Sensors & Transducers

Development of an Automatic Combination System of Clothing Parts for Blind People: MyEyes

[1] Daniel Rocha, [1, 2] Vítor Carvalho, [1] Joaquim Gonçalves, [3] Filipe Azevedo and [1] Eva Oliveira

[1] IPCA, School of Technology, DIGARC, Campus of IPCA, 4750-810 Barcelos, Portugal
[2] Algoritmi R&D, Minho University, Campus of Azurém, 4800-058 Guimarães, Portugal
[3] ACAPO, Delegation of Braga, 4700-219 Braga, Portugal
[1] Tel.: +351253802260, fax: +351253823127
E-mail: a7517@alunos.ipca.pt, vcarvalho@ipca.pt, jgoncalves@ipca.pt, filipeazevedo@acapo.pt, eoliveira@ipca.pt

Abstract: Blind people have been, over time, a reason for motivation in the development of solutions to improve their quality of life. The aim of this work is to propose a solution for one of such problems, namely, the selection and combination of clothing for the blind. Thus, this paper describes the whole project developed, in agreement with the Portuguese Association of the Blind and Amblyopic of Portugal (ACAPO), for the creation of a Web platform to aid the blind in selecting combinations of clothing. Near Field Communication (NFC) technology is the basis of this project in the identification of garments. The features of the garments are inserted manually, and a combination of features is possible. There is also the possibility to automatically identify the color of the garment. The system has been tested by the ACAPO organization and preliminary feedback is positive, which are a good starting point for the future. This solution helps promote an increased autonomy for blind people.

Keywords: Blind People; Image Processing; Clothes Combination; NFC.

1. Introduction

The definition of being human leads us to certain questions: to what extent are we different? Will our society be able to define our species without aesthetic questions? Is our society with its capabilities, whether social, psychological, technological, to help citizens with disabilities? Is there enough technology to minimize the obstacles faced by these people in their daily lives? Certainly, the technology in this field has evolved a lot but there are still some gaps to be filled.

People with visual impairment face difficulties at various levels, since they are limited in their functional capacity to carry out daily activities, such as different domestic tasks, the choice of clothing, and in all the tasks that are easy for people with visual capacity.

Vision is a sense that dominates human life. It allows us to know and have a perception of the world around us, while giving us meaning for objects, concepts and ideas. It is the dominant sensory channel in the acquisition of information from the outside. Vision accounts for about 80 % of our sensory inputs [1-2].

With the advancement of technology, it is important to evolve to minimize all the limitations of a blind person. One issue that remains to be explored is the case of blind people is the selection and combination of garments. Sometimes, even if we do

not have any type of disability, we have difficulty choosing what to wear; we can imagine the difficulty of a visually impaired person in this aspect. Not knowing the colors, the type of pattern, or even the place where the garments are found makes this a daily battle in which resources are not the best. Therefore, we proposed this project to address the issue of combining clothing for the blind.

This paper is organized in 6 sections. Section 2 presents some available solutions to help in the autonomy of blind people. Section 3 describes the system requirements and Section 4 the various components of the solution presented, including system architecture, hardware, software, database as well as Web and windows applications. Section 5 describes the tests performed with blind people to validate the solution presented and finally, Section 6 draws the conclusions and suggests further developments.

2. Related Work

Currently, there is no solution on the market to help blind people with their clothes combination. Indirectly, but not focused on this purpose, we can find applications for mobile devices that can provide, even if far from what is wanted, some help. Some applications already developed in that sense include: Be my eyes, Color Detector, Ibeacons and Colorino.

'By my eyes' [3] is a mobile application considering a video call via the internet to get help from a visually capable person. The color detector is an application of the app store for iOs that uses a screenshot to calculate the average color of a chosen area. The Beacons are small devices that use Bluetooth Low Energy (BLE) technology. This technology has an incalculable practical effect. With the beacons, it is possible to identify, for example, landmarks, bathrooms, stairs, shops and many other things. The Colorino is particularly suitable for people who have a reduced vision and even for the blind, as it assists in the choice of clothes, the washing procedure and the color combination.

The research project Context Extraction for the Blind Using Computer Vision (CE4BLIND) is a mobile digital platform that results in a computer application that can be used on a computer, mobile phone or tablet. This project aims to increase the perception of reality to those who cannot use their vision as stated by those responsible for the project, that is, to facilitate and give these people greater autonomy in tasks such as reading a newspaper, a restaurant menu or identifying a route [4].

