IDSA

REPEEL

A WRISTBAND CONNECTED TO AN APP DESIGNED FOR NAVIGATING COOKING FOR VISUAL IMPAIRED PEOPLE

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PAPER ABSTRACT: Cooking alone can be challenging for visually impaired people. Previous research has shown that people with visual impairment are more likely to have difficulty shopping for, preparing, and eating food. Because of the lack of vision and reduced ability to recollect, some stages of cooking can be unexpectedly difficult and dangerous. According to the observation study, using digital recipes from mobile devices with voice-over assistance interrupts cooking operations consistently. Trying a new recipe becomes a disaster instead of an adventure. To address these issues, the paper proposes the development of a novel product that enables visually impaired users to control recipe apps effortlessly using intuitive gestures. The product was developed through preliminary research, brainstorming, modeling, prototyping, and testing. It can be used with existing recipe apps or its own app, RePeel, to navigate the cooking procedure smoothly and safely.

Keywords: User Interface Design, Individuals with Disabilities & Assistive Technologies, Mobile Devices, Touch/Haptic/Pointing/Gesture

1. INTRODUCTION

Vision plays a pivotal role in a person's daily activities and quality of life. However, a substantial proportion of the world's population suffers from visual impairment, which significantly impacts their ability to perform essential tasks. According to the World Health Organization's estimates, as of 2019, 2.2 billion people globally live with some form of visual impairment (WHO Organization, 2020). The number of visually impaired and blind people will double in the next 35 years in the United States (Varma et al., 2016). This population often faces significant challenges in completing activities such as cooking and eating, which can lead to a decline in their nutritional status and an increased risk of diet-related illnesses (Kostyra et al., 2017).

While there are now apps available to assist visually impaired individuals with cooking, voice assistance alone does not provide an optimal solution. Such apps often lack comprehensive step-by-step instructions and fail to account for the unique challenges that visually impaired individuals may encounter in the absence of visual support (which will be proved in the research phase). For example, individuals with visual impairments often experience a reduced ability to recollect information and increased reliance on their memory, which can be inaccurate. Moreover, visually impaired individuals are often forced to keep pace with a recipe's fast pace, leaving them little time to double-check the instructions on their phones, which can lead to confusion.

To address these issues, a study is conducted to improve the existing step-by-step recipe app for cell phones based on voice-over functions. A wearable product was also designed to complement the app, enabling a hands-free cooking process that reduces the user's memory burden and allows them to review and repeat instructions at any time. The approach seeks to mitigate the challenges faced by visually impaired individuals, enhance their cooking experiences, and improve their nutritional status. It is important to acknowledge that individuals with visual impairment, as opposed to those who are completely blind, retain residual visual capabilities that allow them to perceive basic visual cues. Therefore, the design proposed in this study aims to augment visual perception through the implementation of various interface design methods, enabling visually impaired individuals to access a comprehensive range of information.

2. MARKET ANALYSIS

2.1 VOICEOVER FEATURE

Advancements in technology have paved the way for the development of smart device features tailored to aid visually impaired individuals in navigating websites and applications. The release of VoiceOver and TalkBack Screen Reader, among others, has revolutionized the user experience of individuals with visual disabilities. VoiceOver, for instance, is a screen-reading technology that provides auditory descriptions of on-screen elements, allowing users to navigate the screen using a keyboard or gestures (Accessibility -

Vision, n.d.). Consequently, many visually impaired individuals are now able to access and navigate smart devices with greater ease.

When VoiceOver is on, standard touchscreen gestures, which refer to a specific action or movement performed by a user on a touchscreen interface to interact with a device or application, have different effects, and additional gestures let users move around the screen and control individual items. Table 1 demonstrates a selection of commonly utilized gestures in the design process and their corresponding meanings. Familiarity with these gestures and their consistent implementation can aid in preventing confusion among users who may encounter new learning processes in future design processes.

Action	Gesture
Select the next item	Swipe right
Select the previous item	Swipe left
Start or stop the current action (for example, play or pause music or a video, take a photo in Camera, start or stop a recording, start or stop the stopwatch)	Two-finger double tap
Scroll up one page	Three-finger swipe down
Scroll down one page	Three-finger swipe up
Scroll left one page	Three-finger swipe right
Scroll right one page	Three-finger swipe left

Table 1. A cross-reference to the meaning of gestures and actions in VoiceOver that may be used in the design (Learn VoiceOver Gestures on IPhone, n.d.).

The features have also been applied to the development of cooking applications and websites that cater to visually impaired users. Yes Chef is an example of such an application. Yes Chef is a hands-free cooking application that guides users through recipes and answers their questions. However, despite the provision of such innovative solutions, a survey of existing cooking applications designed for visually impaired individuals has highlighted several issues. Notably, few instructions are presented in a step-by-step format, and the apps' delivery of spoken content is often too fast, hindering users' ability to follow instructions. Additionally, the searching and repeating functions of these applications can cause frustration and confusion for visually impaired users (Yes Chef - Hands Free Recipe Assistant by Conversant Labs, n.d.).

