Leveraging Digital Accessibility Using Generative AI

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Generative AI (GenAI), and especially large language models (LLMs), offer intriguing opportunities to improve accessibility in the digital world. In this position paper, we present our research findings and ideas for next steps in two areas of ongoing work in this field. First, we show that LLMs can adjust HTML code to mitigate deceptive patterns, manipulative designs in online user interfaces, without prior training. For this, we prompted GPT-4o with HTML code, asked it iteratively to make it less manipulative, and manually analyzed 2,600 redesigns that demonstrate the potential of this approach as a technical countermeasure against deceptive patterns. Second, we outline how GenAI approaches can augment screen readers used by blind and low-vision users by enabling natural, conversational interactions and generating missing metadata. A particular advantage of GenAI for this use case lies in its capability to adapt to individual user preferences and needs.

CCS Concepts: • **Human-centered computing** → **Graphical user interfaces**; • **Computing methodologies** → *Artificial intelligence.*

Additional Key Words and Phrases: deceptive patterns, dark patterns, countermeasures, large language models

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1 INTRODUCTION

Interactions in the digital world are rarely friction-free. Some interfaces are designed in ways that try to manipulate users. Other interfaces lack qualities of universal usability, making interactions unnecessarily difficult for user groups with particular capabilities. In both cases, digital accessibility technologies can help remove these frictions and improve the user experience.

In our first example, digital accessibility can support users when they encounter content with *deceptive patterns.* These patterns manipulate users in their decision-making in favor of a service owner [16]. A common example is a cookie banner with a colorful and large button to accept all cookies, while the decline option is barely visible at all. Deceptive patterns are common in various contexts such as shopping websites [10, 16], games [27], social media [17], and apps [6, 12]. Because of this prevalence, researchers call for effective countermeasures to eventually help users [2, 7]. One such approach is technical countermeasures that, e.g., automatically detect deceptive patterns in an interface [5, 16] and then highlight them with an explanation [16, 21] or remove them completely [22]. Generative AI (GenAI) has also started to shift into focus for this purpose [18, 20]. However, large language models (LLMs) have not been used to counter deceptive patterns directly on the web. Therefore, we developed an approach that prompts an LLM with the task of making a given website less manipulative by adjusting the underlying HTML code and CSS classes.

Digital accessibility also plays a crucial role in our second example. There are over 270 million blind and low-vision (BLV) individuals worldwide [3], many of whom are relying on assistive technology, such as screen readers and voice assistants [23]. However, these tools have limitations, such as missing metadata [23]. Moreover, they may come with a range of usability issues: For example, the sequential output of screen readers results in inefficient interactions, and it is

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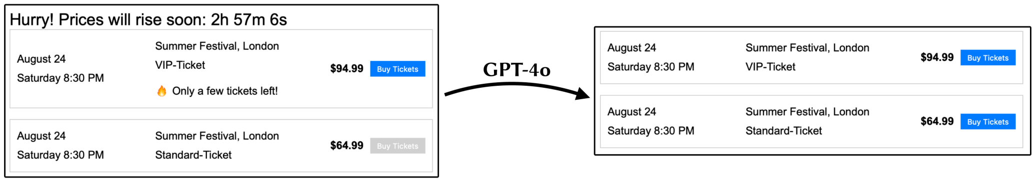

Fig. 1. We prompted the LLM GPT-4o with the HTML source of UI designs like the one on the left and prompted it to "Make that less manipulative". For example, a fictional ticket shop (left side) uses several deceptive patterns to manipulate users into purchasing VIP tickets for a festival. After a few iterations with our prompt, the LLM provided a fair design (right side).

difficult to remember the numerous keyboard shortcuts or voice commands, which increases cognitive load [13, 24]. Researchers have addressed these issues by introducing conversational screen readers that shift away from the linear nature of traditional screen readers and, hence, promise faster learning progress and usage [1, 24]. However, they have been limited in their ability to understand and communicate natural language and adapt to user preferences over time. Recent progress in GenAI, particularly LLMs, holds the potential to address some of the current limitations [19].

