Virtual Hypermarket System

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report **VIRTUAL HYPERMARKET SYSTEM**

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ABSTRACT

With the introduction of smart devices and applications, shopping has become easy and can be done from anywhere thereby avoiding crowd especially during festive seasons thus reducing the spread of COVID disease. It is now common that most of the people return clothes after purchasing claiming that the material doesn't suit them. Since it is COVID times, returning of purchased clothes and trying on dresses people like, is not preferrable as it can lead to contact and infection. Therefore, to be on the safer side, people opting for in-person shopping can try virtual trial room facility after choosing desired dresses. Our motive here is to find an efficient approach to try on clothes and improve the accessibility of clothes by creating a virtual dressing room environment.

Interpretation of grocery images for extracting meaningful information is a growing topic in computer vision. Manufacturers invest resources to check planogram compliance in groceries. The automation of this process is of great importance for inventory management because it is both times saving and more reliable than manual control and assistance. Besides this optimization application, product analysis from images can guide a visually impaired person or a user who cannot read and recognize the product name from the grocery pack thereby eliminating the need of manual help.

1. INTRODUCTION

1.1 PROBLEM DOMAIN

Develop a virtual shopping system ideal for shopping in the current COVID-19 pandemic thereby delivering the same comfort and accessibility as that of normal shopping. We aim to create an integrated dress, fashion accessories and grocery shopping assistance tool for ease of access and would serve as a precautionary initiative. The shopping utility for fashion items creates a virtual environment for trying on accessories and dresses and grocery shopping utility will focus on extracting text, processing it to retrieve details such as price, nutritional information etc.

1.2 SCOPE

The scope of this projects includes various fields such as textile industry, supermarket purchase, shopping malls purchase and marketing. The solution proposed efficiently replaces manual help in stores and function independently and would be of great assistance especially during COVID times. Thus, using the system proposed, people can experience the same comfort they would have experienced at normal times (before COVID pandemic).

1.3 CONTRIBUTION

For the fashion shopping utility, virtual trial room facility is built on programming framework such as Python, Flask .For the grocery shopping utility we have used ML and run an optical character recognition (OCR) system over the query image and database images to extract the text present on the product packaging(front display page).

1.4 SWOT ANALYSIS

1.4.1 Strength

- Access to nutritional information without even touching the product.
- Gives satisfaction to customers as they can check whether the accessory suits them or not.
- Reduces return of purchased items to a maximum extent.
- Reduces the need for manual assistance or workers and can purchase independently thereby reducing contact and thus maintaining social distance.

1.4.2 Weakness

- If internet connectivity is lost, then source verification is important.
- Ambiguity in identifying product with almost same names.
- Large database needed for more optimized prediction.
- Images given as input must be taken properly with good clarity.

1.4.3 Opportunity

- Can be developed as an application specific for each shop where people near that shop can use the application
- Display number of purchases made on the item thereby showcasing the desirability quotient of the product among its users.
- This could be integrated with various dress shops for customers to instantaneously try products on them.
- Can be improvised by including gesture recognition for selection of clothes, thus eliminating the need of an external device to select clothes.

1.4.4 Threat

- Incorrect data can lead to incorrect prediction, thereby reducing the trustworthiness of the predictor.

3. SYSTEM DESIGN

2.1. SYSTEM ARCHITECTURE

The virtual hyperstore system consists of two modules namely grocery shopping utility and fashion store shopping utility. Initially the dataset consisting of grocery product information are to be preprocessed and imported in MySQL database. Then the test images must be given to the pre-defined text extraction tool which extracts the entire text form the front cover of the grocery product. In the database, we have the product name which is actually a substring of the entire extracted text. Thus, by processing the extracted text and by using LOCATE command of MySQL, the details of the corresponding product are retrieved and displayed. The user will also be able to rate the product and also view average ratings of the product. Along with the retrieval the system will also have a text to speech conversion module which speaks out the product details extracted from front cover of the pack.

In the fashion store shopping utility, once the user clicks try now, the camera gets started. It captures the photo from video continuously and detects the face using haar cascade algorithm like full body detection (upper body and lower body) and face detection algorithm and rectangle is created around ROI. After detecting the face and body, the user will select the cloth for trying out virtually.

