Exploring Time Visualization on Tiny Displays for Low Vision Users

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There have been few advancements in how time is visualized on modern devices despite the technical opportunities such devices offer. For low vision users small form-factor devices, such as smartwatches, pose few practical benefits over traditional analogue devices. This demonstration shows two clock prototypes that exploit the computational power of such devices to make time more easily perceivable by users with reduced visual acuity.

CCS CONCEPTS • Human-centered computing → Visualization → Visualization techniques

Additional Keywords and Phrases: Time visualization, Low vision, Accessibility, Visual acuity, Smartwatch

ACM Reference Format:

First Author's Name, Initials, and Last Name, Second Author's Name, Initials, and Last Name, and Third Author's Name, Initials, and Last Name. 2018. The Title of the Paper: ACM Conference Proceedings Manuscript Submission Template: This is the subtitle of the paper, this document both explains and embodies the submission format for authors using Word. In Woodstock '18: ACM Symposium on Neural Gaze Detection, June 03–05, 2018, Woodstock, NY. ACM, New York, NY, USA, 10 pages. NOTE: This block will be automatically generated when manuscripts are processed after acceptance.

1 INTRODUCTION

We depend on time to fulfil our daily routines and responsibilities. Smartphones and smartwatches can be a convenient source of time information. Visualization of time is currently dominated by two idioms, namely clock faces and digit representations [1, 2]. Inspections of common products reveal that time displays often do not fully exploit the available display real-estate. Unnecessary space is often wasted on aesthetics. However, users with reduced visual acuity often read time at a close distance, with their face close to the display. Near viewing is noticeable to bystanders. It is associated with stigma as the required viewing posture deviates from that of social norms [3].

The motivation for this work was to explore alternative presentations of time to compensate for low visual acuity by exploiting the computational power of small devices, allowing low vision users to read time at the same display distance as users with uncorrected vision.

2 ZOOM AND MULTIPLEXING

The visualizations explored herein are utilizing two mechanisms, namely zoom [5] and multiplexing [6]. Zooming is a common way to increase the viewing angle of information since there is a relationship between the size of the smallest visual display element, the viewing distance, and the users' visual acuity. For instance, the standard EN 301 549 states that text in public spaces should at least have a height corresponding to an arc angle of 0.7 degrees.

DOI: https://doi.org/10.1145/3652037.3663940.

Multiplexing is the second mechanism employed herein where information is split into parts and each part presented individually [6]. In this study the information elements (hours, minutes, and seconds) are shown cyclically in sequence; each view visible for a sufficient time duration to be perceivable. To help users with orientation in the high-contrast views background lightness is used where the far/least detailed view (hours) has the lightest (less intense) background, and the nearest/most detailed view (seconds) has the darkest (most intense) background.

2.1 Digit time

Units of 2 digits (hour, minutes, and seconds) are shown cyclically in sequence allowing the text to be displayed with a larger font (300% zoom) than what is possible if all this information (6 digits) is displayed simultaneously. Furthermore, the digit pair is zoomed further so that they are partially cropped/obstructed (20%) by the viewport (see Figure 1). The goal is to strike a balance in maximizing the zoom while making the digits perceivable. The justification is that there is sufficient visual information present even if the digits are partially obscured. The user will intuitively know that the left digit will never be larger than 5 for minutes and seconds, and never larger than 2 for hours.

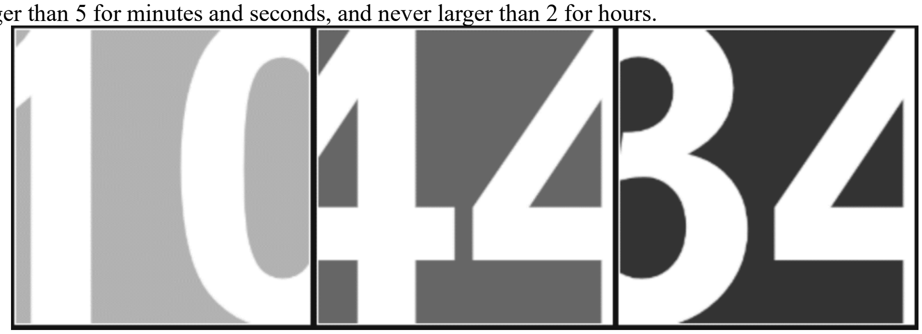

Figure 1. Zoomed multiplexed digit representations of 10:44:34 (hours, minutes, and seconds). We know that it is 34 minutes and not 84 as minutes are reported in cycles of 60 (left digit never larger than 5).

2.2 Clock face

The clock face representation also exploits zooming and multiplexing of the hours, minutes, and seconds (see Figure 2). However, there are a few subtle additional points. First, the hours, minutes and seconds are shown at increasing levels of zoom, i.e. the hour view shows a larger part of the clock face (100%), the minutes view (200%), while the seconds view shows the smallest part of the clock face (400%). The clockface is thus presented as a disc allowing the regions of the border to reinforce the perceived angle of the clock handles. These distinctive visual cues help the user orientate through the views. Furthermore, the seconds view is showing the continuous move of the second dial, providing another strong cue characteristic of seconds.

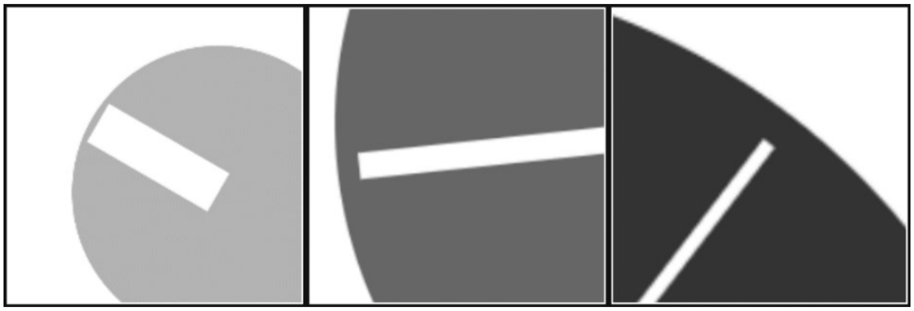

Figure 2. Zoomed multiplexed clock face representations of 10:42:12 (hours 100%, minutes 200%, and seconds 400%).

Another difference is that the zoom for the seconds view is centered around the tip of the seconds handle, while the hour view is centered around the midpoint of the hour handle (clockface radius), and the minutes view positioned ¾ towards the end of the minutes handle).

Explicit efforts were taken to minimize the visual details to facilitate faster perception.

3 CONCLUSIONS

Approaches for reading time on tiny displays with low visual acuity were presented. Zooming and multiplexing were exploited. The 400% zoom means that the display can be read at a distance 4 times that of ordinary representations. Experimentation reveals that 2 seconds seemed a suitable dwell-time for each view. Thus, one needs up to 6 seconds to read time. One may argue that the longer time needed to read time with a "cool" posture indeed is a justifiable compromise. Also, the clock face representations contain less visual detail than the digit view and may be possibly easier to perceive. On the other hand, certain angles are more difficult to perceive than others [4]. Further user studies are needed to evaluate the benefits and limitations of the proposed visualizations in context. A live demonstration of the time visualizations can be found at https://frode-sandnes.github.io/multiplexClock/.

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