

Visualization on Smart Wristbands: Results from an In-situ Design Workshop with Four Scenarios

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Scenario: Office



Scenario: Walking

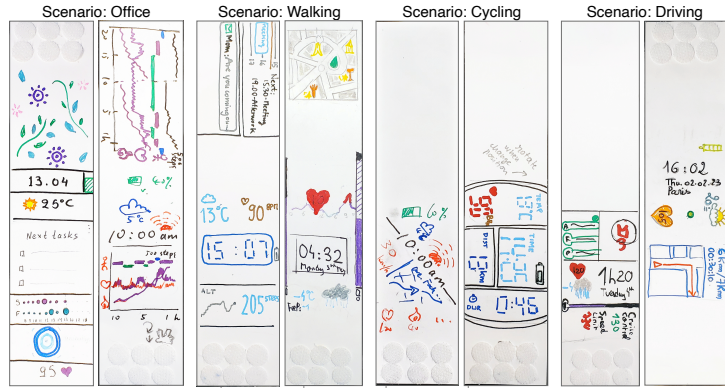


Scenario: Cycling



Scenario: Driving

(a)



(b)

Figure 1: (a) The workshop included four scenarios: office, walking, cycling, and driving. (b) Eight sketches (two per scenario) show the participants' varying use of wristband display zones. Office and walking designs used more display zones while cycling and driving used fewer. Participants expressed interest in responsive design, featuring dynamic changes based on arm posture (2), (5), and (6), the use of decorative elements (1), angled designs (5), (7), and (8), and detailed advanced visualizations (2).

ABSTRACT

We present the results of an in-situ ideation workshop for designing data visualizations on smart wristbands that can show data around the entire wrist of a wearer. Participants of the workshop created 64 sketches in four usage scenarios: office work, leisurely walks, cycling, and driving. Our analysis of these sketches shows how spatial layout and visualization design on smart wristbands may need to vary depending on the performed activity, the types of data items of interest and arm postures. Participants expressed a strong preference for responsive visualization designs that could adapt to the movement of wearers' arms. Supplemental material from the study is available here: <https://osf.io/4hrca/>.

Index Terms: Wrist-display, smartband, micro visualization.

1 INTRODUCTION

Smart wristbands, similar to traditional wrist-worn devices such as smartwatches and fitness bands, are designed to be worn on the wrist for quick access to information. These wristbands offer larger curved displays that wrap around the wrist, overcoming two main limitations of traditional wrist-worn devices: limited screen space and fixed display position. Previous research showed that the display size of smartwatches limits the number of data items that wearers typically display to 5 data items on average [3]. The limited display space also influences the type of data representations, with designs favoring simple representations such as text and icons over

charts. The small size of smartwatch displays can also negatively affect user reaction time compared to large wristband displays [1]. Another advantage of wristband displays is the possibility of using diverse locations around the wrist for visualizations tailored to the wearer's activity. For instance, when biking or driving, an individual's arms are often in positions that make it difficult to quickly check a smartwatch without rotating the wrist. In contrast, smart wristbands display information on the side of the wrist, allowing quick glances without adjusting the wrist position.

Past research focused on hardware designs and interaction techniques of large wrist-worn displays. Some work used bendable displays that wrap around the whole or a big part of the wrist surface, for example electrophoretic [1] and E-ink [5] displays. The primary research emphasis of many of these works was usability evaluation of the wrist display prototypes: when used for different functions [5] (e.g., a worn watch or a flat handheld PDA) or under different interaction modalities (e.g., gesture-based [1]). Although prior research highlights the need for larger smartwatch form factors [4] and emphasizes the benefits of interacting with larger wrist displays [1], few studies have explored visualization design and diverse usage scenarios for expanded wristband form factors. In our design workshop, we focus on four usage scenarios: office work, leisurely walks, cycling, and driving; these contexts often have people moving or holding their arms in different postures. While prior work on wearables in these scenarios exists [1, 4] the impact on visualization choice, layout, and design has not been explored.

2 METHODOLOGY

We used an exploratory ideation methodology that emphasizes individual in-situ journaling [2], centered around a sketching exercise. The goal was to determine whether routine activities could inspire context-specific designs.

Participants. We recruited 16 participants: (10 F and 6 M) aged 24–34 years old. All participants were university graduates, includ-

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ing 5 Master's students, 8 PhD students, and 3 researchers.

