Accessible Operation Methods of Coffee-Machines

Thomas M. Wendt
thomas.wendt@hs-offenburg.de
Offenburg University of Applied Sciences
Offenburg, Germany

Anke Fischer-Janzen
anke.fischer-janzen@hs-offenburg.de
Offenburg University of Applied Sciences
Offenburg, Germany

Katrin-Misel Ponomarjova
katrin-misel.ponomarjova@hs-offenburg.de
Offenburg University of Applied Sciences
Offenburg, Germany

Kim Zähringer
Offenburg University of Applied Sciences
Offenburg, Germany

Andi Schnebel
Offenburg University of Applied Sciences
Offenburg, Germany

Kristof Van Laerhoven
kvl@eti.uni-siegen.de
University of Siegen
Siegen, Germany

ABSTRACT

This work presents an extension for a coffee-machine that is intended to facilitate its use by people with disabilities. For this purpose, a control method was developed using three wireless buttons and a user interface that allows the selection of several coffee specialties. This selection is translated by a Python script into stepper motor movements fixed to the coffee-machine. With this setup, it is possible to incorporate multiple input modalities such as eye tracking and voice control. Detailed instructions can be found in [1].

CCS CONCEPTS

• **Human-centered computing** → **Accessibility theory, concepts and paradigms**; **Accessibility technologies**; • **Hardware** → **Displays and imagers**; **Sensors and actuators**.

KEYWORDS

Gastronomy, Shared Workspace, Automation

ACM Reference Format:
Thomas M. Wendt, Anke Fischer-Janzen, Katrin-Misel Ponomarjova, Kim Zähringer, Andi Schnebel, and Kristof Van Laerhoven. 2024. Accessible Operation Methods of Coffee-Machines. In *The PErvasive Technologies Related to Assistive Environments (PETRA) conference (PETRA '24), June 26–28, 2024, Crete, Greece.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3652037.3663900

1 INTRODUCTION

In 2021, 0.9 million jobs in Germany were staffed by people with severe disabilities [6]. Such jobs can be found in various sectors such as gastronomy, health and social services, construction, agriculture and forestry. In the gastronomy sector, few companies complied with the employment obligation in 2021 [6].

Based on research conducted in home kitchens, factors that indicate inaccessible kitchens have been identified. These include kitchen counter heights and wall-mounted cabinets that are not suitable for wheelchair users [2, 3]. In addition, people with cognitive or visual impairments may have difficulty locating ingredients and kitchenware [2]. Accessible kitchenware was identified as one of the top three unmet needs for people with hand motor impairments, along with speech recognition and environmental control systems [7]. To the best of the authors' knowledge, retrofitting of existing kitchen appliances such as ovens, coffee machines and food processors has not been considered. One reason may be the additional manual labor to make these systems usable. However, involvement in social activities such as cooking has been shown to improve the quality of life (QoL) of people with tetraplegia [5].

A project at Esther-Weber Schule, a school for the physically disabled, has shown that gastronomy can be a promising and interesting career choice for people with disabilities. The students manage the school cafeteria with the support of teachers and assistive devices [4]. This project is still ongoing. This work presents an accessible and easily programmable user interface for a coffee-machine. The reprogramming can be done with beginner level knowledge of Python and Arduino. This system can be used by people with physical and cognitive disabilities and has been developed in collaboration with a workshop for the disabled.

2 METHODS

In collaboration with the workshop for the disabled, the requirements for an accessible coffee machine were identified based on their mobile coffee stand project and the gastronomy project [4]. In these projects, people with disabilities are employed as baristas. The requirements for this coffee machine were evaluated through interviews. The results showed that the interface should be applicable to a variety of coffee-machines and also be usable by multiple input modalities such as touch screen, buttons, eye tracking or speech recognition. Furthermore, the cost should be as low as possible. Therefore, the development was divided into two phases. First, basic functionalities are developed, including a button-controlled interface and a customizable mechanical device to transfer the desired action to the coffee-machine. In this context the word "action" refers to the selection of a coffee specialty. In a second step, the other input modalities that are part of the ongoing research will be implemented. In the following, the setup is described and an introduction to the details of the specifications is given.

PETRA '24, June 26–28, 2024, Crete, Greece

ACM ISBN 979-8-4007-1760-4/24/06
https://doi.org/10.1145/3652037.3663900

3 RESULTS

Detailed instructions for building the system are provided in the form of an instruction in [1]. It provides 3D-printable parts and the code needed to build the system using the Melitta CI Touch coffee-machine as an example. The system consists of three wireless buttons, the user interface visualized on a display, and an Arduino Giga R1 WiFi to control two stepper motors as shown in Figure 1. In this setup, six actions were selectable (espresso, coffee, latte macchiato, cappuccino, hot milk, and hot water). The first button is a toggle that allows the user to move to the next action, the second button is used to confirm the action and the third button is used to reset the system. The buttons are 6 cm in diameter and the housing measures 8.5 cm x 8.5 cm. Due to the larger surface area of the buttons compared to the original coffee-machine's 2 cm x 2 cm buttons, they are easier to use for people with reduced hand motor function, such as people with cerebral palsy, muscular disorders or paraplegia. The wireless design allows the buttons to be placed on a desk or a table attached to a wheelchair. If a different coffee-machine is used, the layout and code can be changed to accommodate the new setup. This may include changing the available coffee specialties and the layout and type of buttons, e.g. mechanical or touch screen.

