Designing for Visually Impaired People with Data

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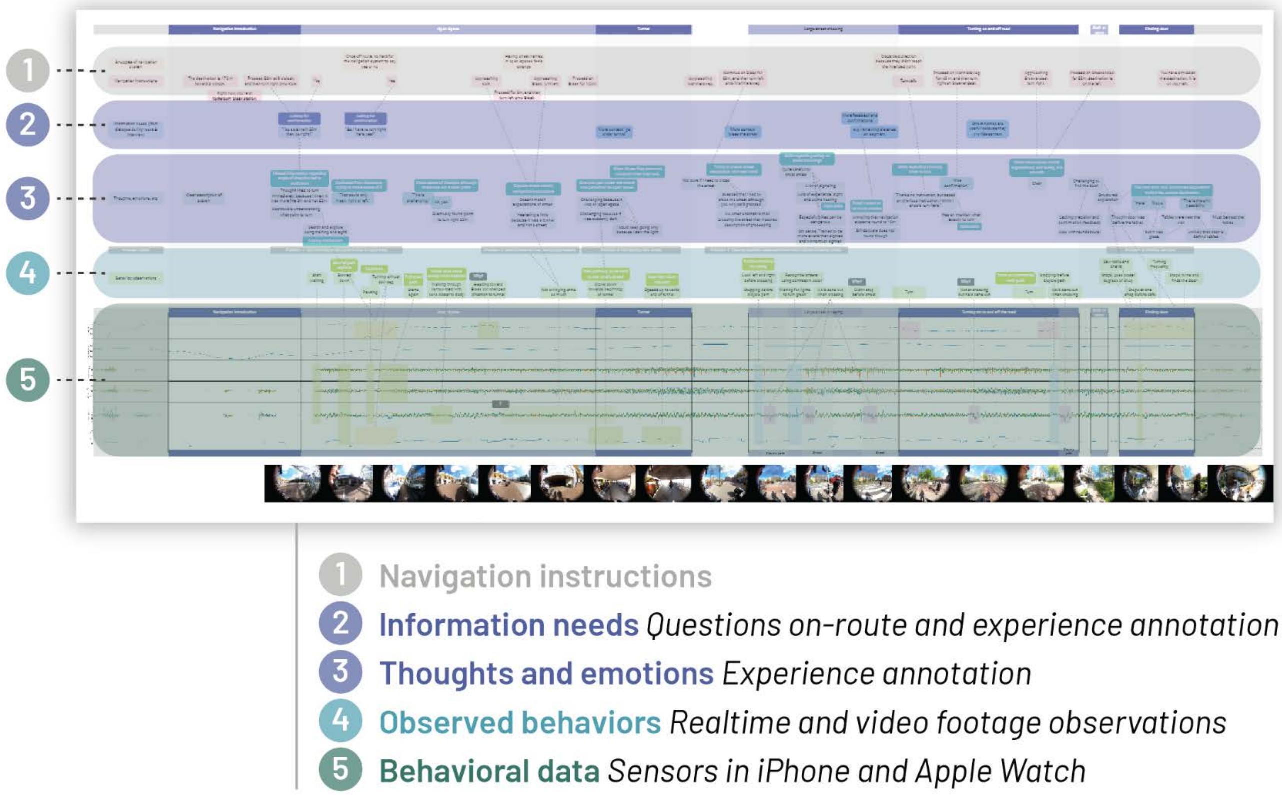

Figure 1: Things, users and researchers. The three perspectives emerging from a Data-Centric design process.

ABSTRACT

While the Internet of Things promises opportunities for ubiquitous support, solutions often need to be more reliable and address the core user needs. We explored the context of Visually Impaired People in which the reliance on their support (e.g., humans, guide dogs, or technologies) is critical to ensure their safety and ability to reach their destination while walking on an unfamiliar route. Our data-centric design approach led us to identify two simple yet essential situations that technology can reliably detect and support: 'Following' the route and 'Reorienting' on-route. This paper briefly describes the use and role of data in this process as critical enablers of active collaboration and grounded idea generation.

1 INTRODUCTION

This project focused on uncovering the problem areas, information needs, and desires of Visually Impaired People travelling outdoors by leveraging behavioural data. We conducted two user studies involving different types of behavioural data. The research question is: How can an agent partner with these users and make this process less demanding, allowing people with vision impairments to travel independently? We reflect on the use of data in the research and design process, highlighting opportinities for better grounding and new ways to engage participants.