2.2 DESIGN PRINCIPLES FOR THE VISUALLY IMPAIRED

To facilitate the cooking process for individuals with visual impairment, a thorough examination of interface design principles for an app with a high potential for addressing this issue is conducted. Given the nature of the visual impairment, special design considerations are necessary to effectively display information within these interfaces. Specifically, text information must be substantially enlarged, and the contrast ratio between text and background should be at least 4.5:1 (Color Contrast Ratios - Accessibility Guide, n.d.). It is also crucial to avoid relying solely on color to provide information and instead use symbols as an aid. In many instances, users fill out forms and inadvertently enter incorrect

information, causing the corresponding box to turn red. While this may be a simple visual cue for sighted individuals, visually impaired users cannot interpret this color change and may struggle to understand why they are unable to proceed to the next step. However, by incorporating symbolic language such as a cross or exclamation point in the red box, users can readily recognize their mistakes. Additionally, utilizing textures rather than colors can assist in distinguishing one element from another, which is particularly vital in the design of sibling menus ("How to Design Accessibility App for Visually Impaired?", 2019).

3. METHODS AND PROCESSES

Several research approaches were employed to gain a comprehensive insight into the culinary experience of individuals with visual impairments and the consequent design complexities. Alongside an extensive review of the existing literature, a plethora of videos recording visually impaired individuals cooking themselves were observed, providing a detailed account of their cooking process and recollections of the associated intricacies. Furthermore, an empathetic study was conducted, which aided in substantiating the identified pain points and insights garnered from the preceding research endeavors. This multifaceted research methodology served to gain an in-depth understanding of the unique challenges faced by individuals with visual impairments in the culinary realm and informed the design of interventions to enhance their cooking experience.

3.1 ANALYSIS OF YOUTUBE VIDEO

To obtain a more comprehensive understanding of the experiences of visually impaired individuals when cooking, an analysis of multiple YouTube videos was conducted as a realistic representation of blind and visually impaired individuals engaging in the cooking process. Through these videos, participants were observed as they demonstrated the various steps of the cooking process and shared their firsthand experiences of cooking without sight. By closely reviewing each video and taking references from others' observations (Li et al., 2021), a thorough account of the challenges faced by visually impaired individuals when cooking was compiled and categorized into three distinct phases: pre-cooking which mainly includes the preparation of materials and utensils, cooking including different operations, and post-cooking including cleaning and organizing. This rigorous process helps to identify and summarize the specific issues and obstacles encountered by visually impaired individuals throughout each stage of the cooking process.

The following are some of the representative challenges found in these three phases (Li et al., 2021).

- Touching and feeling: Sensory information plays a critical role in ensuring accurate and safe execution of cooking procedures. However, for individuals with visual impairments, relying solely on touch can be challenging. Although hand feeling can provide some useful information, it may not convey all the necessary details for certain cooking tasks. Additionally, using hands to feel hot surfaces can lead to injuries, and it may take longer to determine whether an ingredient is adequately prepared. Therefore, it is essential to explore alternative sensory modalities and assistive technologies that can support visually impaired individuals in cooking safely and efficiently.

- Information access: Individuals with visual impairments often face significant challenges when cooking due to the lack of accessible information and instructions for kitchen appliances. Guide manuals and recipe instructions typically lack the necessary level of detail to support those who cannot rely on visual cues. Additionally, many recipes are structured in a way that is not user-friendly for individuals with visual impairments, making them difficult to follow. This led to frustration and further difficulties when trying to interact with the recipe while cooking. Therefore, there is a need to create more inclusive and accessible recipe structures that take into account the unique needs and challenges faced by visually impaired individuals.
- Precision and ambiguity: Cooking requires a high level of precision and attention to detail, making it challenging for individuals with visual impairments. The inability to rely on visual cues during precise steps can hinder their ability to cook safely and efficiently. Moreover, learning new cooking methods can take a long time, leading to a reliance on familiar techniques despite their limitations. However, following cooking steps precisely is crucial for achieving optimal results. Therefore, it is essential to explore new cooking methods and technologies that can assist visually impaired individuals in following cooking steps accurately while minimizing the learning curve, promoting independence, and enhancing their overall culinary experience.