4 DISCUSSION

This coffee-machine extension is an example of a simple way to integrate severely disabled people into work, such as gastronomy, through low-cost modifications and retrofitting of machines used in everyday life. The system can be built with a minimum of materials and does not require any manipulation of the coffee-machine. Because the buttons are wireless, people with gross motor skills or limited range of motion can use the system by placing the button in front of them, such as on an electric wheelchair. Another positive aspect of the wireless buttons is that the task can involve multiple people, such as a disabled person and a supervisor to correct or confirm an action. This allows for a degree of independence in professional activities and the employment of people with a wider range of disabilities. By providing a user interface, the interaction methods can be adapted to the needs of the user. The use of pictograms, pictures or text-to-speech can facilitate training. Although the task of placing empty cups and serving coffee cannot be completed without the assistance of able-bodied people, the staff approved of the helpfulness of the system. In future work, the system will be tested and evaluated in the environment of the above-mentioned school project. However, for severely disabled people who cannot move their extremities, this solution needs to be extended to other input modalities such as speech recognition or eye tracking. Due to the ongoing development of text-to-speech programs as they are used in AAC devices, speech recognition modules in particular provide an easy solution to access this coffee-machine extension and other smart home devices.

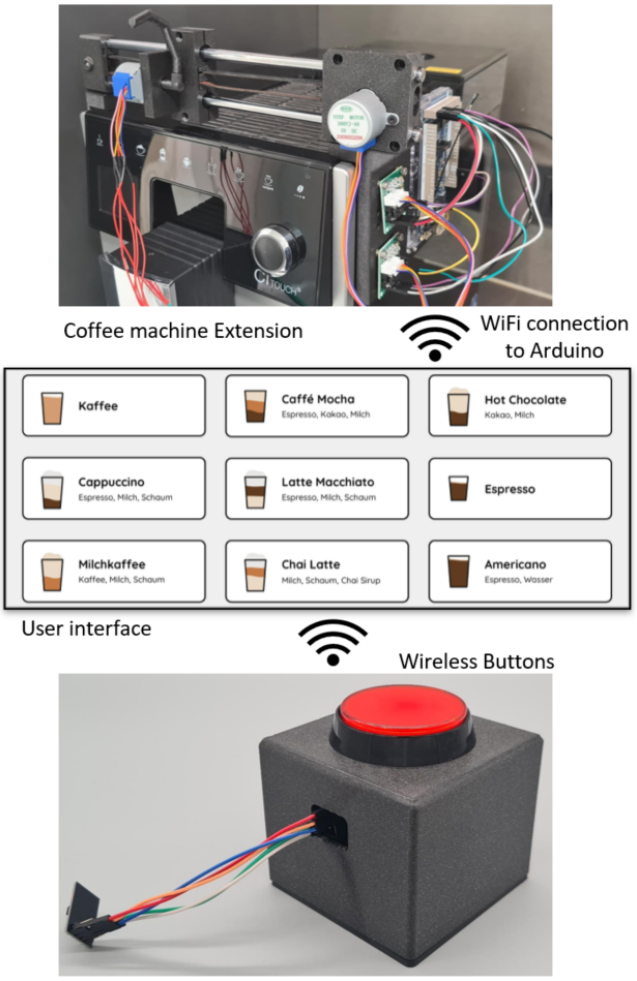

Figure 1: System overview of the setup containing the components. The first input modality for this system is based on three wireless buttons.

REFERENCES

[1] A. Fischer-Janzen, K. Zähringer, and A. Schnebel. 2024. *How to build an accessible coffee machine interface.* Retrieved February 23, 2024 from https://www.instructables.com/How-to-Build-an-Accessible-Coffee-Machine-Interfac/

[2] M. Gavaletakis, A. Leonidis, N.M. Stivaktakis, M. Korozi, M. Roulios, and C. Stephanidis. 2022. An Accessible Smart Kitchen Cupboard. In *Proceedings of the 24th International ACM SIGACCESS Conference on Computers and Accessibility* (, Athens, Greece,) *(ASSETS '22)*. Association for Computing Machinery, New York, NY, USA. https://doi.org/10.1145/3517428.3550379

[3] I. Goodwin, E. Davis, D. Winkler, J. Douglas, C. Wellecke, K. D'Cruz, P. Mulherin, and S. Liddicoat. 2022. Making homes more accessible for people with mobility impairment: A lived experience perspective. *Australian Journal of Social Issues* 57, 4 (2022), 956–969. https://doi.org/10.1002/ajs4.214

[4] H. Leiber. 2012. Pilotprojekt IKU -Innovative Kommunikations- und Umweltsteuerung. *Ludwigsburger Beiträge zur Medienpädagogik* 15 (2012). https://doi.org/10.21240/lbzm/15/08

[5] D. Lulé, C. Zickler, S. Häcker, M. A. Bruno, A. Demertzi, F. Pellas, S. Laureys, and A. Kübler. 2009. Life can be worth living in locked-in syndrome. In *Coma Science: Clinical and Ethical Implications*. Elsevier, 339–351. https://doi.org/10.1016/S0079-6123(09)17723-3

[6] Rehadat. April 2023. *Beschäftigungsstatistik schwerbehinderter Menschen.* Retrieved February 22, 2024 from https://www.rehadat-statistik.de/statistiken/berufliche-teilhabe/beschaeftigung/beschaeftigungsstatistik-schwerbehinderter-menschen/

[7] S. Wäckerlin, A. Gemperli, D. Sigrist-Nix, and U. Arnet. 2020. Need and availability of assistive devices to compensate for impaired hand function of individuals with tetraplegia. *Journal of Spinal Cord Medicine* 43 (2020), 77–87. Issue 1. https://doi.org/10.1080/10790268.2018.1479054

Received 27 February 2024; revised 12 April 2024; accepted 1 May 2024