

DREU Final Report

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ABSTRACT

Clothing is an inherently visual medium currently not readily accessible to those with visual impairments. Presently, the best method for conveying information is with high-tech devices that identify fabric colors. However, these devices don't give information about pattern, graphics, washing instructions, or style. We have prototyped both low- and high-tech systems to explore different methods for tagging clothing and visual information retrieval. Each prototype system will be presented to members of the target audience in order to obtain feedback. The contribution we hope to make with this study is to identify the tagging system preferred by visually impaired users. The results of the pilot study will be used to develop and test a fully functional tagging system that will empower visually impaired users when making clothing decisions.

Categories and Subject Descriptors

K.4.2 [Social Issues]: Assistive technologies for persons with disabilities

General Terms

Design, Human Factors

Keywords

1. INTRODUCTION

People's wardrobes have a great effect both how we perceive ourselves and how we are perceived by others. Clothing is a means for self-expression. Our appearance will have a significant impact on other people's impressions of us. Dressing appropriately can be essential in many situations such as job interviews and weddings. Clothing gives us control over how we represent ourselves as individuals in a society.

This crucial method of self expression poses specific challenges to those that are visually impaired [2]. The current systems used to assist identifying items in a wardrobe are

both severely limited in functionality and could be enhanced by the use of technology such as radio frequency identification or smartphones.

The first step towards an improved system is to find the limitations of the current systems, identify their weaknesses, and explore how technology can improve these areas. Present systems are mostly aimed at wardrobe organization and are often difficult for the user to implement [1]. They may rely on the user remembering the physical location of specific clothing, on the use of tactile identifiers such as buttons or safety pins for differentiation, or using color identifiers on a phone or hand-held device [5]. These solutions can be taxing on the user's memory, while providing inadequate information about the user's clothing. The extent to which the user can commit these systems to memory is variable by individual. Visually impaired users also often have to rely on the help and opinions of other people to make their clothing decisions [2]. Therefore, the goal of our proposed systems are to shift the burden off the user and greatly improve universal usability.

In this paper, we will discuss the low- and high-tech tagging systems we built that can be embedded into the clothing to help store relevant information for visually impaired users. One of the low-tech systems we developed uses buttons (Section 3.1) in congruence with a website that lists the information associated with each button or pin type. Another low-tech system uses tags with braille ID numbers (Section 3.2) sewn into the clothes in addition to a website to look up information about a specific ID number. The first high-tech system we prototyped uses QR codes (Section 3.3) ironed inside the clothing in conjunction with a cell phone barcode reading application. Another high-tech system uses washable radio frequency identification (RFID with near field communication (NFC) tags (Section 3.4) sewn into the clothing, whose information can be read by a NFC-enabled phone or RFID reader. Supplemental information that can be stored in a database includes: washing instructions, whether an item is casual or formal, graphics or writing, pattern, and other coordinating items in the wardrobe.

We built seven tagging systems with seven to ten sample items in each system. We will be using these prototype systems in collaboration with feedback from visually impaired users in order to inform the design of an optimal tagging system.

2. RELATED WORK

Visually impaired users already implement some systems

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for organizing their wardrobes. Most of these are low-tech, Do It Yourself (DIY), systems. For instance, some visually impaired users will hang their clothes in a specific order. They are then required to remember where everything is located. For instance, they might use the alliteration "light is to the left" to remember that all their light colored clothing is hanging on the left side of the closet. Another way to help remember visual data about clothing is to take safety pins and have all the coordinating clothes have the same number of safety pins attached to them [1]. Or safety pins can be used to indicate specific information, such as color. For instance, a single safety pin could mean blue while two safety pins linked together could mean green. All of these sorting methods rely on memory, which limits the lexicon of what the tags might mean. Using buttons or safety are also limiting in the type of information that can be portrayed. A button can only stand for one detail such as color or pattern, but not indicate both.

There are also applications for the phone or standalone devices that can scan clothing and report the color. It will only tell a user the color, but will not give them other information, such as pattern or graphic. This method can also be unreliable and potentially cost prohibitive [5].

One proposal uses RFID tags to track clothing in a Smart Closet [4]. This system utilizes RFID tags in the clothing and a software system helps the user make decisions about their daily wardrobe. Using RFID tags in clothing can be extended to aid the visually impaired identify visual information about their wardrobe.

3. CLOTHING TAGGING SYSTEMS

Several different clothing tagging system prototypes were built including both low- and high-tech systems. These systems include button tags, braille ID tags, QR codes, and RFID/NFC tags.

3.1 Low-Tech Systems: Buttons

One method of tagging clothing is to sew buttons onto the inside of clothing. The simplest form of this tagging system is to use buttons to differentiate color or pattern of clothing that feels the same. This is a method that is already being implemented by the visually impaired [6]. This system is currently being used to coordinate items that match.