3.2 EMPATHETIC STUDY

Empathetic design is a user-centered approach that enables designers to identify and understand the real needs of users by immersing themselves in their roles. To validate and verify the issues that were identified through observation, and determine the direction of design, an empathetic study was conducted on visually impaired cooking. The study involved the use of a belt to cover the eyes, thus simulating a visual impairment, while the entire cooking process was recorded and observed by a team member (Fig 1). While the simulation employed in this study does not precisely replicate the visual impairment experienced by the target user group of individuals with visual impairment, the rationale behind blindfolding the respondents was to attenuate the visual component of the experience. By restricting visual input and creating an environment of total darkness, the aim was to amplify the tactile experience and heighten the sensitivity to discern genuine needs more acutely. A user journey map was then developed based on the experiences during the entire process, recording each action, touchpoint, struggle, and emotion that arose during different phases. Using stickers, different senses were indicated to provide a more detailed understanding of the user experience (Fig 2). Based on the observations, it was concluded that recollection during visual-impaired cooking is an abstract and essential component and a crucial area for design intervention.

Figure 1. Empathetic study by experiencing visual-impaired cooking.

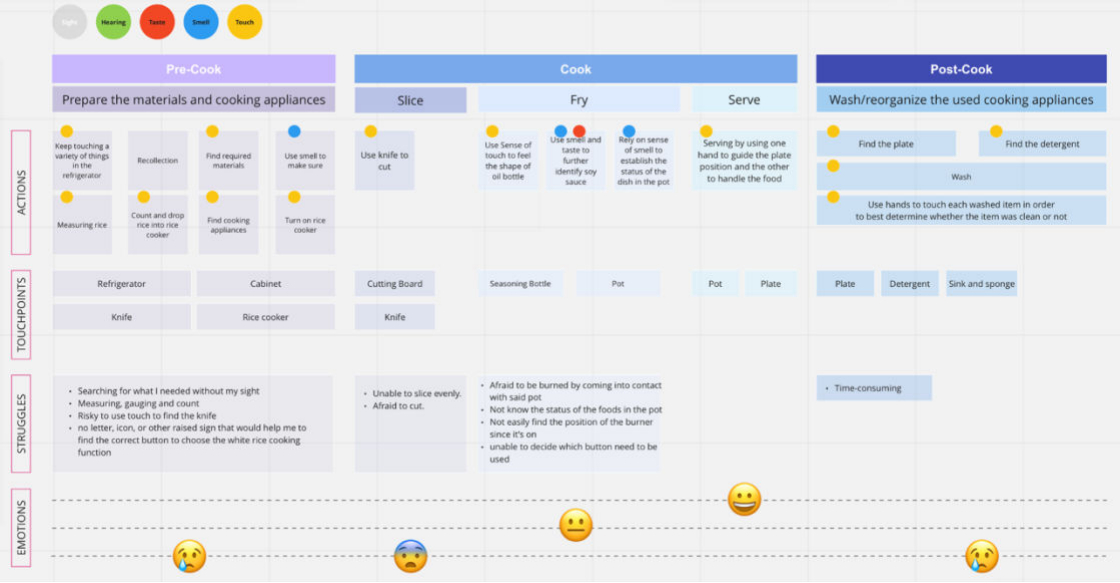

Figure 2. User journey map after empathetic study.

4. RESULTS

The problem identified from previous research is short-term recollection. Visual-impaired people must rely on short-term recollection to determine the current state of cooking because they lack the ability to see it. Therefore, they are always unaware of where they are in the recipe, especially the current step and the right order. Since visually impaired individuals rely heavily on touch as their primary sensory experience, and given the efficacy of digital products, a hybrid design is sought to be developed that marries the strengths of both physical products and digital apps. In particular, the approach integrates physical products with an app, where the former controls the latter, allowing for a completely hands-free experience during the cooking process. The design goals were informed by the results of the research, which revealed three primary objectives. First, to alleviate the burden of memory for users, which is exacerbated by visual impairments, and to minimize the occurrence of errors resulting from memory lapses. Second, to provide users with a controlled, step-by-step approach to cooking. Because visually impaired individuals are unable to quickly move back and forth between cooking actions and the app, they cannot rapidly rectify errors. To address this, a wristband that enables users to control the app even when their hands are occupied is developed. Further, the design is sought to be aligned with users' natural habits and behaviors, which reduces the burden of learning a new process and promotes consistency in usage.

4.1 APP DESIGN

The design of the final app, catering to the needs of visually impaired individuals, was guided by a set of guidelines aimed at optimizing user experience. The first guideline was based on the premise that minimal interaction is preferable, and thus, gestures were designed to follow natural usage habits. The app incorporated a VoiceOver feature to allow users to navigate the app with ease. The second guideline was focused on ensuring that the interface was friendly to visually impaired individuals. To

address the unique requirements of interface design for visually impaired users, a range of enhancements were implemented to improve information transfer. Specifically, the contrast between the text and background was increased, and the text was enlarged to facilitate reading. Additionally, icons and textures were strategically incorporated to enhance the user's understanding of the app's content. The third guideline was centered on making it clear to users where they were in the app at any time. To accomplish this, guidance was provided in a step-by-step manner, and clear navigation was incorporated.

