

Optimal Design of Book Listening Machine for Visually Impaired Group

Yan YAN^a, Fang ZHANG^a and Yi LIU^{a,1}

Beijing Institute of Fashion Technology, Beijing, P. R. China

Abstract. The paper analyzes that we study the reading paths and preferences of visually impaired groups, compare the current situation of audiobooks for visually impaired groups on the market, analyze the pain points of volume and font adjustment and unreasonable button design that users encounter when using such audiobooks, and base the product design on handheld portable audiobooks to find out The product design is based on the handheld portable dictaphones, and the feature that people will change the distance between the product and themselves according to the volume and the size of the pictures, and add the sensor that can measure the distance between the human face and the dictaphones to realize the adaptive adjustment of the font and volume according to the change of the distance, and finally produce the product prototype to achieve the purpose of intelligent adjustment of the volume and font.

Keywords. Visually impaired group, audiobooks, intelligent products, product design

1. Introduction

According to the Second National Survey of Persons with Disabilities, there are approximately 17 million blind people in China, and about 450,000 new blind people appear each year, or about one blind person every minute. Blind people have extremely limited means of recreation, and many of them prefer reading in order to enrich their spiritual and cultural needs.[7].

The mainstream reading methods on the market are touching Braille books, listening to audiobooks, and using magnifying aids. Through research, we found that Braille books are limited and expensive, electronic audio books for the general public are not friendly to the blind, and most visually impaired people are totally blind and cannot use magnifying aids. For this group, it is necessary to provide them with a good way to read. Nowadays, due to the popularity of smart phones and the continuous development of listening software screen reading software, auditory reading has become the preferred way for blind people to read.[6].

¹ Yi LIU.

2. Current status of the visually impaired group

2.1 Classification of visual disability

The current criteria for different visual disability levels in China are divided into four types, as shown in Table 1:

Table 1. Visual disability level chart			
Level of visual disability	Best Corrected Visual Acuity	Field of view radius	Visual acuity chart test
Class 1 Blind	Less than 0.02	None	Cannot recognize first line
Class 2 Blind	0.02~0.05	Less than 5 degrees	Identifiable first line
Grade 3 low vision	0.05~0.1	Less than 10 degrees	Identify the first row at 2.5 meters
Class 4low vision	0.1~0.3	Greater than 10 degrees	Identify the first row at 5 meters

The four levels of visual disability can be derived from the fact that disability levels containing up to second-degree blindness have some visual ability and have different levels of recognition of words.

2.2 Social support

In order to improve the cultural level of the blind, Article 29 of the Law of the People's Republic of China on the Protection of Persons with Disabilities and the "14th Five-Year Plan" for the implementation of cultural services for the disabled indicate that the relevant departments should organize and support the research and application of Braille and sign language.

2.3 Demand Analysis Demand Analysis

The traditional way of reading paper Braille books has many limitations and drawbacks today. Most of the existing Braille books are produced by charitable organizations or official funds of the Disabled People's Federation, and they have a small variety of titles, single content, and lagging information.[1].

With social progress and new technologies, the expansion and innovation of reading services for the blind has triggered a change in the mode of reading services for the blind, and the way of reading for the blind has become rich and diverse.[2].The survey found that using computers, reading web pages, using smartphones through accessible technology, using audiobooks and other means gradually became the main way for the visually impaired group to acquire knowledge.

China Braille Press has developed the "Sunshine Book Listener" and Tsinghua University has released the "Large Format Tactile Graphic Display Terminal", which allows blind people to perceive images and provides a new way of reading for the visually impaired.[3].

3. Product Status

3.1 Pain points

The common listening machines on the market are divided into two categories: audio listening machines and handheld listening machines. Handheld listening machine is

divided into no display and display. These two categories of products have been on the market for a long time, the product type is more, for the enterprise has accumulated a certain market position. But these two types of products are only considered the iterative update of technology, such as hard disk memory, the number of audios, screen resolution and other hardware configuration upgrades, ignoring the upgrade of the user experience.[4].