Another project described in literature is "Assistive Clothing Pattern Recognition for Visually Impaired People" which consists of recognizing patterns of clothing being able to identify 11 clothing colors and recognize 4 categories of clothing patterns [5-7]. The paper "Rotation and Illumination Invariant Texture Analysis" suggests a form of clothing combinations of complex patterns for visually impaired people [8-9].

Also, the project described in the paper "Recognizing clothes patterns and colors for blind people using neural network" allows to classify the type of pattern of garments through extracting their characteristics by a camera [10-12].

As described, although there are some projects that can be used to help the blind, none of them contains the idea presented in this project. Thus, the development of an application for combinations of clothing pieces was elaborated.

3. System Requirements

As the main focus, it is intended to develop a system for the blind, capable of proportioning better independence and consequently well-being, to aid in the combination of clothing garments.

The system will be able to identify characteristics of the clothing garment, as well as combinations for it, able to be selected according to the user's taste, in this case, the blind person.

In order to develop an application that meets the requirements, a Web platform with integrated with Near Field Communication (NFC) technology was designed.

As its main purpose, the Web application should be able to incorporate the following functionalities:

- Register each user on the online platform;
- Registration of all pieces of clothing of each user;
- Possible combinations between the various pieces of clothing;
- Unique identification for each piece of clothing;
- Use of NFC technology as an identifier.

The NFC technology should provide an interface with the Web Application Programming Interface (API), in this case it would be an NFC reader, as shown in Fig. 1, connected to the computer via USB, to make the respective readings. A camera was included for later use of image processing techniques.

Fig. 1. Reading System for Garments.

The way to identify garments is through the use of NFC technology, using a minimal invasive tag for

their identification. In addition, we consider an Arduino platform with a PN532 module, which allows the clothing label to be read. The Arduino is connected to a PC which allows the interface with the Web platform.

4. Application Development

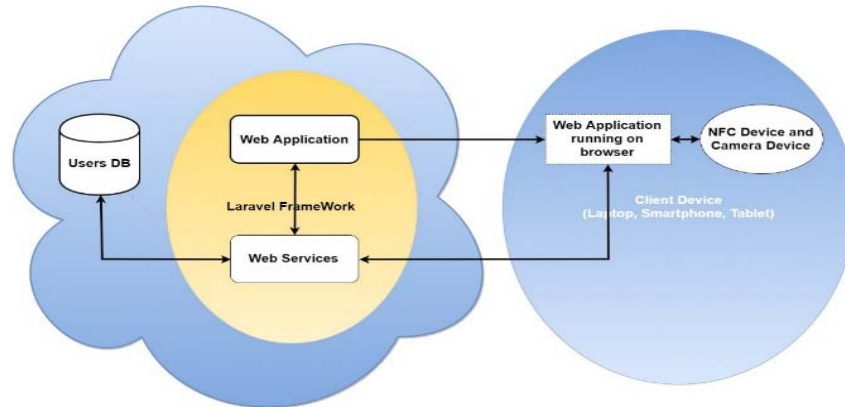In this section, we will present the system development, including all the hardware and software.

4.1. System Architecture

First, to develop this project, it was proposed to develop a Representational State Transfer (REST) system architecture (Fig. 2).

The system is composed of an API and a front-end application that is all that the user "can see". The API is responsible to process all requests of the user, coming from the front-end interface, such as image acquisition and processing, automatic combinations, among other features.

Fig. 2. Rest Architecture.

In the back-end application we have Web services which are a set of files with specific procedures to match all the *http* requests by the front end. This type of structure also allows applications of different types, android, IOS and desktop to be able to use the same Web services simultaneously through *http* requests.

4.2. Hardware

The hardware platform focuses on the Arduino Uno, equipped with an Atmel AVR microcontroller and a C++ programming environment (Fig. 3).
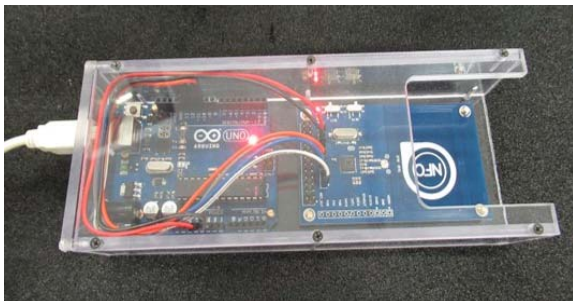

Fig. 3. Hardware Developed.