These systems are constrained by how many button shapes exist, remembering what shapes mean, and the difficulty of maintaining records of the data. The button systems proposed in this paper implement a website to alleviate memory load.

3.1.1 Button Shape Indicating Coordination

This button system does not require a website or any other technology. Every coordinating article of clothing has a matching button shape.

3.1.2 Button Shape Indicating Color

This button system maps the button shape to a specific color, which is documented on the website (Figure 1).

3.1.3 Button Shape Indicating Washing Instructions

In this system, the information of interest is washing instructions. The button shape matches with different washing instruction, which can be found on the website (Figure 2).

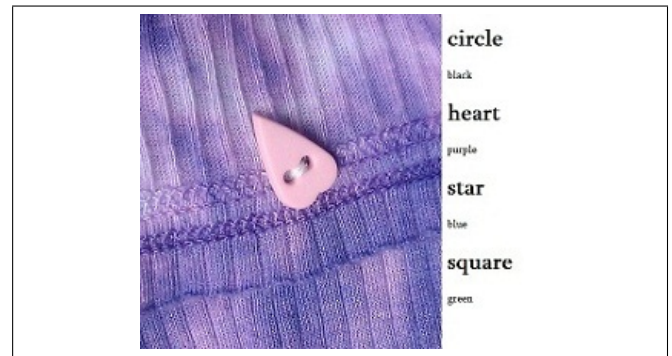


Figure 1: This heart shape buttons matches "purple" on the website.

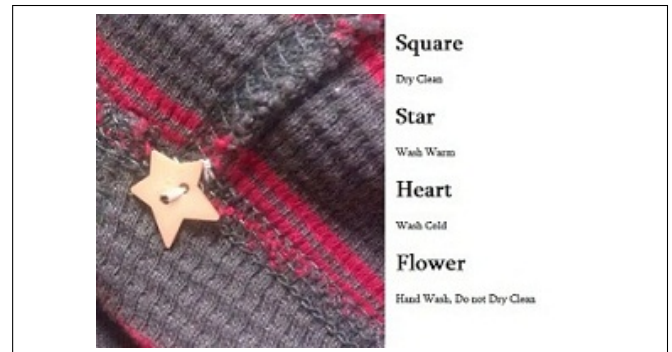


Figure 2: The star button matches "Wash Warm" on the website.

3.1.4 Button Shape and Button Location Matrix

This system uses not only unique button shapes, but also the location of the button on the article of clothing to create two levels of visual data available. For example, in our prototype, the shape indicates color and the physical location indicates washing instructions. The information can be referenced using menus on the website (Figure 3) to reduce memory load.

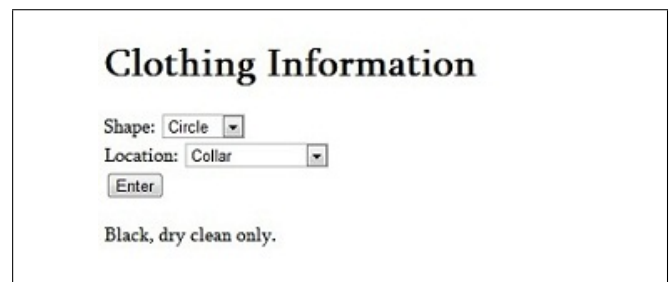


Figure 3: Select the shape and the location to get the clothing information.

3.2 Low-Tech System: Braille ID Tags

To allow for more than two distinct groups of visual information to be accessible in the tagging system, a more complex database of information has to be built. Each item of clothing in the wardrobe is given a unique ID number. The number is then attached to the clothing using a braille ID tag.

There are several options for creating braille ID tags. One option is to use machine or hand-stitched embroidery. This

was found to be difficult and time consuming. There are also washable tags on which braille can be written available for purchase on the internet [1]. These tags will contain some information about a clothing item such as color. For this prototype system, the tags were created with puff paint on ribbon (Figure 4).

The paint needed to be activated in order for the braille to be felt easily along the ribbon. These tags are made of ribbon sewn inside the clothing which allows more comfort for the wearer. These tags were sewn near pre-existing tags or near a hem.



Figure 4: Tags with puff paint braille were sewn into the clothing.

A numbering system for the ID tags was devised in order for clothing to be sorted by clothing before accessing further data on the website. For example, if the user was looking specifically for a black top, they could feel for the first two digits of the ID. Since "40" corresponds with top black, they could narrow down their search to all IDs beginning with this code. This prototype system uses a four digit number, as seen in Figure 1.

Table 1: A four digit ID number corresponding to the items in the table.

First Digit	Second Digit	Third and Fourth Digit
Clothing Type: 1 = pants 2 = skirts 3 = dress 4 = tops	Main Color of Item: 0 = black 1 = white 2 = red 3 = blue 4 = green 5 = tan 6 = yellow 7 = purple 8 = brown 9 = pink	Unique ID

The ID numbers can also be input into a search box on a website (Figure 5). This will provide all the current information about the item associated with that number.