2 PARTICIPATORY DATA STORYTELLING

In the first study, we aimed to capture the behaviour of Visually Impaired People (VIP) when walking on an unfamiliar route. We equipped our four VIP participants with off-the-shelf components: an Apple Watch (Accelerometer, Gyroscope, Pulse sensor), a GoPro Max (camera and microphone) and an iPhone (GPS, Accelerometer, Magnetometer). We asked them to walk to a café a few streets away

Figure 2: Participant 1 walking to the destination

(in the Rotterdam Black area) while the second author followed along, playing the role of navigation technology (Figures 2 and 3).

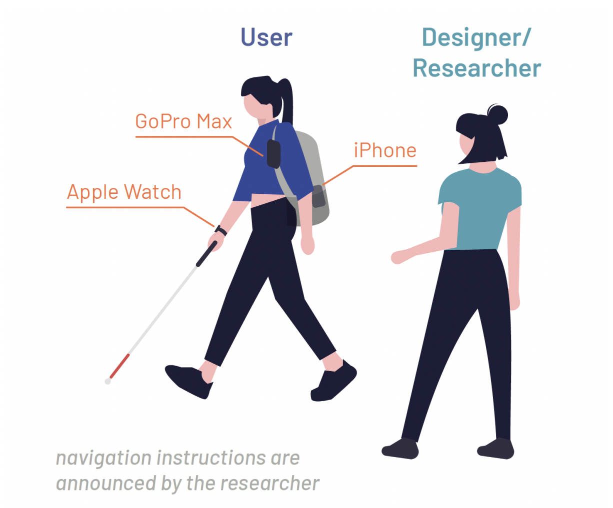

Figure 3: Setup with data collection equipment and researcher following along

We chose the route for its urban characteristics and combination of known challenges, including open space, a tunnel, a large road crossing with an island and a staircase. The researcher following the participant focused on preview and instruction type of information as illustrated in Figures 4 and 5.

Reaching destination, the researcher guided the participant to a quiet area, extracted the collected data and walked through the

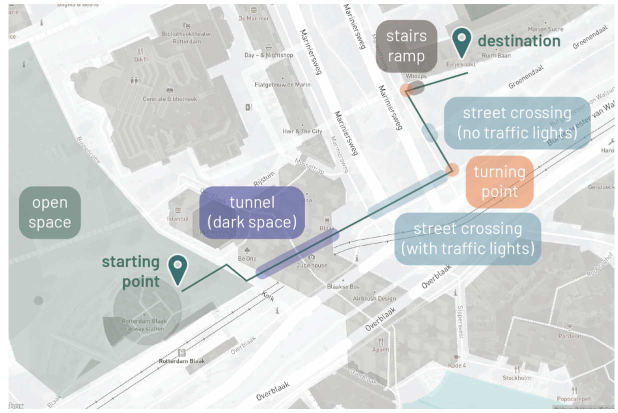

Figure 4: Route to walk in Rotterdam Balck area, with point of interests

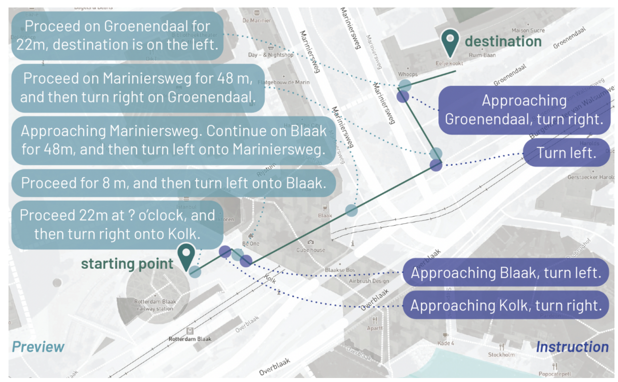

Figure 5: Instructions asked by the participants and provideed by the research during the journey, mimicing an navigation app

data with the participant. As participants were visually impaired, the researcher facilitated the participatory data storytelling in two ways. First, she replayed the video and used the sound to trigger the participant to remember the situation. Second, she described interesting moments noticed from the sensor data. This led to a three-dimensional perspective depicted in Figure 1: the object perspective from the sensors, the user's perspective from their annotation and the researcher's perspective from her data analysis.

This process led to identifying two critical situations of VIPs walking an unfamiliar route: 'following the route' and 'reorienting on the route'. These two situations appeared through the participant annotations, reflecting their mental state, moments of ease, and moments of uncertainty, and through the sensor data. We trained a machine learning algorithm to assess the agent's capability to detect the two states.