Since, the technology used for this project is the NFC, it requires an NFC shield to Arduino. The reading module is the ITEAD PN532. It has SPI (Serial Peripheral Interface), I2C (Inter-Integrated

Circuit) and UART (Universal Asynchronous Receiver/Transmitter) communication interfaces. However, the mode of communication used is the SPI. In this way, the Arduino is connected to a PC and allows the interface with the Web platform.

The TAG chosen to place in the clothes is the NTAG213 which is minimally invasive (Fig. 4).

Fig. 4. Clothes with TAG.

The TAG used has the following characteristics:
- Chip - NTAG213;
- Frequency - 13.56 MHz;
- Memory - 144 bytes;
- Data transfer: 106 kbit/s.

The NXP NTAG®216 chip offers excellent memory capacity, ideal for storing more information, however, in this project we will not make use of it once it is identified by its UID (Unique Identifier) [13-14].

4.3. Software

The application development uses Laravel [15], which is a PHP (Hypertext Preprocessor) Framework that uses the MVC (model-view-controller) architecture, Fig. 5.

This architecture allows simplifying the application in 3 layers, namely user interaction (view), data manipulation layer (model), responsible for reading and writing, and the controller layer, responsible for all user requests that controls the model to be used and the display to be shown to the user. The database used by default in Laravel is MySQL.
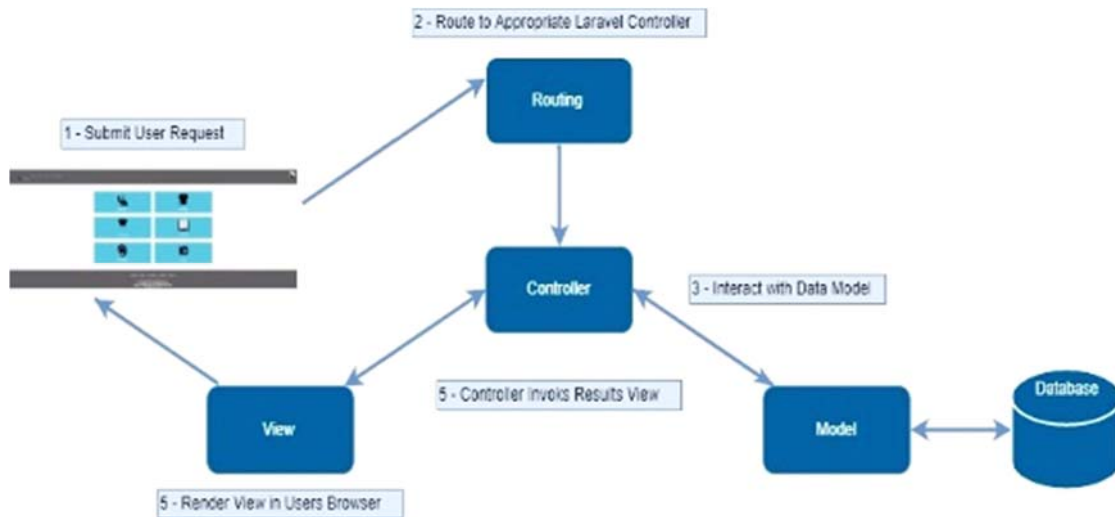

Fig. 5. Laravel Components.

4.4. Database

The database was developed to respond to a set of challenges posed by the system that results in the following key requirements:

1. A user can perform more than one function;

2. Each role is associated with a set of permissions, regardless of which user executes it;

3. Each clothing item (with a unique identifier) is associated with a set of parameterized characteristics:
- Size;
- Washing;
- Printed;
- Season;
- Type;
- Color;
- Style.

The database created was based on the Entity-Relationship (ER) Model. In the database management system, a set of tables will also be considered, which will assist in the decision making. The application also has an administrator level that is composed of the following tables:
- Users;
- Profiles;
- Permissions.

This way, we guarantee privileged access to certain areas of the application and a level of administration.

4.5. Accessibility

Accessibility on the Web is the possibility that anyone with a disability can enjoy, contribute and have access to the Web.

There is an initiative called Web Accessibility initiative integrated in the W3C consortium that has the purpose to help all people with disabilities. At the moment, some Web sites and Web software have accessibility obstacles that make it difficult or impossible for disabled people to use the Web. As more accessible Web sites and software become available, people with disabilities are able to use and contribute to the Web more efficiently [16].

This initiative defined some requirements regarding information presentation and navigation. In "My Eyes" we have implemented these requirements to make it accessible to the blind.