For example, research has identified BLV users' desires for natural conversational interactions, as well as systems capable of learning and adapting to user behavior and individual preferences over time (e.g., speech rate, information order, or interaction granularity) [19]. Accordingly, recent studies augmented traditional screen readers with LLMs, enabling more efficient natural language interactions [13, 25]. Instead of performing a series of keyboard shortcuts through voice commands, they enable the use of natural language dialogs to achieve the same in a single step. Compared to conventional practices like the JAWS screen reader[1], user studies with BLV participants revealed significant improvements in interaction efficiency and usability. To further explore the potential of GenAI to improve digital accessibility for BLV users, we interviewed 13 BLV participants and collected qualitative data from 19 BLV participants in an online survey. Participants expressed their wish for AI-based conversational screen readers that provide additional functionalities beyond their traditional counterparts. Examples of this include engaging in natural conversations, as shown by previous research, offering descriptions of visual elements lacking alt text, and completing actions on the user's behalf.

In the GenAICHI workshop, we want to spark discussions about using GenAI to leverage digital accessibility. To support this, we bring the above two concrete examples from our ongoing work to the table. In the remainder of this position paper, we therefore provide results from our current work and ideas for future research in these two contexts:

(1) Mitigating the effects of deceptive patterns
(2) Enhancing digital accessibility tools for BLV users

2 USING GENERATIVE AI TO MITIGATE DECEPTIVE PATTERNS

Deceptive patterns have become widespread [6, 10, 14]. Because of this, researchers have classified and unified existing patterns [8] and called for effective countermeasures [7]. Proposed countermeasures range from educating users or designers to regulatory approaches to technical countermeasures [2]. Such technical countermeasures often require reliable automatic detection of deceptive patterns. However, automatic detection and classification are hard problems to solve, and some patterns might not be automatically detectable at all [5]. To bridge this gap, we introduce an approach for a technical countermeasure that does not rely on explicit a priori detection and classification. Instead, it feeds the

[1]https://www.freedomscientific.com/products/software/jaws/, *Accessed: February 20, 2025*

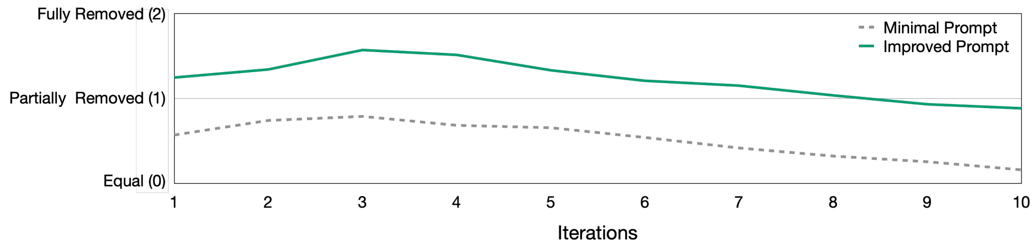

Fig. 2. The average value of each iteration of the redesigns compared to the initial design for all deceptive patterns using the *minimal* and *improved prompt*. Both prompts achieved the least manipulative designs after three iterations.

HTML code of web elements into a large language model (LLM) and iteratively prompts it to make these elements less manipulative. We evaluated our approach with OpenAI's GPT-4o[2] LLM and both self-created deceptive and fair web elements, and real websites.

We started with a *minimal prompt* "Make that less manipulative". This zero-shot prompt already successfully removed several patterns and worked surprisingly well, given that we did not provide any further information to the LLM. Still, several problems occurred repeatedly in the LLM's redesigns. Sometimes, the LLM introduced additional deception, e.g., by making one of several buttons look grayed out. In other cases, the LLM hallucinated additional facts or options. Based on the problems that we observed using our *minimal prompt*, we constructed a more advanced, *improved prompt* that contained several rules that the LLM had to adhere to, such as not changing any numbers. This *improved prompt* drastically reduced hallucinations across trials. Both prompt variants yielded the best results after three iterations (Figure 2). With our improved prompt, 91% of deceptive elements were less manipulative than our initial designs at that point. To also evaluate this approach in the field, we performed preliminary tests with our *improved prompt* on real websites. These first tests appear promising, and the generated HTML code visually fits the remaining website.