This study investigates two existing product categories and points out the advantages and disadvantages and application scenarios. The following is summarized in Table 2:

Table 2. Comparison chart of two types of audiocassette players

Type	Schematic	Advantages	Disadvantages	Applicable scenarios
Audio Book Listener		High number of sound, good sound quality, low number of keys	Volume is too large, can only be played out, the function is relatively single	Indoor or quiet environment
Handheld Listener		Small size and light weight, easy to carry, diversified functions, can be external playback can wear headphones	The number of keys, stacked functions, relatively complex operation, more frequent adjustment of the volume on different occasions	Any occasion

Based on a list analysis of the advantages and disadvantages of the two types of products, it was decided on the basis of merit to use the handheld dictaphone as a modified prototype for the modified design. The handheld dictaphone with an electronic screen was decided because it contains a disability level below the second level of blindness with a certain degree of visual ability.

3.2 Design opportunities

The existing handheld listening machine on the market at the same time there are, for example, too many stacked functions, the number of buttons, more complex operation, low button comfort, low handheld comfort, the proportion of listening machine does not meet the human body efficacy and other problems.

In addition, the volume of the handheld dictaphone is adjusted more frequently on different occasions, and different blind groups have similar worries about the screen font adjustment when using the screen. In order to improve the user's experience and to take instinctive design as the design guide, we decided to improve the design to address this pain point.

4. Design scheme and realization

4.1 Physiological analysis of handheld electronic devices

The study indicates that the user's thumb is used preferentially when moving from a relaxed state (thumb straight) to a state that requires contact with the screen.[5]. The other two joints are used only in positions outside the range of motion of the wrist-palm joint. The first joint can only be bent back and forth, operated up and down, and can only row but not slide in an arc. The angle of the first thumb is comfortable within 90 degrees, but it becomes more uncomfortable when the angle of the first thumb is infinitely closer to 90 degrees.[8].

The following are the requirements that the correct handheld phone should meet and the types of joints used:

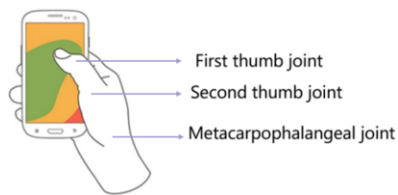


Figure 1. Physiological diagram of the correct handheld cell phone

4.2 Product solution proposal and analysis

4.2.1 Problem solving

Through the crowd analysis of the blind to use the machine listening to books pain points: too far to hear too close to the volume is too loud, the operation is difficult to need the assistance of others, the keys are mostly a key multi-use function memory is easy to confuse.

The pain points of visually impaired people with visual functions including grade 2 and below: reading highly dependent on auxiliary devices for the device is not humane design tolerance time longer, long time close reading damage shoulder and neck, reading fonts are too small exist to focus.

4.2.2 Solution

The following is a concept diagram of a solution that automatically adjusts volume and font size by distance:



Figure 2. Solution concept diagram

The design is positioned to solve the volume and font better adjustment as the main, the number of buttons and the shape of the listening machine for humane improvement as a supplement, through people will instinctively in the distance when they can not hear the invisible situation closer to the phenomenon, design a distance can automatically adjust the audio-visual volume and font size of the intelligent listening machine. The listening machine built-in a distance sensor that can emit ultrasonic waves, used to capture the distance between the human face and the listening machine, to achieve the font near small and far, the volume near small and far function.

4.3 Specific implementation

4.3.1 Implementation of intelligent regulation schemes (processes, procedures)

Below is a flowchart of this reader and a flowchart of this use:

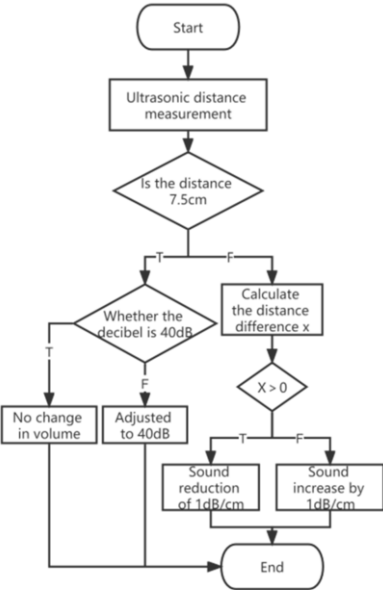


Figure 3. Flow chart for fully blind use

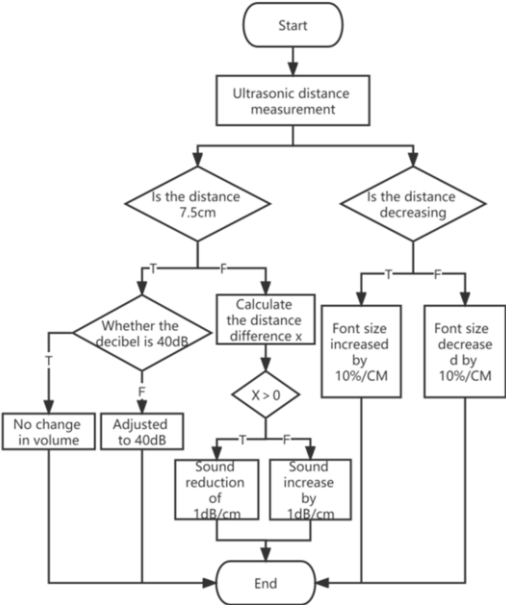


Figure 4. Flow chart for non-fully blind use

The use process is divided into two categories, one for the fully blind use of the dictaphone, the dictaphone will change the volume according to the distance between the ear and the machine. The second is the non-fully blind use of the dictaphone and look at the screen area on the dictaphone, the dictaphone will change the volume according to the distance between the ear and the dictaphone, and the screen size will change the font size according to the distance between the eye and the dictaphone.

4.3.2 Smart Component Implementation

The following is an expression of using intelligent hardware to achieve basic functions:



Figure 5. (a) Two-color LED power display module



(b) SRF10 ultrasonic sensor

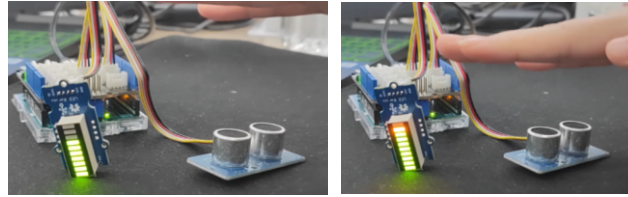


Figure 6. Actual operation diagram

The components used include Arduino Uno R3 development board motherboard, two-color LED power display module, SRF10 ultrasonic sensor, and code to drive the smart hardware on the Arduino. The actual operation of the distance between the lower hand and SRF10 ultrasonic sensor, simulating the distance between the face and the listening machine. The number of frames of the two-color LED power display module simulates the volume level. By hand close to the SRF10 ultrasonic sensor so that the number of dual-color LED power display module grid increases, simulating when the face is close to the listening machine, the intelligent adjustment of the listening machine volume and font size change.

5. Conclusion

This paper completes the analysis of the use process and existing product situation for hand-held listening machines, and makes some program ideas, improvements and refinements.

This design aims to improve the comfort of visually impaired people who love to use dictaphones. By analyzing the frequent volume and font adjustment and the long-time close reading damage to the shoulder and neck, and the pain point that the reading font is too small to focus, the ultrasonic sensor is added to the handheld dictaphones to measure the distance, and finally the intelligent hardware is used to change the light brightness according to the distance. In fact, the function of changing the volume and font according to the distance, to achieve the purpose of intelligent adjustment of the volume and font in different occasions cell phone type listening machine.

In future products, we hope to see more instinctive design, abandoning repetitive and tedious operation methods, and appearing human-centered design to improve user comfort. In addition, the product buttons and functions should be in line with the situation, to avoid excessive stacking of functions and more ergonomic.

Acknowledgement

This paper is sponsored by Beijing Institute of Fashion Technology National College Student Innovation and Entrepreneurship Training Program “Design of Multi-Child Family Lifestyle Product” (2022), BIFT Graduate Education Quality Improvement Project of Beijing Institute of Fashion Technology ' Future-oriented Arts and Crafts Integration Cross Team Building ' (NHFZ20220206), Beijing Digital Education Research Project ' Data-driven Design Professional Personnel Training Validity Evaluation Research ' (BDEC2022619006).

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