Procedure. The workshop started with an introduction to smart wristbands and how they might work. Then, we asked participants to craft a smartband face—akin to a smartwatch face which holds the main interface from which users can glean essential information—for each of the four usage scenarios (Figure 1(a)). Before starting the design process, we fit a 4 cm-wide white paper prop around participants' wrists (see Figure 1(b)). For each scenario participants spent the first 2–3 minutes envisioning themselves engaged in the activity that they were going to design for (e.g., working at the office desk or holding the handlebars of a bike) while wearing the wristband prop. Next, participants sketched an extended smartband face on the paper prop, showing time, battery level, temperature, heart rate—common smartwatch data [3], and at least two additional data types of their choice. After initial sketches, participants removed their wristbands and spent 4 minutes refining their drawings. Upon completion, one author of the paper reviewed designs with participants and took notes on their comments. Finally, participants wore the wristband again to describe their designs aligned with their intentions, i.e., while riding a stationary bike, sitting at an office, sitting in the driver's seat without actually driving, and walking along a corridor. By the end of each step, we captured photos of participants' arms and their designs. Each design session lasted 60 minutes on average.

3 RESULTS

We collected a total of 64 sketches from the participants. To analyze the sketches, three of the authors conducted an open card sorting exercise. We annotated different aspects of the design sketches for each participant and condition, including preferred data items, data representation types, chosen display zones for data representation, viewing arm posture, any mentioned rotation angle and type, and any comments they made. Coded annotations from the sketches were compiled into a structured spreadsheet and analyzed to construct quantitative summaries of the coded items by participants and scenario, ensuring that the reported results could be traced back to the relevant sketches. Here, we present the most interesting categories observed from the card sorting.

Preferred Wristband Data. Apart from the four mandatory data items (time, battery level, temperature, and heart rate) that we instructed participants to include, they were also required to choose two additional data items based on their preferences. These additional data varied depending on the context of use. For instance, route navigation data appeared as a top choice in activities involving movement: 18.6% of the time in the cycling context, 12.3% in walking, and 11.1% in driving. Other data was chosen in all scenarios: weather information on sky conditions was consistently one of the most frequently reported data items (23.3% for office work, 21.1% for walking, 18.5% for driving and 16.9% for cycling), ranked in first or second position across all activities. Similarly, health and fitness data, including step count, calories burned, and stress level, were commonly chosen in all scenarios.

Preferred Wristband Data Representations. Participants used a total of 12 different data representations across the four study scenarios, including text, icons, charts, maps, animations, and various combinations of these representations (e.g., icon with text, chart with icon and text). Text was the primary data representation in all scenarios with 30.9% of the total representation types. Also, the use of icons was very frequent, either shown alone (14%) or in combination with other forms of representation, such as maps, charts, and animations. While representations only consisting of charts were less common (13.8%), they were often combined with other forms, including text (9.4%), icons (1.7%), or both (2.9%). The map-based representations, alone or combined with icons or text, were exclusively reported to show navigation itineraries for scenarios that re-

quired long-distance traveling. Finally, participants' designs rarely envisioned animations. When animations were used, they appeared primarily in the driving and office scenarios.

Many of the participants' ideas relied on the responsiveness of the display to make the information reading convenient by adjusting the visualization rotation angles. Participants rotated the representations in two main angles: 90° (see Figure 1(b)-(6)) and 45° (see Figure 1(b)-(5)) from the initial viewing posture they defined. In general, the 90° rotation was used for 27 designs (9 for cycling, 8 for driving, 5 for walking, and 5 for the office) compared to 4 designs with the 45° rotation angle (2 for cycling, 1 for driving, and 1 for walking). We also noticed that while the majority (23 designs) of the rotations described by participants were static, i.e., the display rotation was fixed and independent of the arm movements, only 8 designs were dynamically rotated, i.e., the display rotates following the wearer's arm movements in real time.

Spatial Layout of the Representations. Our findings indicated that participants placed the representations in four primary locations: the dorsal zone, volar zone, radial zone, and ulnar zone. The majority of data was displayed in the dorsal zone (279×)—which is where people typically wear a watch display—followed by the volar zone (79×) (below the wrist), radial zone (46×) (inside, thumb side), and ulnar zone (7×) (outside) for all types of data categories.

4 CONCLUSION

In summary, our design workshop points to several visualization design considerations for smart wristbands, but it also has limitations—for example, participants often preferred text despite its drawbacks described in prior research. The technology for smartbands is not yet commercially available, and our findings have not been tested outside the lab. Yet, research prototypes already exist, giving the visualization community an opportunity to help shape how these wristbands will be used. These prototypes can also be used to evaluate open questions suggested here: how to detect postures and viewing angles, the usability and practical advantages of dynamically updating visualizations, perceptual challenges of using curved displays and viewing data across different zones, but also how to integrate data in designs that allow to make “fashion statements.”

ACKNOWLEDGMENTS

We thank the participants of our design workshop, Konstantin Klamka and Shaela Quader Ontu, for their feedback. This work was funded by ANR grant ANR-18-CE92-0059-01 and DFG grant EXC 2075-390740016.

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