

# Social Sensing with Smart Cup

## Introduction

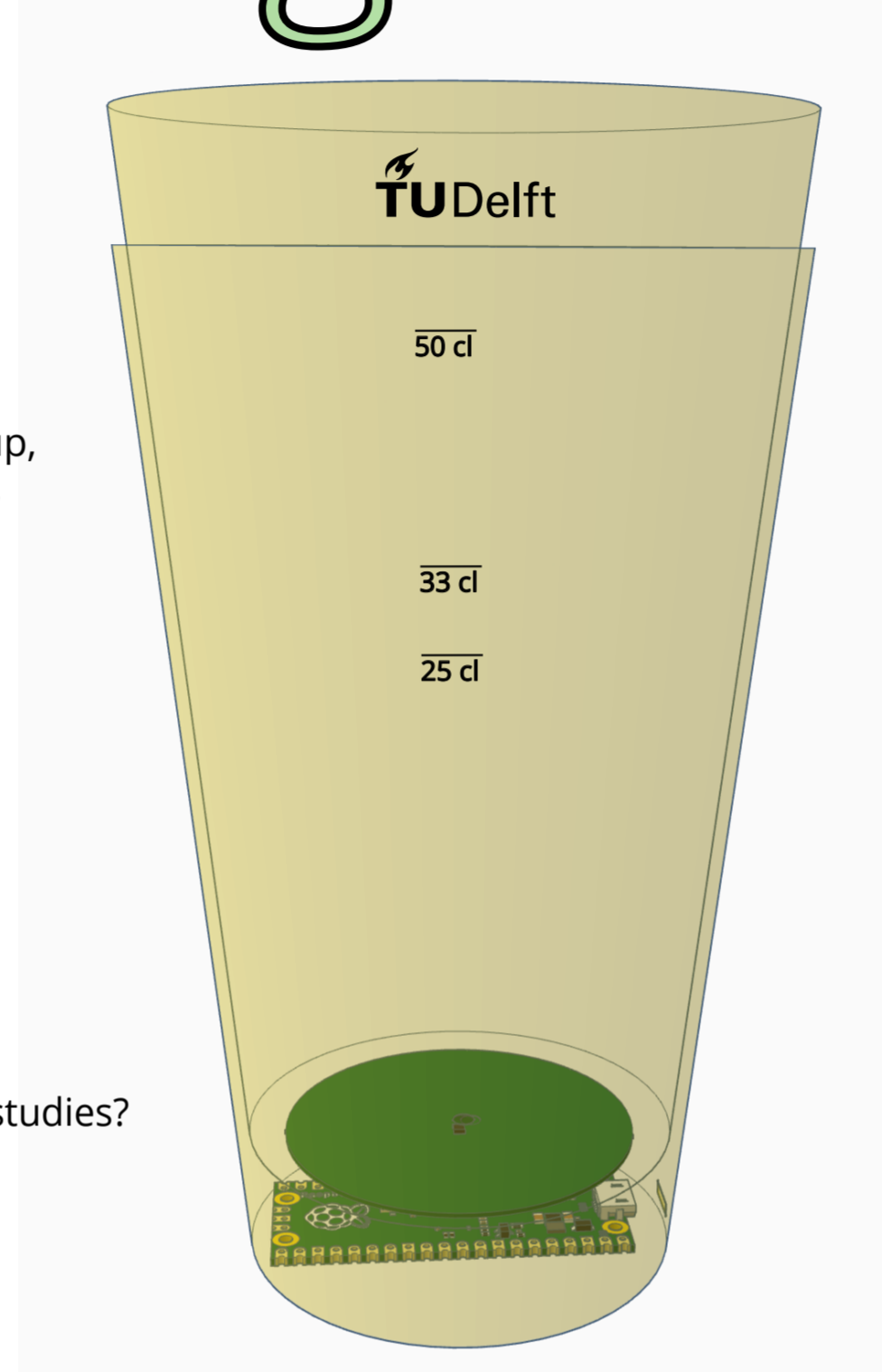
- Studying human interactions in social settings is crucial for developing socially intelligent systems
- Existing studies such as ConfLab[1] often rely on wearable sensors
- An alternative approach is to embed the sensors into a drinking cup, which is already prevalent accessories during these social activities

## Objective

- Design and build a prototype for a sensor cup, which can be used in various social sensing studies to study the drinking behaviour of participants in a social setting

## Research Question

- How can we best design a cup suitable for social sensing studies?
  - What liquid sensing technique is most suitable for social sensing studies?
  - How can these sensors be integrated into a drinking cup?



## Sensing methods

- Pitch of the cup if measured using an accelerometer (LIS2DW12)
- For volume estimation the hydrostatic sensing approach is deemed most suitable for this application
- The pressure sensor also features a temperature sensor (ILPS28QSW) allowing us to also measure the temperature of the liquids inside the cup
- A capacitive sensor is used to detect whether the cup is held (AT42QT1070)

## The Prototype

- Two plastic cups with the sensors and microcontroller inserted into the bottom compartment, keeping the appearance of a regular cup
- Sensors are embedded onto custom two layer PCB
- Pressure and temperature sensor on top of PCB exposed to contents cup
- Accelerometer and capacitive sensors on bottom of PCB along with LED
- Aluminium foil inserted between the inner and outer cup connected to the capacitive sensor
- Raspberry Pi Pico used as microcontroller collecting data to onboard storage

## Results

- Measurements were validated by a small experiment where we give specific instructions, illustrated in Figure 1
- A separate experiment was conducted to test the accuracy of the volume estimation by comparing it to a reference value, this resulted in a mean absolute error of 4.4 mL

## Conclusion

- Liquid level detection can be achieved using a pressure sensor
- Accelerometer can be used to measure cup orientation, detecting pitch changes during drinking
- Capacitive sensing with aluminum foil to detect cup holding proved unreliable due to the influence of the contents inside the cup

## References

- [1] Chirag Raman, Jose Vargas Quiros, Stephanie Tan, Ashraful Islam, Ekin Gedik, and Hayley Hung. ConfLab: A Data Collection Concept, Dataset, and Benchmark for Machine Analysis of Free-Standing Social Interactions in the Wild. *Advances in Neural Information Processing Systems*, 35:23701–23715, December 2022

Figure 1: Sensor values of Smart Cup annotated with given instructions

