Bilkent University

Department of Computer Engineering

CS 491: Senior Design Project

Rhapso

Project Specification Report

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1. Introduction

In our age of technology, it is a common practice that many traditional daily activities are supported with tools implemented in engineering domains. Thanks to a wide range of available software, users can execute said daily activities more comfortably. Some examples include: *Spotify* [1], by which the users can basically carry around all the music that they would like to listen to throughout the day; this activity would otherwise be more complicated, having in mind that the users would had to carry the music records and the hardware to listen to the music with them, which would be extremely inefficient. *Google Maps* [2], by which the users can navigate easily in the streets of even the most complicated and congested cities; again in the absence of this software, the users would have to use some traditional methods like some physical maps, which are large to carry and do not have any interactive component like Google Maps like telling the traffic, offering alternative routes, suggesting different paths for different means of transportation, etc. There are more examples on a similar basis that we could grow our list on, but we believe that these examples suffice in terms of clarifying our justification. Among explained examples, one other important common point is that all of the examples given include mobility, that the users can install these software as mobile applications in their mobile devices, and use them wherever they want as long as they have their mobile devices with them.

Having made the previous points, our project *Rhapso* will be based on easing a particular daily activity, while using the blessing of mobility of mobile devices. The project will be explained to a greater detail in 1.1, but here we want to give a brief description of *Rhapso*. As explained, our project will be a mobile app. With this app, we want to implement and provide the functionality of creating a virtual wardrobe using the photos of the clothes of the user. In comparison to a regular wardrobe, our wardrobe will be interactive which will give shopping suggestions in terms of the already existent items in itself. We want to pay attention to the sustainability of the environment, such that the material that the clothing items that were produced with, carries high importance in our project. Followingly previously explained suggestion will also take into account the material that the item was produced with. If there are clothes produced with more sustainable material in terms of the sustainability of the environment, these options will be superior. Lastly, in our application, the users will have the opportunity to try on the clothes virtually, so that on occasions that the time is constrained, our application will provide practicality, which we believe will be essential.

Other than the mobility aspect of the application, one other issue that we are trying to solve with *Rhapso* is the unnecessary consumption of clothing pieces. From the statistics of people buying 60% more clothing garments in 2014 than in 2000 while only keeping half of these garments, to fashion production making up 10% of humanity's carbon emissions, to the impact of exceeding fashion consumption on the drying up of water sources, pollution on rivers and streams, it is undeniable that overly high

consumption of clothing is a problem of modern world [3]. A paper on shopping behavior from researchers in University of Michigan state that:

> *Participants described wanting features that encourage deliberation or reflection by, for example, completing a needs assessment before making a purchase: "Asking what I would use it for and if I truly need it" [...] Other participants wanted to be prompted to reflect on their current possessions: "Ask me do you really need that. How many do you have now?"* [4]

Individual activities such as thrifting aim to offer a solution to the problem of pollution of clothing garments, but they do not have a wide impact as they are and they still do not affect customer behavior. One aim of *Rhapso* is to offer another solution to the present over-consumption of clothes by comparing new clothes to existent ones in the saved closet, recommending sustainable options when available, and making the user "try on" the new clothing garment with the clothes they own so that they can see if the new clothes fit in with their closet, as the application also recommends outfits with the new clothes and if the clothing does not fit in it will inform so. By doing these tasks, the application will result in reduced consumption of clothes for customers over time.

In the technical part of the argument, we want to make use of computer vision algorithms. The algorithms will mainly be used in the detection of the cloth from the photo, and while comparing clothes with each other in terms of their similarity. On the other hand, in the part of enabling users to virtually try on clothes, again we will be making use of computer vision algorithms, which for this part will be embraced in *GANs (Generative Adversarial Networks)*.

This report consists of the description of the project 1.1, explanation of some of the possible constraints 1.2, information about possible professional and ethical issues related to our project 1.3, definition of functional 2.1 and non-functional 2.2 requirements of the project, some similar technologies to our project 3, and lastly our references for this report 4.

1.1 Description

Rhapso is an online closet service in which the users can keep track of their existing clothes by taking photos of them and saving them into the application. The clothes will be detected from the photos provided by the user and located inside the online closet. One of the features provided by *Rhapso* is shopping suggestions. The users will be able to take a photo of the clothes during shopping and *Rhapso* will tell if the selected piece can be combined with the ones people already have and show them to the user. Furthermore, *Rhapso* will compare the photographed clothes with the user's closet stored in the application. By this comparison, there will be a similarity score based on the shape, color, figures of clothes they have and considering this score, the user will decide

to buy it or not and this will help users not to buy unnecessary outfits. Furthermore, the app will also suggest more sustainable options with high similarity scores based on their material and cost. Another feature is the aspect of trying out the clothing virtually. There will be a virtual body whose body measurements will be modifiable by the user and the user will be able to see the clothes on this body.

1.2 Constraints

1.2.1. Implementation Constraints

Underlying database will be implemented with MySQL [5]. The implementation will be available for Android users and in extend for iOS users. The version control system will be handled by Git VCS.

1.2.2. Economic Constraints

Datasets that will be used for training are free. Other than the datasets, the economic constraints will be imposed by the cost of server hosting and the cost of maintaining a database. The application will primarily be hosted to be used on Android phones, therefore the cost of hosting a Google Play application, which is a one-time fee of 25$ with no fixed time limit [6].

1.2.3. Ethical Constraints

The data obtained from the users will not be published elsewhere. The application will be bound to ACM Code of Ethics and Professional Conduct [7].