3 PARTICIPATORY DATA CREATION

This inspired the initial idea for a user-aware navigation agent, which could announce different types of data depending on whether the user is 'following' a route or 'reorienting' on the route. In our follow-up study, we explored this situational awareness depicted in Figures 6 and 7. Here, the point of attention is the potential for collaborative data generation. The research had a control panel, notified by the participants whether they were following the route or reorienting themselves. This allows for sharpening the algorithm and shaping further the system behaviour.

Figure 6: Setup of the second study, with a researcher mimicing navigation aid adjusted based on the situation 'following' or 'reorienting' (top) information provided by the researcher (middle), information requests from the participants (bottom)

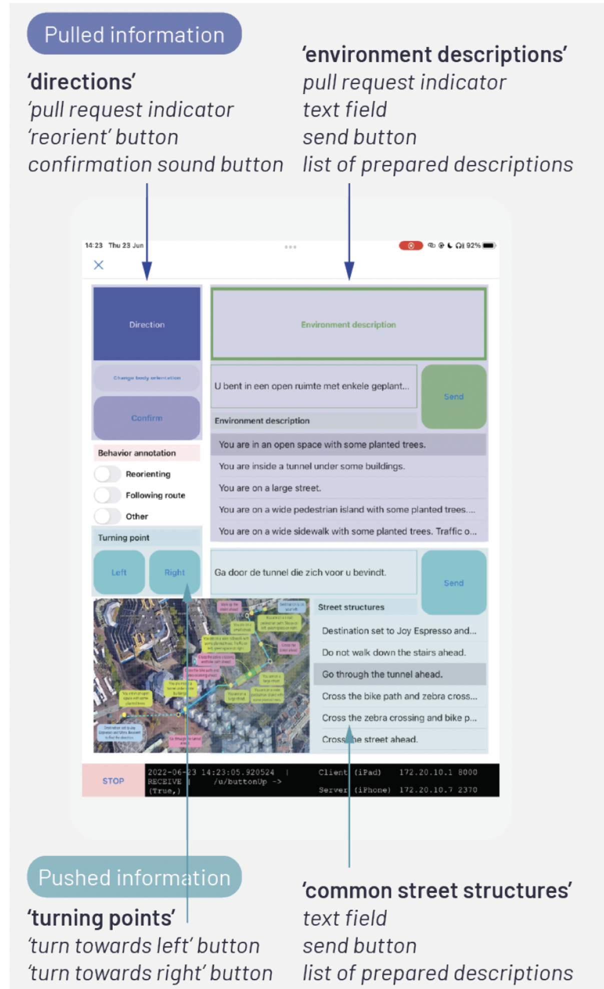

Figure 7: Researcher wizard-of-Oz control panel

4 REFLECTION

In the first user study, we collected behavioural data, analysed it with users and used it as material to tell a detailed story of what user experience. However, since the target user had vision impairments, it was not possible to directly show the data to the user. Therefore, we searched through the data, identified notable situations, and discussed these moments with the users in the follow-up interview.

The user study aimed to explore the problem and dive deep into the context. No specific hypotheses could be made at this stage. Therefore, we collected all relevant behavioural data. This project involved a lot of time-series data from sensors embedded in off-the-shelf devices.

Behavioural data is powerful because it often reflects one's mental state, which is hard to detect through observations. For example, Participant 1's travel speed decreased in the tunnel because the environment suddenly became dark. The change in travel speed was not noticeable through observations, but it showed up on the sensor data. These subtle changes in the behavioural data are effective conversation triggers. It lets designers know this could be an interesting moment to discuss.

The second user study resembles the first one in many ways. We captured behavioural data and then reviewed it with the users to gain further insight into user experience and needs. However, the significant difference was the collected data. The behavioural data was the location of where information was pulled. The participants used the prototype to guide themselves on a route. However, this stream of data that the participants were naturally creating reflected the needs and desires on the route. This collaborative process to create meaningful data that reflects user experience is the reason behind the name 'participatory data creation'.

The behavioural data collected in this second iteration was much thinner than the sensor data collected in the first user study. Therefore, the analysis was more straightforward, avoiding the need for complex data analysis tools. A visualisation (e.g., density map) was all that was necessary. Thin data also opens opportunities for big data, as explained in the previous section. Of course, the insights from the first user study were significant, driving factors in the second user study. The thick data capture rich insights but is only feasible for short sessions (maximum 1 hour) and small samples. However, this transition from thick to thin data made the thin, big data as meaningful as the thick data.