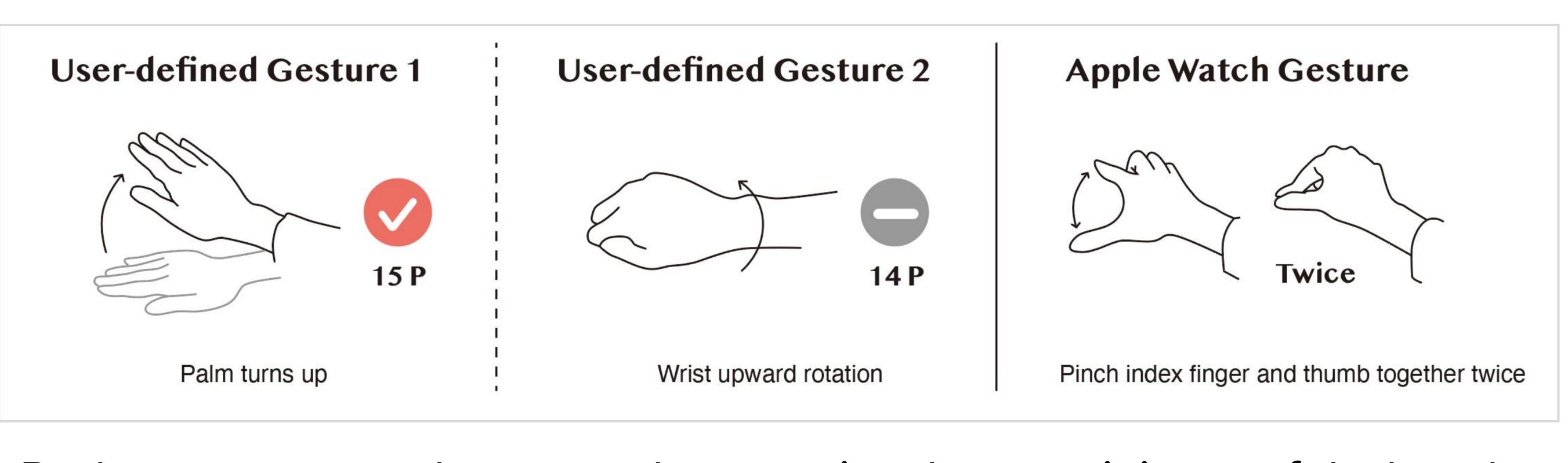
Participants mentioned many advantages of the semantics of userdefined gesture 1, "My palm moves upward with the watch screen button move in the same direction, this interaction effect with a good sense of manipulation let me feel reasonable", and "The action is really like swiping a short video in TikTok".

"Next Button" Function



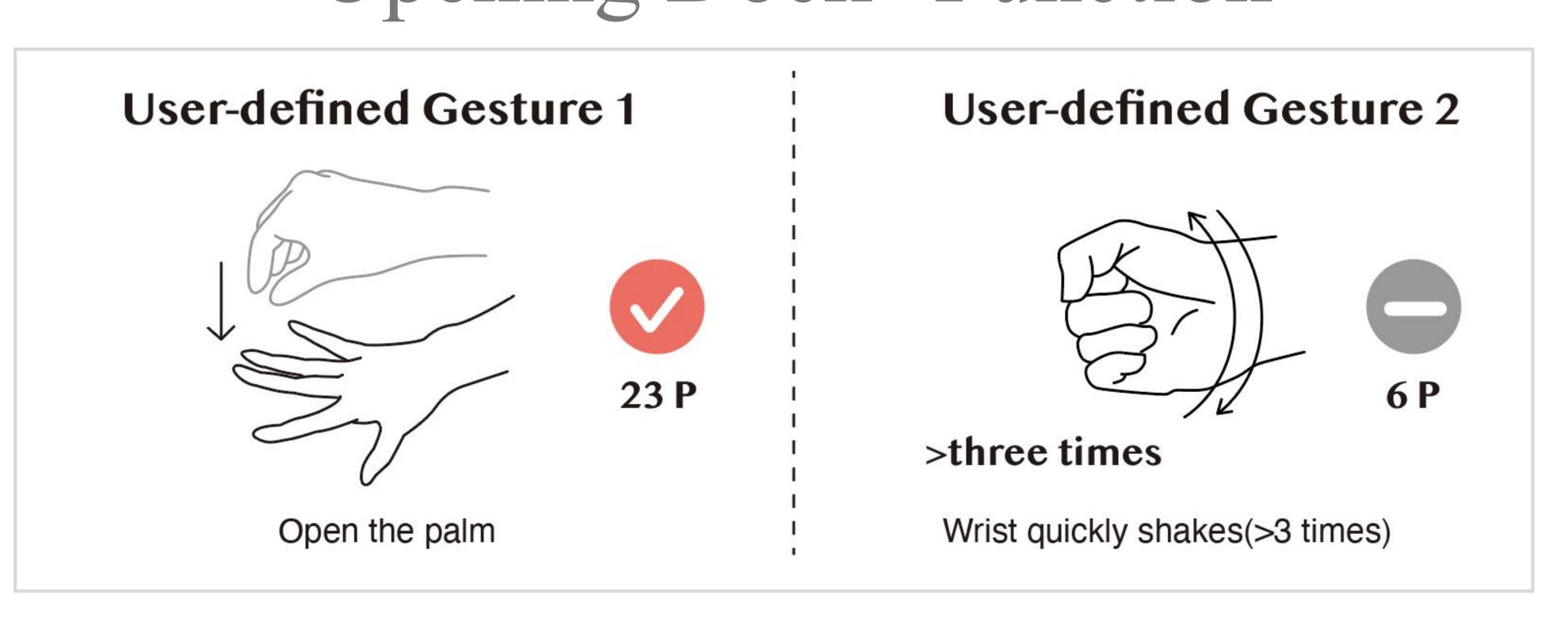
Interestingly, in the comparison between user-generated 1 and user-generated 2, participants mentioned that "Wrist rotation downward is too easy, which has no sense of control ", and "Though turning palm up and down is a bigger set of gesture, more comfortable and easier to understand than wrist rotation".