Input Number:

Number 3315. Tie with diagonal stripes of dark blue, light blue, off-white/grey, and orange.

Figure 5: ID numbers can be searched for in a website.

3.3 High-Tech System: QR Codes

A QR code is a square barcode that can be scanned and read by a smartphone. QR codes allow for plain text information to be stored directly into the code. All the information about an article of clothing could be entered as text and stored in the code. This code is then ironed onto the inside of the clothing (Figure 6) using fusible iron-on transfer media. When the phone scans this code, the information will appear on the screen and can be read directly by a screen reader application.



Figure 6: A QR code near the collar of a shirt.

This system allows for direct access to the information without the need for a large database or website. However, once the information is encoded, it cannot be altered. An alternative would be to create a QR code that links to a specific web database and displays the information. This would allow clothing information to be modified by the user without having to iron on a new QR code.

3.4 High-Tech System: RFID and NFC Tags

In this system, RFID/NFC tags (Figure 7) are sewn into the clothing. These tags use the Near Field Communication (NFC) standard, which means they can be read from a few centimeters away [3]. These tags are washable; they can be laundered with the clothes without being damaged from the water, detergent, or high temperatures.

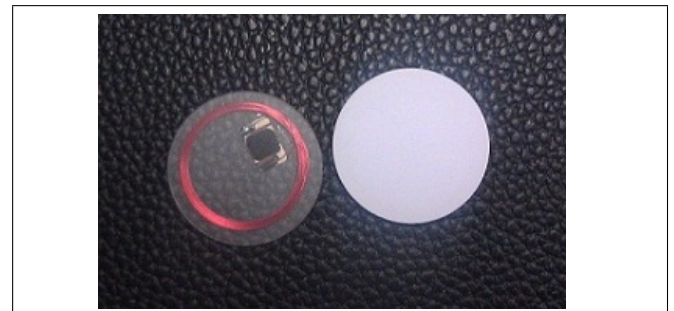


Figure 7: Washable RFID/NFC tags before they are embedded in the clothing.

The RFID/NFC tags are encoded with a unique number during manufacture. This number can be read by a separate NFC reader device. NFC tags are also readable by NFC enabled smartphones. For this prototype, we built a RFID handheld device that plugs into the computer. When it reads the tag, it sends the ID number to the computer. This

Table 2: Clothing Tagging Systems Summary.

Tagging System	Interface	Tag Used	Price Per Tag	Advantages	Disadvantages
Coordination	N/A	Button	\$0.01	Simple to Create, Inexpensive	Limited Information
Button Shape for Color	Enhanced with Website	Button	\$0.01	Inexpensive	One Level of Detail
Button Shape and Location Matrix	Enhanced with Website	Button	\$0.01	Inexpensive	Two Levels of Detail
Braille ID Tag	Website	Puff Paint on Ribbon	>\$0.05	Detailed Information	Time Consuming to Create
QR Codes	Smartphone QR Code Reader	QR Codes Ironed On Clothing	\$0.10	Detailed Information, Scan from Smartphone	Code May Fade, Difficult to Scan, Must Have Smartphone
RFID Tags	Smartphone NFC Reader or RFID Reader	Laundry RFID Tags	\$2.50	Detailed Information, Scan from Handheld Device	Expensive

can be interfaced with a database much like the braille ID tags.

4. DISCUSSION

There are advantages and disadvantages to using each of the proposed systems. These have been listed in Table 2, including an approximate price for each tag type at the time the systems were built.

Using a high-tech system seems like the better choice in terms of ease of use and the amount of information that can be stored for each item of clothing. The QR code tags are inexpensive, easy to create, and can be scanned by any smartphone with the QR code reading application. However, the drawback of this system is that it is quite difficult to scan. The phone has to be aimed precisely over the code and held at a specific height in order to read the code. This may prove to be a significant challenge for visually impaired users. Using RFID tags are a good alternative to QR codes. They require only that the scanning device be close enough to the tag to scan. However, the price of the tags is currently quite prohibitive at \$2.50 per tag. It would cost \$50.00 in tags to outfit a wardrobe of only 20 items. Also, smartphones in the United States are only now beginning to come enabled to read the tags.

Until the technology comes down in price, low-tech systems may be the better solution for tagging clothes. Buttons are the ideal solution for a user to create and maintain their own system. The braille ID tag offers the most detailed information. While it would time consuming to create the tags and database, once initial set-up is complete, the wardrobe would be as accessible as one with RFID technology.

5. FUTURE WORK

These prototype systems will be used in interviews with visually impaired users. The goal is to determine which system or systems will be the most effective for the end users. Feedback will help inform the design of future clothing tagging systems.

Implementing a website with a database will allow users to input an array of information about their clothing. This can include information gleaned from crowdsourcing and subjective information.

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