In the context of information presentation, the following aspects were considered:
- Ensure that all images are captioned or described with text, so that the screen reader used by the blind will read the alternate text associated with the image;
- Ensure that the text size can be increased with browser options;
- Ensure that the length of the text fits the window size;
- Identify the fields in the forms, thus identifying their functionality.

When it comes to navigation, it will allow the activation of the elements of the page through the keyboard and ensure that the text of the links is understandable out of context. In addition, the page should provide a simple way to contact support when the user has difficulty accessing the content of the site. The accessibility symbol on the Web should be on the home page to indicate that the page contains accessibility features [17].

4.6. Web Application

To understand the structure of the Web application, Fig. 6 shows the block diagram of the organization considered.

With the login done, it is possible to access the "Menu", where there are 6 topics, "My profile", "My Clothes", "Combination", "History Data", "Color Palettes and Camera" (Fig. 7).
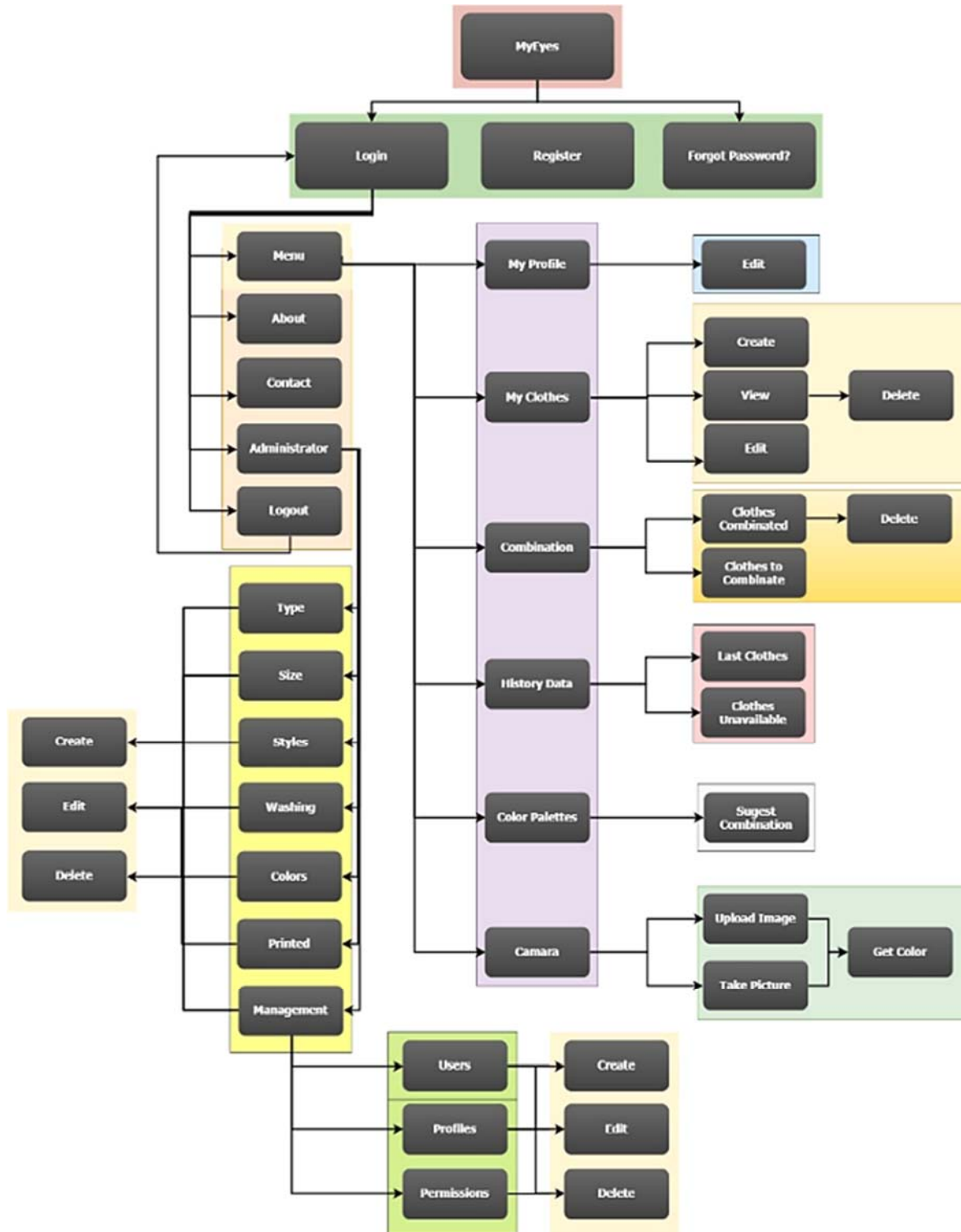

Fig. 6. Block Diagram of MyEyes.