"Confirmation" Function



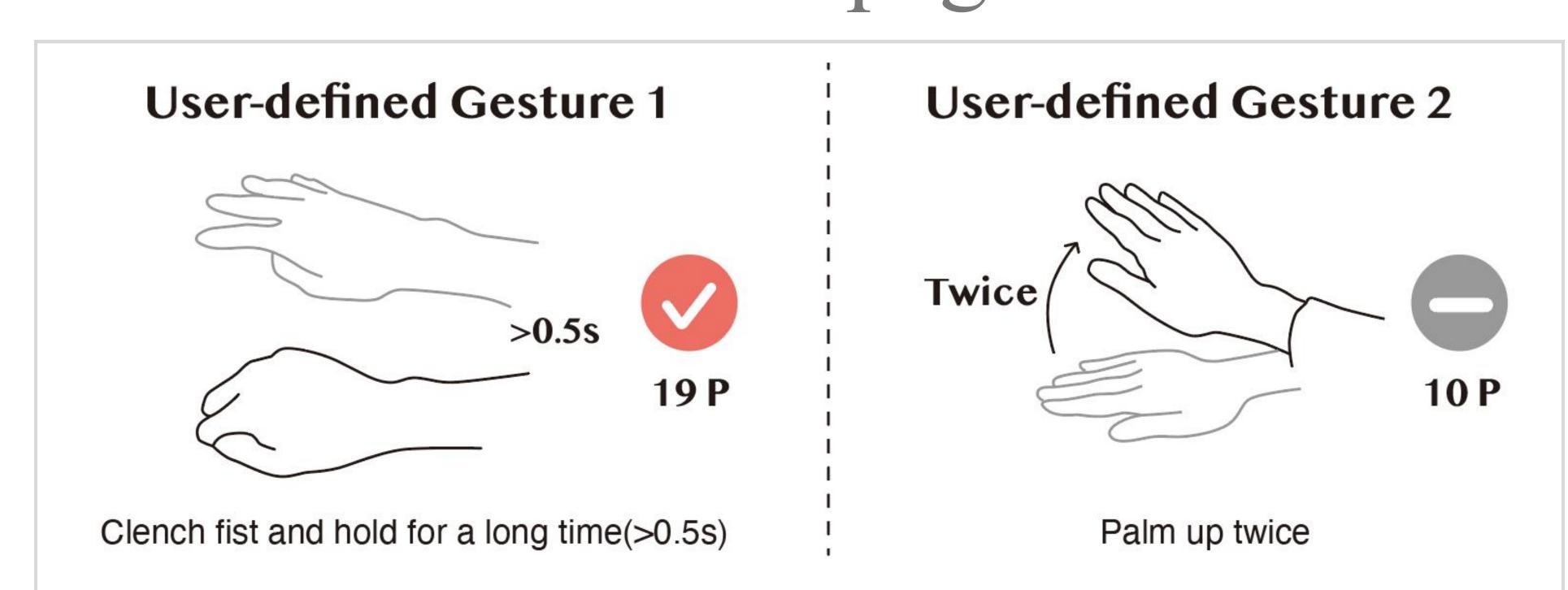
Both two gestures have good semantics, but participants felt that the semantics of the Apple Watch gesture was stronger than the user-defined gesture 1. Our Analysis is that the "Confirmation" function is so frequently used and important, so the gesture needs a strong sense.

