PUCK: Enabling everyday hydration tracking for older adults

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Abstract— Older adults face challenges in maintaining adequate hydration, yet current fluid tracking technologies often fail to integrate seamlessly into their daily lives. We propose further development of Puck, a compact, attachable device that enables fluid intake tracking using weight and motion sensing while allowing continued use of familiar cups. Designed to reduce stigma and disruption during social interactions, Puck addresses both functional and social barriers identified in prior work. Our ongoing efforts aim to enhance the device's sensing robustness and long-term reliability for real-world, daily use by older adults.

I. Introduction / Background

Assistive technologies can support older adults in maintaining or improving independent living [3,4]. Nonetheless, there are several domains of life in which potentially helpful assistive devices have not been integrated. An example of such a domain is tracking fluid intake at home, which is critical for avoiding dehydration-related health issues, from confusion to heart problems. Traditional methods of monitoring fluid intake, such as logs, are often prone to errors, difficult to maintain consistently, and burdensome. As a result, technological solutions have been proposed to support fluid intake monitoring, ranging from wearable sensors and vision-based systems to smart containers. Despite the growing variety of assistive technological solutions, and the availability of these tools, adoption among older adults remains limited [2, 6]. Previous research has identified a core issue: Many existing solutions do not adequately account for the actual context of use and individual and social experience of older adults [2,7].

Our previous work sought to address this gap by conducting an in-home field study with independently living older adults using an existing smart cup system (MyBeaker) as a technology probe[7]. The study revealed not only functional and usability issues but also pronounced social and emotional barriers.

In response, we developed Puck, a proof-of-concept prototype that exemplifies four requirements concerning social and individual use that we identified. While Puck demonstrated potential, our previous work also identified limitations in the device's sensing system, particularly with regard to long-term robustness and ease of maintenance. To enable extended, unsupervised use in real-world settings, the system's data collection and reliability mechanisms require further development.

II. Related work

A. State of the art fluid tracking technologies

The current Assistive technologies for tracking fluid intake can be divided into four categories: wearables, surfaces with embedded sensors, vision-and environment-based solutions, and smart containers [2]. Among these, smart containers are the most prevalent in the literature and as commercial products, as these systems can often embed surface sensors, which are a reliable option for tracking drinking events and volume changes in the vessel automatically and accurately.

However, commercial smart containers are rarely designed with older adults in mind. As noted by Plecher et al. [6], these products often fail to accommodate the physical and cognitive needs of older users and are therefore not widely adopted. Furthermore, most research prototypes have not been extensively evaluated with older adults in realistic, day-to-day contexts, leaving a gap in understanding how these technologies function in practice for this demographic.

B. Lifestyle fit requirements

To address this, our earlier work employed MyBeaker as a technology probe to study how older adults use fluid tracking devices at home [7]. Through interviews and thematic analysis, we identified key design requirements to address needs for both individual use, and social use.

For the individual uses, the following requirements were defined:

- R1: The device should allow users to use cups they already have to track.
- R2: The device should be easy to place, carry, and clean.
- R3: The usage of the device should introduce minimal hurdles in a daily routine.

For the social uses, we add the following requirement

- R4: The device should be less obtrusive during social practices where drinking is involved.

This requirement refers to the guidelines *'covert technological capability to minimize perception of assistive nature and minimize external design overlap between current traditional medical designs and new assistive technologies'* suggested by Bright et al. [3].