Fig. 7. Menu MyEyes.

My Profile: is where all user's personal management is done, where all the user's authenticated fields can be seen, such as name, email and password. This data can be edited anytime.

My Clothes: serves to manage the clothes that the user owns. The clothes can be listed by their attributes, such as: style, type, pattern, size, colors and season. During the listing, the user can edit and delete the part, thus allowing stock management (Fig. 8).

Fig. 8. My Clothes Details.

Combination: The whole combination of clothes is implemented here. The user can see their combinations, edit and delete them in "view details" (blue boxes), referring to each piece of clothing (Fig. 9).

History Data: It allows the user to consult the registry of the last pieces of clothing added, as well as the clothes unavailable, Fig. 10.

That is, if it is necessary to put a garment in this state, and in case it may be for washing, a quick perception about the state of it is presented.

Color Palettes: This mode is like the combination, but has an automatic mode in which the application makes a filter through the seasons (autumn, winter, spring, summer), suggesting only parts from the same station or that can be used in both. In this way, we guarantee that all the possible combinations agree with the season of the time, eliminating numerous pieces that would generate confusion to the user.

Camera: Here, it is possible to obtain the predominant color of a garment. There are two ways to do this, one is to upload an image of a garment, and another is to take a photo of the garment with the webcam, Fig. 11.
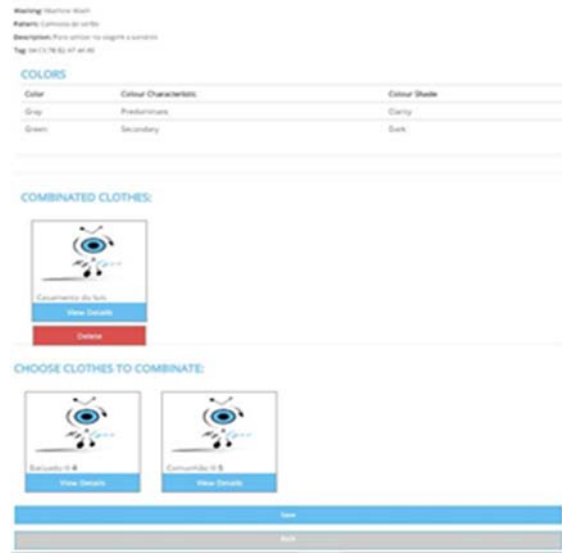

Fig. 9. Part of Combination Layout.

Fig. 10. History Data Management.

Fig. 11. Desktop Application.

After choosing one of the two modes, the predominant color of the garment is shown.

4.3. Windows Application

To allow the interface with the NFC reader, a computer application was developed a computer application (Windows operating system) in C# language, capable of performing the readings of NFC tags (Fig. 12).

This application is very simplistic in the way that it allows to read a tag when the user wants. The fact that this application acts as a communication interface with the Arduino allows communication

configurations, such as serial port or communication speed, to be knowledge of the user.

In this case, the algorithm has been thought out in a way in which the application detects the device automatically, at the time of its connection, autonomously establishing a communication.
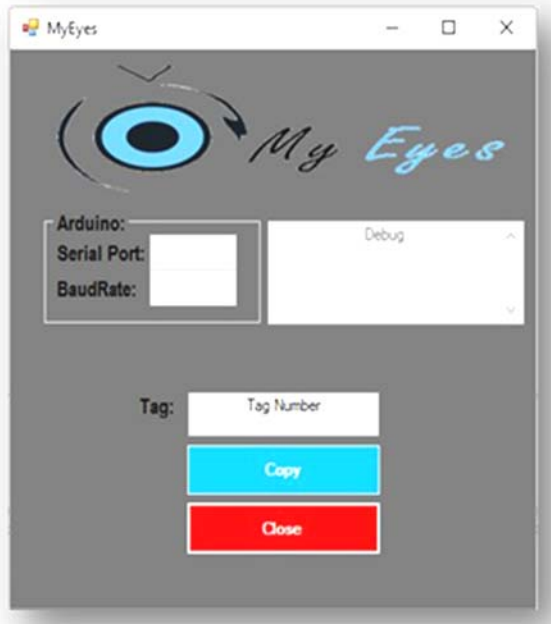

Fig. 12. Desktop Application.

