MyEyes - Automatic Combination System of Clothing Parts for Blind People: Prototype Validation

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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 article 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-Inclusion; Blind People; Image Processing; Clothes Combination; NFC.

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

II. 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.

III. DEVELOPED APPLICATION

In this section, the entire system developed is presented, including all the hardware and software.

A. System Architecture

First, to develop this project, it was proposed to develop a Representational State Transfer (REST) system architecture (Figure 1).
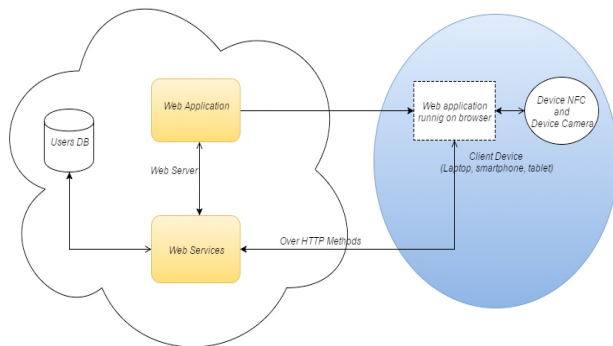

Figure 1. Rest Architecture.

For this, the system is composed of an Application Programming Interface (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.

B. Hardware

The hardware platform focuses on the Arduino Uno, equipped with an Atmel AVR microcontroller and a C++ programming environment (Figure 2).

Since, the technology used for this project is the NFC (Near Field Communication), 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.

Figure 2. Hardware Developed.

The TAG chosen to place in the clothes is the NTAG216 tag minimally invasive (Figure 3).

Figure 3. Clothes with TAG.

The tag used has the following characteristics:
- Chip - NTAG216;
- Frequency - 13.56MHz;
- Memory - 888 bytes;
- Data transfer: 106 kbit/s;
- Maximum number of characters (URL) – 854.

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].

C. Software

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

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.

D. 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.

E. Web Application

To understand the structure of the Web application, Figure 4 shows the block diagram of the organization considered.

Considering Figure 4, it is possible to verify that there are four main elements, the "Menu", "About", "Contact" and "Administrator", and, to be able to access them, a user authentication is necessary.

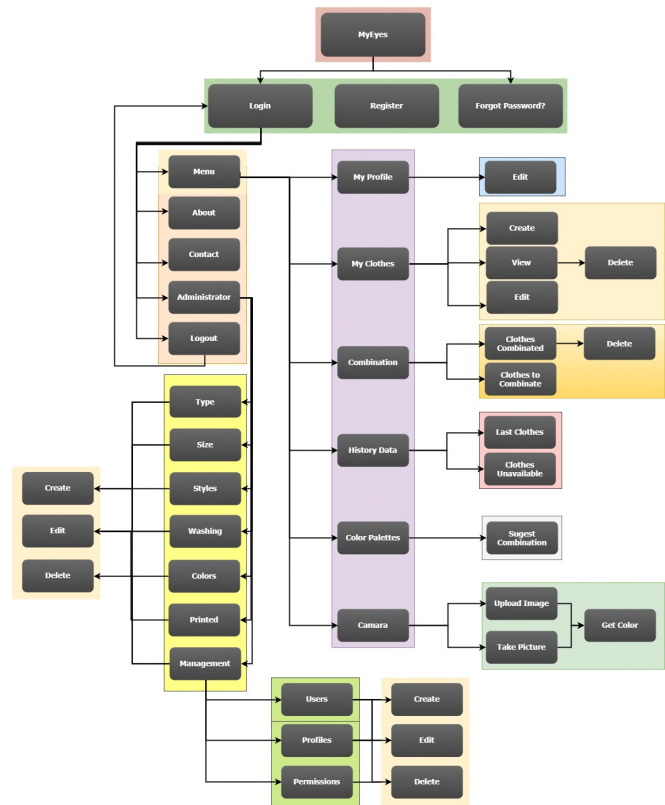For this purpose, it is necessary to access the "Register" to create the user.

Figure 4. Block Diagram of MyEyes.

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" (Figure 5):
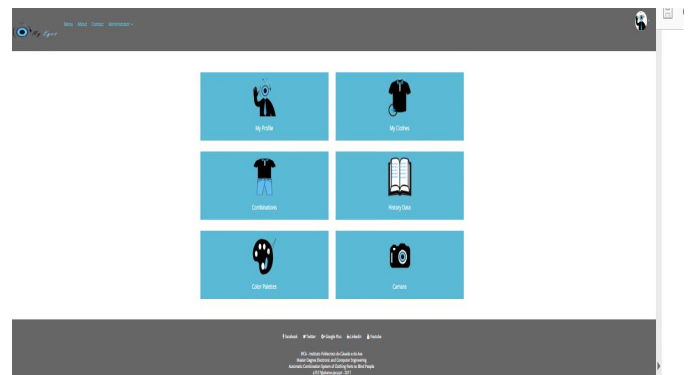

Figure 5. Menu MyEyes.

- **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 at any time.