1.2.4. Health and Safety Constraints

Our application will support distance shopping indirectly by allowing the user to try on the clothes virtually. This will help better maintain social distancing and precautionary measurements against coronavirus both by making them more inclined to stay at home or by trying out the clothes in different ways when shopping in real life environments.

1.2.5. Sustainability Constraints

Rhapso will suggest more sustainable options with high similarity scores based on their material and cost. The application will also compare the new clothe with the ones already owned by the user (in the “closet”) and give the clothing a similarity score based on that, from which the user can see the clothing garment they already have and then compare and decide if they really need the new clothing piece.

1.2.6. Speed Constraints

The application will use computer vision in order to put the selected items (such as clothes) on the customer's representation which was created using image detection. The process of image detection of the desired item and the computer vision should be fast enough to satisfy the customer. In order for this application to be a practical service, it should be under 1 second.

1.3 Professional and Ethical Issues

1.3.1 Professional Issues

Within our team, besides asynchronous communication, face to face or online synchronous communication are planned for each week. Also, topics that are discussed, decisions that are taken and task division will be recorded into files during these meetings to reference when it is necessary.

A team drive file is created and shared for accumulating and accessing shared items easily. Also, for codes we will use Github VCS [8] to develop our application.

1.3.2 Ethical Issues

We respect the privacy of the users so that we will take actions according to it.

While the application shows combinations of clothes, we will need the photo from our users. We will store clothe images with encryption algorithms to avoid any data leak and protect the privacy of the users. Moreover, we will not use the information of users' clothes for any purposes to develop our application. Also, created combinations by the users will not be used to improve the model of combination recommendation.

Furthermore, cameras will be accessed only when the user chooses to upload images of the clothes. Other than that no other accesses are needed for our application.

2. Requirements

2.1. Functional Requirements

- Users will be able to give photo input to the application through the phone camera.
- Users will be able to register to the application with a username and a password.
- Users will be able to use the application without the need for an account.

- Users will be able to add clothes to and remove clothes from their “closet” stored in the database.
- Users will be able to get sustainable recommendations of new clothes they want to buy from online alternatives, either from sustainable brands or from regular brands with more sustainable options (i.e. made with cotton instead of polyester).
- Users will be able to retrieve their previous information stored in the application later and with different applications if they choose to store their data with a registered account.
- When the user takes the photo of a new clothing piece using the camera feature of the application, the user will be able to see possible combinations of this new clothing piece with the clothes already present in their “closet”.
- When the user takes the photo of a new clothing piece using the camera feature of the application, the user will be able to see a comparison score of the new clothes with the ones already present in their “closet”. Based on this, the application might recommend not buying this new piece of clothing.
- Users will be able to virtually try the clothes present in their “closet” as well as a new dress they want to buy by trying them on a body model provided by the application, provided they took photos of each piece of clothing beforehand with the application camera.
- Users will be able to adjust the body measurements of the body provided by the application.

2.2. Non-functional Requirements

2.2.1. Security

The application must be secure enough with passwords and usernames so that no other outsider could access another account’s information directly. The application must ensure that the camera inputs given to the application will not be accessed by a 3rd party application. Users must accept terms of service before using the application.

2.2.2. Usability

The application must be supported by Android and supported by different versions of Android phones.

2.2.3. Performance

The application must be fast enough with its processing of clothing images such that its segmentation and the feature of comparing the newly acquired clothing piece with the ones already saved in the database must take no longer than 1 second. When the user wants to see recommendations of other clothes, it should take no longer than 2 seconds for the application to search through sustainable brands and clothes made with more sustainable materials. As for the virtual clothing trying-on aspect of the application, the application must take no longer

than 2 seconds to add each piece of clothing to the model the clothing piece is added onto.

2.2.4. Extensibility

The application will be developed primarily as an Android application but it must be extensible for iOS environments.

2.2.5. Reliability

The application must detect clothes, particularly their structure and their textures if they have anything printed on them, correctly and render new images of the clothes, adjusted to the body model that we will put the clothes on to, as close to real life as possible. The application should also give correct approximations of the closeness of the new clothing piece that is being scanned when it is compared to the clothes already present in the user's "closet", i.e. it should not give too high of a closeness score to two clothes that are similar in no way. These are factors that will determine the user's satisfaction with the application, hence the necessity for reliability of them.

2.2.6. Scalability

The application must have scalability enough for the database for clothing to be added to be used concurrently by a large number of users.

3. Similar Technologies

As an example of a non-commercial use, an "image based virtual try-on network" called VITON was developed in the year 2018, where 2D models with different poses and clothes are used as examples to put on different photos of clothes taken from the front view [9]. TryNDBuy however is a technology developed for profit where the user tries the 3D model where different clothes rendered in 3D could be tried on the model [10]. There is an abundance of applications with similar premises, however our team has decided that most were not working as intended and as such, are not given as examples here.

Rather than an emphasis on styles and outfits as well as the general emphasis on the aspect of virtually trying on clothes, our application has an emphasis on reducing consumption of clothes by the use of comparisons with clothes already owned, determining whether a new piece of clothing could be used in conjunction with the clothes in the "closet", suggesting more sustainable options when the user wants to look for similar items in the market. Although the app could, in theory, still be used for the same reasons as one would prefer to use the other applications of a similar format, our belief is that *Rhapso* will result in the user eventually reducing their consumption of clothes.

4. References

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