"Opening Dock" Function



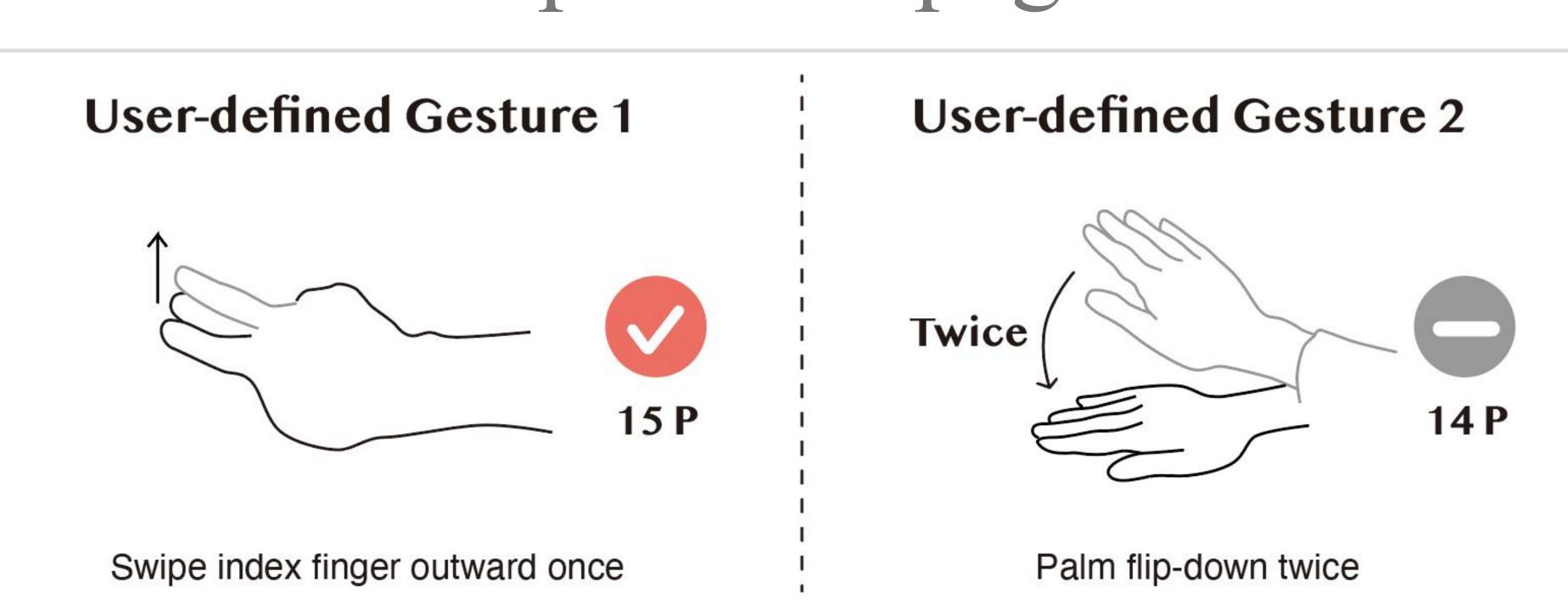
Apple Watch does not define a specific gesture for the "Opening Dock" function. So this user-defined gesture 1 can not be compared with the Apple Watch gesture. This "Opening Dock" user-defined gesture 1 got the best scores among all the user-defined gestures. Many participants expressed their love for the gesture, "It makes me imagine the blooming fireworks, fireworks also have a semantic meaning of opening", "There is no any separation between the gesture and the operation, it matches perfectly and is easy to remember ".

"Return to Homepage" Function



A total of 19 participants preferred user-defined gesture 1, and 10 participants chose user-defined gesture 2. Comparing the average scores of user-defined gesture 1 and the Apple Watch combination of gestures, gesture 1 performs better in all four dimensions. Participants mentioned many semantic advantages of gesture 1.

"Back to the previous page" Function



Among all user-defined gestures, it has the largest average score beyond Apple Watch. Many participants agreed that this gesture is reasonable, as they said "Thumb outward gives a sense of getting out of the current interface", and "The direction of the thumb is the same as the direction of returning to the previous page on the phone. Easy to remember".

Design Recommendation

Based on qualitative and quantitative results, we present some design recommendations for the one-handed gesture.

- Users prefer gestures that are simple and easy to associate, and user-defined gestures may have better semantics
- 2. Less effort is not always better
- 3. Shortcuts could be considered instead of a basic gestures combination interaction flow
- 4. Avoid designing gestures that required repeated multiple times
- 5. Gestures for "Continuous function" is worthy to be considered
- 6. Consider transferring people's experience of using flat gestures on a phone or computer to one-handed gestures in the air.
- 7. Men and women may give different ratings about the level of effort cost of a gesture.

Conclusion

This paper presents a complete study and analysis of one-handed gestures from generation to evaluation, combining user participatory design, qualitative methods, and quantitative methods.

The main contributions of this paper are:

- 1. Demonstrating a new set of simpler and more user-friendly one-handed gestures.
- 2. Propose an experimental procedure, experimental prototype and scales to develop more user-friendly one-handed gestures. This process tests the semantics of gestures twice, increasing the possibility that the semantics of gestures will be understood by most users.
- 3. Gathering interesting user qualitative insights.
- 4. Extracting some design suggestions for future gesture design.