Our findings suggest that LLMs can defuse certain deceptive patterns without prior model training, promising a major advance in fighting these manipulations. We openly share the labeled dataset of our 26 initial designs and 2,600 generated redesigns, including all responses and justifications provided by GPT-4o, on an Open Science Framework repository[3]. Overall, we observed surprisingly positive results from our tests with GPT-4o, and we see this approach as promising to assist people facing manipulative designs in their daily online interactions.

3 AUGMENTING SCREEN READERS WITH GENERATIVE AI

Through a short online survey, we asked 19 BLV participants about their currently used AI assistive technologies, potential use cases of AI-enhanced assistance, anticipated challenges when using such technologies daily, and desired features for enhancing their usefulness. Additionally, we interviewed 13 regular screen reader users online for more in-depth insights. Since we recruited participants of varying technology proficiency levels, we created a simple demonstrator of a GenAI-based voice assistant using GPT-4o to present a potential use case of GenAI. Participants could interact with the demonstrator by speaking or typing before receiving a read-out answer from the underlying model. The UI was kept simple, containing only one button for starting and stopping voice recording, and provided natural voice and auditory feedback. After familiarizing themselves with the demonstrator, participants performed four example tasks we had prepared to foster a similar level of exposure across participants. We defined tasks based on

[2]https://platform.openai.com/docs/models/gpt-4o, *Accessed: February 20, 2025*
[3]https://osf.io/tgrw9/?view_only=584e0cdcf4b143428fc29b0989210a0c, *anonymous repository for review*

Marchionini's classification of search actions [15]. In a semi-structured interview, we discussed participants' thoughts, experiences, and ideas on GenAI-enhanced assistive technology. We analyzed the transcripts of our audio recordings and the written survey data using reflexive thematic analysis [4]: We inductively coded the data and iteratively refined and grouped the results into broader themes encapsulating current challenges, visions, and opportunities expressed by participants.

A recurring topic was the potential of augmenting screen readers with GenAI-based functionality. As identified in related research, our participants stated that, even after a long learning phase to learn how to control a screen reader, the interaction feels cumbersome because elements are mostly read out sequentially. Instead, natural language processing (NLP) capabilities of LLMs integrated into a screen reader might enable a conversational, natural interaction [9, 13]. For example, instead of using keyboard shortcuts to navigate to and open a specific file, the user could just request to open the presentation file attached to yesterday's email from the financial department.

Moreover, some participants mentioned the possibility of an AI-supported screen reader analyzing the screen content and generating short summaries to provide an initial overview of what is displayed. Users could ask more detailed follow-up questions about specific content in a natural dialog instead of manually locating information with a screen reader. In particular, one participant envisioned metaphorical auditive feedback based on the screen content. For example, a clock's ticking sound could be played to represent loading times.

> P05: "Maybe it can make a scrolling noise, and then when it looks like it's done or it gets to know that website, play me a little song or something."

Additionally, participants reported that required metadata, such as alt text or labels of UI elements, is often missing or inaccurate on websites, limiting screen readers' functionality. These elements can be identified by object detection and image recognition models [26, 28], and corresponding metadata can be generated after the fact. Again, the conversational nature of the GenAI-based screen reader would allow users to ask more questions, e.g., about the image for which the alt text was generated/adapted. Besides this, the capabilities of AI to learn over time could be used to personalize the metadata for individual users depending on their personal preferences and respective contexts.

Furthermore, participants emphasized the importance of the screen reader output:

> P02: "So for everybody, it should be possible to make some changes on these things [voice and speed]. Because everybody has different preferences."

While basic customizations are already available, participants envisioned more dynamic adaptations to transform the user experience of assistive systems into something that feels more like a personified assistant. This includes matching the voice to a specific character, role, or mood, which could be realized via voice synthesis based on GenAI combined with LLM-based NLP [11].

Our user study revealed several opportunities to augment traditional screen readers with GenAI-based functionality from BLV users' perspectives. However, participants emphasized that AI should not replace existing assistive technology but extend its functionalities instead.

4 CONCLUSION

We see potential for GenAI, and especially large-language models (LLMs), to forge a new path of online browsing accessibility. As examples, we showed how current LLMs can be used to automatically remove certain deceptive patterns that are embedded in HTML code and how GenAI may improve and expand the user experience of current screen readers. With these impulses, we hope to spark fruitful and exciting discussions at GenAICHI 2025.

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