Inclusive Indoor-Navigation Systems With Conversational User Interfaces

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Abstract
Indoor-navigation systems often present a challenge to people with impairments who have specific informational needs. We envision two directions for inclusive indoor-navigation systems by using a Conversational User Interface (CUI): A feedback option in an indoor-navigation system and a map editor. Both will empower people with impairments to independently create content for maps. In our research agenda we present our visions and address expected challenges about functionalities and research fatigue, which was previously found as an anecdotal effect.

Author Keywords
Conversational User Interface; Participatory Design; Indoor-Navigation; Accessibility

CCS Concepts
•**Human-centered computing** → **Sound-based input / output;** *Human computer interaction (HCI); Accessibility design and evaluation methods;*

Introduction
Based on experiences from the project DYNAMIK [6], we envision how a CUI can be implemented to improve indoor-navigation systems for marginalized groups. Our scope is specifically set on empowering people with impairments to navigate independently and comfortably in unknown build-

ings. We first give an overview on indoor-navigation. Then we propose how to use CUIs for an inclusive design based on our experience from DYNAMIK. Lastly, we detail our research agenda, expected challenges and an conclusion.
While outdoor navigation is a part of day-to-day life, indoor-navigation is still not used widely. It is an effort to enable this option, as a building has to be fitted with localisation technology and needs to be mapped [6]. Most public buildings are missing even a simple indoor mapping, which is the basis to enable navigation [7]. Our research agenda lays out a path on how to use CUIs as more than an inclusive feature for more accessible indoor-navigation. We complementary propose them as a participatory method to create data, both in the day-to-day use and specifically in the creation of map content for indoor environments. This will give marginalized groups sovereignty on the information in the maps they are using.

Inclusive indoor-navigation designs with CUIs

Both, indoor-navigation systems and mapping editors are more inclusive with CUIs and can empower marginalized groups. A graphically based user interface can be overloaded with information and may be inaccessible for visually or mentally impaired people. The guidance and simpler interaction provided by a CUI can enable people with impairments to participate in the process of creating map information that is relevant for them. This idea is based on experience from DYNAMIK, a research project from 2020 to 2022 about an indoor-navigation app for people with mobile and visual impairments [6]. The project realized an indoor-navigation app prototype for the university library to improve access for marginalized groups to services like consultation, shared study spaces and an accessible workspace for visually impaired people. The building was mapped in the OpenStreetMap (OSM) format. OSM is an open platform that is curated by a worldwide community [5]. The mapping of the building, the navigation algorithm, and the app user interface were fitted for the needs of people with impairments. To the end of the project, we could pinpoint one promising area for future research: the map data, with information about the building and its objects. This includes rooms, doors and furniture, dimensions of these objects and sensory information like sounds and temperature. The needs for these navigation information are dependent on the needs and abilities of the users [8].
For inclusive CUIs we propose to work on designs that can produce some immediate and visible results. It is even better to reduce the effort for participants by reducing the number of experiments and instead integrate a participatory method in usable designs. Our research agenda proposes the integration of a CUI as a feedback option while the indoor-navigation is ongoing. Research fatigue is an effect that we observed in interviews that were conducted for DYNAMIK [2]. People with impairments are often asked to participate in various different experiments for inclusive designs. It was mentioned by participants that the time and effort required to participate is not met with visible improvements for their personal daily life. This is accompanied by lost trust from participants, especially in research projects with a limited runtime as they often can not produce a sustainable solution.
To offer more inclusive indoor-navigation systems, it is not enough to make the CUI itself accessible. It is rather important to think about how a CUI can make a design more inclusive overall. We found in DYNAMIK that the mapped information of a building has influence on the accessibility of the whole navigation process. We envision a second design to explore necessary changes for the data acquisition of these maps. A mobile mapping editor will empower people with impairments to easily add relevant information for them about objects in an indoor environment.

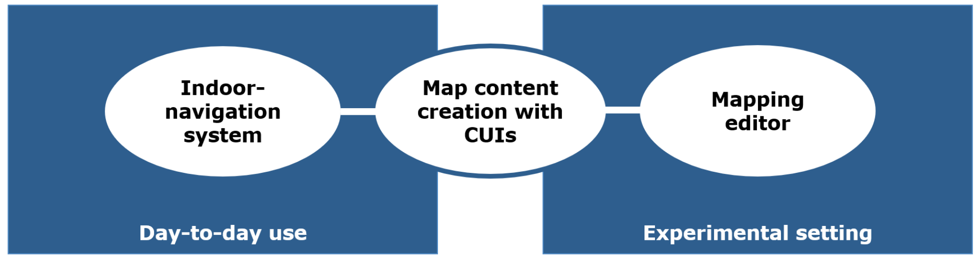

Figure 1: The graphic shows both directions with which map content is created with CUIs. An experimental setting for a mapping editor and the day-to-day use of an indoor-navigation system.

Research agenda

This research agenda describes our vision on how inclusive indoor-navigation can be designed by implementing CUIs. We want to address this from two different directions, as can be seen in Fig. 1.

The first direction is to include a CUI in the day-to-day use of an indoor-navigation system. A similar option was implemented in DYNAMIK, where users can add information on missing or wrongly mapped objects. Our intended result would not only be a feedback option, but also increases the participation of marginalized groups. The integration of the content creation in the indoor-navigation system itself will reduce effects like research fatigue. Instead of having to remember every important detail in an experimental setting, people with visual or mental impairments can actively shape the map content according to their daily needs and with minimal additional effort. This gathered knowledge can then also be applied to future navigation services by making it directly available to the OSM community. The CUI feedback option allows people with impairments to directly act as content creators. While this is already possible on the OSM platform, the accessibility of map editors should be more inclusive.

This improvement is the main focus in our second direction of the research agenda. We envision a mobile mapping application that is based on a CUI with speech input and natural language processing. This will enable people, especially with visual or mental impairments, to easily add information to objects in a map. Previous results from DYNAMIK already show strong differences between the needs of people with visual or mobile impairments and able-bodied people [8]. This includes for example sensory information about the environment that people with visual impairments use to navigate [1, 3]. In an experimental setup, we will compare specific and individual mapped information from participants with impairments and able-bodied people. These direct results are in our opinion always preferable over other methods like literature research, interviews or surveys.

Challenges

We expect several challenges in the realization of our research goals. The biggest one is to translate the inherent focus on graphical interaction with a map to a conversational setting. While the CUI in the indoor-navigation system can work with the current coordinates of the participant to anchor any content to the map, this is different for the proposed mapping editor. There, an already prepared map has to be filled with information. For this, the participants will need to choose a specific object on the map and add data to it that they can perceive, like its height, width, or material. This translation from a graphical user interfaces to a CUI will not be trivial [4]. The CUIs also have to be accessible so that they can be used equally by people with impairments and able-bodied people. This includes creating a straightforward workflow with easy task instructions.

Conclusion

To conclude, we find that CUIs are a promising feature to include in indoor-navigation systems for a better inclusion of marginalized groups. We want to approach this research from two direction: First, by including a CUI in the feedback option of an indoor-navigation system in the day-to-day use to create map content. Secondly we want to create a map editor with a CUI that will empower people with impairments to share their perception of spaces. Related research challenges include a deeper look at research fatigue, which was anecdotally found in previous research. It can be evaluated if there are existing factors or effects that can be generalized for the collaborative design with marginalized groups.

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