5. Preliminary Validation

This project was submitted for validation at the Association of the Blind and Amblyopic of Portugal (ACAPO) in Braga, Portugal. Application testing focuses on accessibility and usability (Fig. 13).

During this validation, the user used the NVDA (Non-Visual DESKTOP Access) screen reader that permits the interface between a blind person and a computer, by interpreting the information present on the screen and allowing blind and visually impaired people to hear the information displayed on the screen.

While validating, there were added pieces of clothing and for each one was attached its NFC tag. After, recognize of each clothing was performed with the NFC reader.

The feedback given about the prototype MyEyes [18] was very positive. However, some remarks were discussed to improve the application, like:

- Include more info in social networks (Facebook, YouTube and so on);
- In the windows application, implement a beep sound when detecting a new TAG;
- Create a "back button" at the end of each page to improve usability;
- Invert the order the clothes are shown in when an additional clothing item is added. This means that the last record needs to appear in the first row;

- Exchange the TAG number by Description field when the Clothe is displayed, since that TAG number is insignificant to remember the clothe;
- Remove the confirmation button when attempting to see more details or edit, and keep the confirmation only in case of deleting.
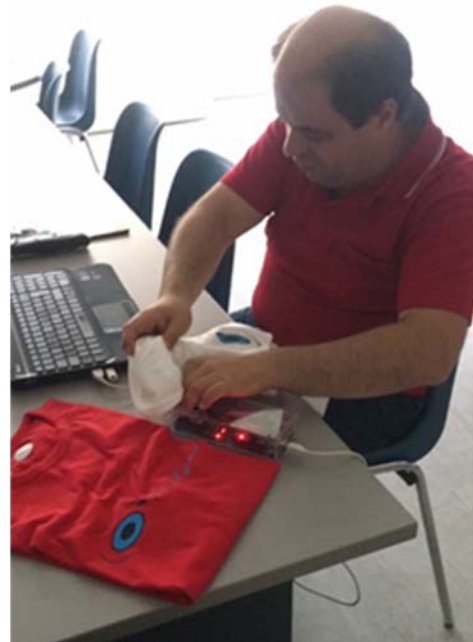

Fig. 13. Blind People Reading Clothes.

Afterwards, all topics above were considered and a new version of the application was validated again; it means that the second validation was tested without any other additional changes.

Considering the preliminary usability tests performed by the ACAPO member, the blind people community considered that this project will be very useful for the blind population because it could fill a major gap that affects this population, which is related to the identification and characterization of clothing. This solves an obvious difficulty in the task of making combinations at the time of choosing the pieces of clothing that they are going to wear.

These obstacles go so far as to prevent a blind person from being able to choose their daily clothes in a completely autonomous way, forcing them to ask for help from others to describe the pieces that they have, and to organize their wardrobe to not be confused by the colors, shades, fabric types and other characteristics of the garment. Moreover, they consider that as there are many blind citizens who live alone and several couples consisting only of blind people, the usefulness of such a tool will increase their autonomy and promote a better inclusion in society. It would be extraordinary if, with this platform, people no longer had the need to ask for help from others regarding clothing combinations. It is true that video calls today make this kind of task much easier, but we must clearly aim for autonomy and independence, and MyEyes can offer blind people this legitimate desire to be able to choose in an informed and conscious way the clothes they wear every day.

6. Conclusions

This paper presented a system able to allow visually impaired people to combine cloths based on their taste and options.

The introduction of NFC technology in clothing allows the creation of an autonomous clothing management for a blind person. Being a Web application, it is accessible to all. This application will make possible to contribute to the lack in the existing technology in relation to the aesthetics and visual image of a blind person. The user interface is intuitive and of great usability.

The tests performed with the Portuguese Association of the Blind and Amblyopic of Portugal (ACAPO) validated the proposed solution.

For future work, there are certain aspects that can be optimized and potentiate this project. Among them, the following stand out:

- **Hardware Optimization:** designing a dedicated PCB for the main block where only the components needed for the study, reducing the associated power consumption as well as facilitating the implementation of software improvements.

- **Integration of the application in mobile platform:** Since the equipment makes use of NFC technology, it would make sense to associate it with mobile Android platforms, thus making it more practical and interactive.

- **Implementation of artificial intelligence algorithms:** implementation of automatic learning algorithms in clothing combinations, as well as the automatic insertion of garments, using a camera and image processing algorithms in the extraction of characteristics.

- **Implementation of Multilanguage:** this function would increase the number of potential users.

Acknowledgements

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