- **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 (Figure 6).
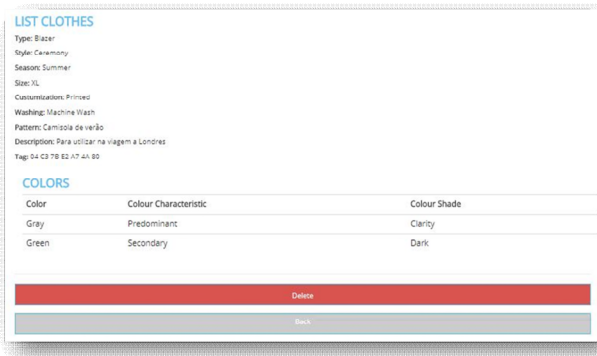

Figure 6. My Clothes Details.

- **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 (Figure 7).
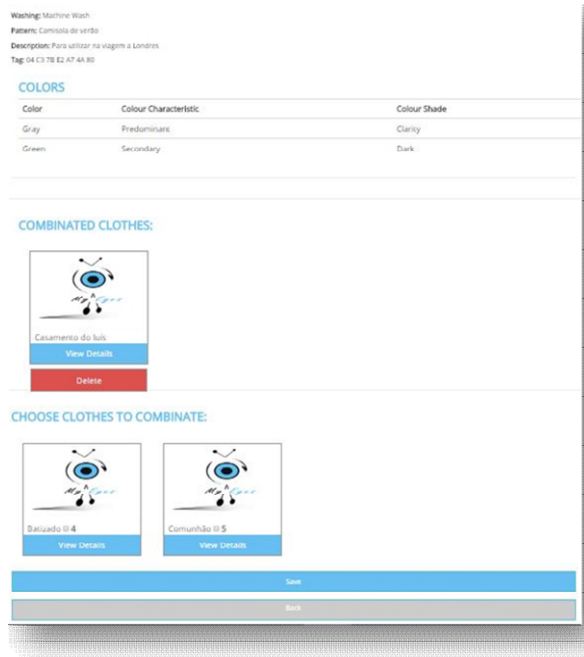

Figure 7. Part of Combination Layout.

- **History Data:** It allows the user to consult the registry of the last pieces of clothing added, as

well as the clothes unavailable. 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. After choosing one of the two modes, the predominant color of the garment is shown.

F. Windows Apllication

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 (Figure 8).
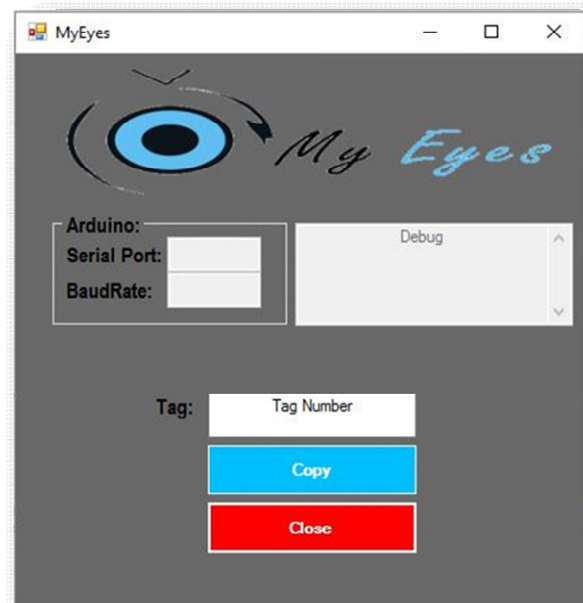

Figure 8. Desktop Application.

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

IV. 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 (Figure 9).
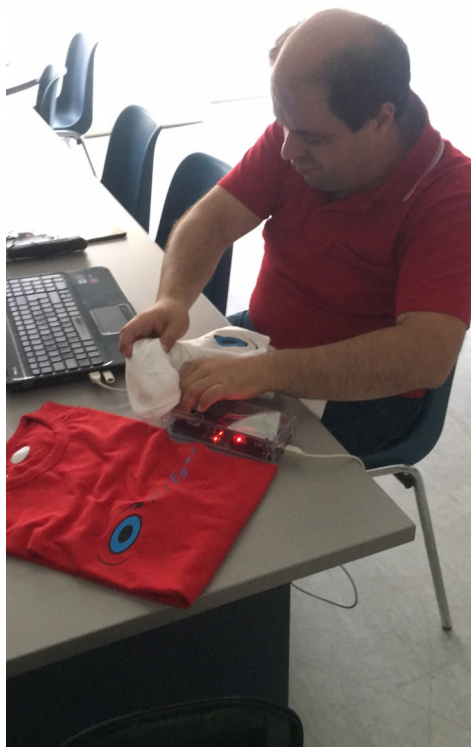

Figure 9. Blind people reading clothes.

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

The feedback 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.

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 in order 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 My eyes can offer blind people this legitimate desire to be able to choose in an informed and conscious way the clothes they wear every day.

V. CONCLUSION AND FUTURE WORK

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.

As future work, we intend to implement machine learning in combinations of garments, as well as the insertion of garments automatically using a camera and image processing algorithms in the extraction of characteristics. The multi-language capability needs to be implemented also to increase the number of potential users. Moreover, we intend to use NFC from mobile devices to incorporate this project.

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