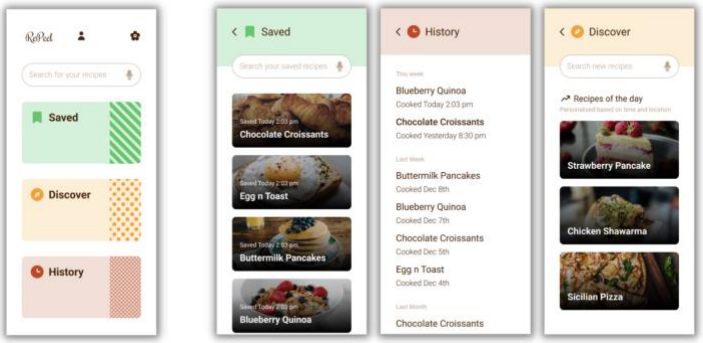

Figure 3. Home page of RePeel.

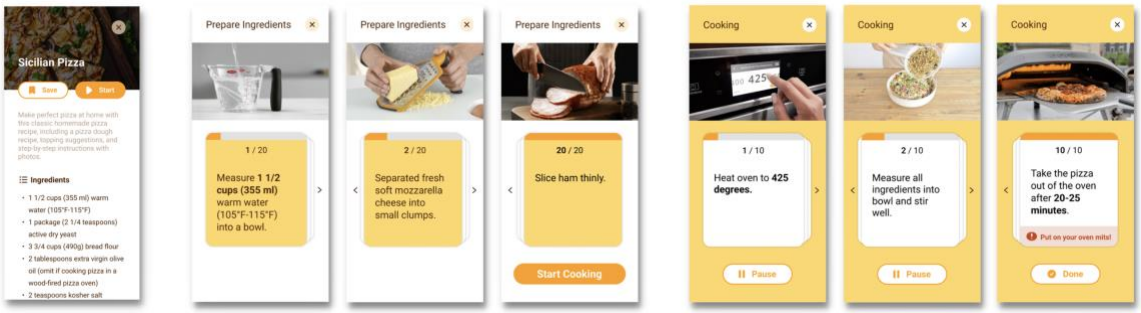

Figure 4. Step-by-step guidance of recipe.

The application under discussion features a primary interface, as depicted in Figure 3. This interface serves as the first level and exhibits a simplistic design, comprising solely of three primary menu entries- Saved, Discovery, and History- apart from a search bar. These menu entries are distinguished by distinct colors and textures and cater to the users' preferred options, untried menus, and history, respectively. The bottom bar was consciously omitted, which is typical of mobile applications, to provide ample space for the interface and avoid inadvertent touch inputs. Additionally, the profile and settings at the top have been integrated, substituting the app logo in the middle. Notably, the profile and settings should have been located at the corners of the interface. This placement pattern was deviated to accommodate the sequential reading style of VoiceOver, which is employed for the interface content. The subsequent level of the application entails the user clicking on a specific menu item, following which they begin the recipe step-by-step, as represented in Figure 4. The design approach partitions the cooking process into two phases- the preparation phase and the cooking phase. This is based on preliminary research suggesting that visually impaired individuals tend to organize all ingredients before initiating the cooking process. The steps in the recipe are elucidated with pictures and large text, augmented by a progress bar to indicate the user's advancement and a warning pop-up for critical steps. The interface omits all other non-essential visual elements. Visually impaired users can utilize VoiceOver's gestures to navigate

through the recipe and control progress and can also pause or repeat the current step at any point in time.

4.2 PRODUCT DESIGN

To optimize the usability of the product, a wristband has been developed that uses physical buttons to control the app (see Figure 5). This design choice was made based on the accessibility of a wristband as well as the need to avoid interference with cooking activities. The wristband has been designed with five integrated actions: Right (Go next), Left (Go back), Up (Undo), Down (Skip), and Push (Confirm/Repeat). Braille is used to describe each action on its corresponding side, which enhances the device's visual appeal. The device's inclined sides have been carefully designed to allow for easy and intuitive tactile navigation. All the actions correspond to the gestures in Table 1, making them intuitive and easy to use without requiring any additional learning on the part of the user. By using the wristband and accompanying app, visually impaired individuals can successfully follow step-by-step recipes without holding their phones constantly during the cooking process.

Figure 5. A wristband works together with the App.

5. CONCLUSION

Cooking can pose significant challenges for visual-impaired individuals. To address these issues, the study developed an app and wristband to reduce memory burden and facilitate intuitive, step-by-step cooking. While the design shows promising results, there are still areas that require refinement, which can be hard to measure and test without a real environment. Therefore, the next step will focus on creating a detailed working prototype and evaluating its effectiveness.

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