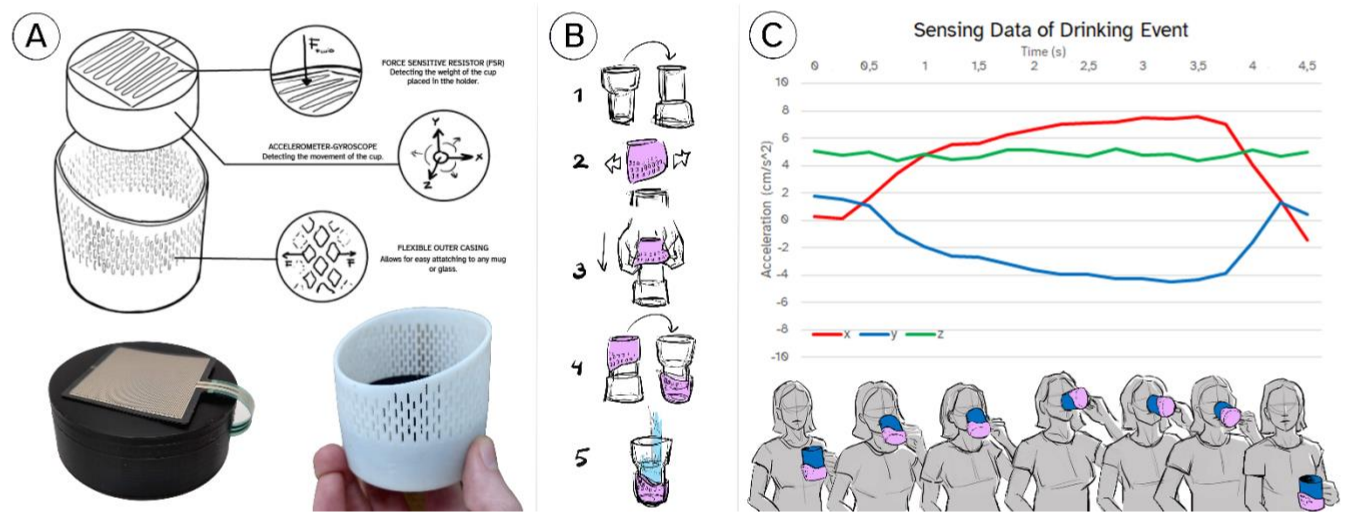

Figure 1 A) Overview of the hardware and sensor of Puck, B) Procedure of use, C) Data stream from the 3-axis accelerometer.

III. Proof of concept prototype

These requirements informed the development of Puck, a small, attachable device that uses weight and motion sensing to detect drinking events and estimate intake volume.

A. Addressing design requirements

Figure A illustrates the hardware overview of Puck, which is a flexible attachable device allowing the user to attach it to the bottom of a glass or mug by following the steps illustrated in Figure B. The sloped shape and flexible silicone outer case allow different cups to be used (R1), including those cups with ears and is minimally designed to be less obtrusive and hindering during social practices (R4).

Removing the Puck allows the glass or mug to be cleaned as usual. The device is small and light to ensure it is easily stored and carried (R2). The outer case's perforations increase malleability and lower the force needed to stretch the silicone. Making the device easy to place on any mug, even if the end-user has limited strength and flexibility in fingers and hands (R2). The data can be obtained through wireless communication and the system's power supply can be retained through a wireless charger (R3).

B. Fluid intake detection system

The fluid intake detection system works similarly to the designs presented by Zimmermann [34] and Liu et al. [21]. When the glass with a Puck attached stands stationary, the Puck measures the cup's weight using a force-sensitive resistor (FSR) and saves the value. During use, the accelerometer, which samples at four times per second, detects the glass's movements as shown in Figure C, using the detection model proposed by Liu et al. [21]. Once the accelerometer values get stabilized after use, the system estimates the liquid amount by subtracting the measured weight from the cup's weight. The event triggers data logging, so the frequency of drinking can also be tracked.

However, while Puck addressed our identified social and usability concerns, technical limitations remain. The current sensing system, though functional, lacks the robustness needed for long-term deployment and continuous data collection. Our goal is to enhance its sensing capabilities and reliability in real-world conditions, making it more viable for extended, unsupervised use by older adults in everyday environments while preserving the adherence to the design guidelines as described before.

IV. Responsible innovation

My research is focussed on how emerging sensing technologies can be leveraged to add value to society through ideally low-cost non-invasive health monitoring solutions. At its core, this work aims to prevent disease and reduce the burden on the healthcare systems, by enabling early intervention and prevention of deterioration.

From a social perspective this innovation aims to empower individuals to manage their health more proactively, with the aim to improve and prolong independent living. In doing so, it alleviates pressure on the healthcare infrastructure, which is challenged by our aging populations.

V. Author bio(s) / experiences

I am a second-year PhD student in the field of industrial design. The goal of my PhD is to create embodied systems for preventive healthcare. Fluid intake is one of the design cases in which I focus on the needs of the patient and end users. My skills are mostly focussed on quick prototyping and creating minimal viable products.

I am good at sketching, 3d modelling and skilled in several fabrication techniques, such as 3D printing and laser cutting. Additionally, I am comfortable using software tools such as Arduino and Processing.

VI. Acknowledgements

The prototype was originally created for my second year master project at Eindhoven University of technology, and resulted in a work in progress for TEI25. Portions of the text in this paper have been taken from the report submitted for that project, and the WIP paper.

I am thankful for all those who helped me with throughout this project, and specifically all healthcare professionals and older adults involved up until now.

VII. Refernces

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