Using the lower and upper body detection algorithm the shoulder points are detected and the 2D cloth model is positioned on the user's body. Then scaling of the cloth model takes place as required by calculating distance between body joints and distance of the user from camera. Then superimposition of the cloth model takes place on the user's image from the video capture. After that the superimposed view is displayed on the screen. The system architecture of real time virtual hyperstore system is shown in the figure 2.1.

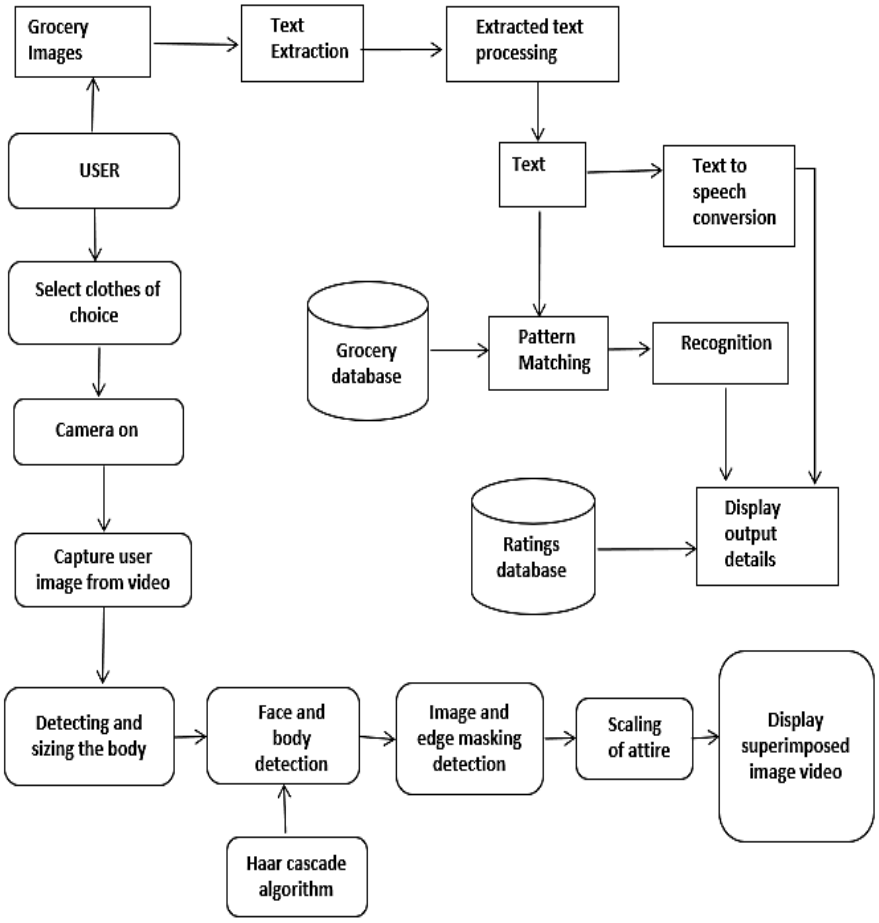


Figure 2.1. System Architecture

2.2. GROCERY SHOPPING UTILITY

In grocery shopping utility we use machine learning and run an optical character recognition (OCR) system over the query images to extract the text present on the product packaging. The text on the query image can be matched to the database using locate () function of MySQL. Preprocessing of database is done so that the system is robust to OCR errors such as spelling mistakes, misrecognitions, failed recognition of words on product packaging.

2.2.1 DATA PREPROCESSING

The shopping utility has its database from *MyFoodData.com – Nutrition Facts Database*. The database has unique id for each product. The dataset is pre-processed where price of the corresponding product is also added to it.

From the dataset, grocery products such as meat, fish, herbs, spinach, fruit and vegetables are excluded as they do not contain front cover and or not packed. As a part of pre-processing, the product names are reconstructed in such a way that they exactly match the product tag name in front cover with same arrangement of words. As a small-scale system, about 100 grocery product images have been consolidated and imported from the database. While selecting query images, clarity of the image is to be considered. Images of poor quality or blurred and distorted images can lead to incorrect results.

2.2.2 TEXT EXTRACTION FROM IMAGE

Here, we have used a pre-defined web module with advanced text extraction API that can extract information from images very accurately. The text extraction API is a web-based module pre-defined and deployed as web module named brandfolder. There are many features within this API, but our focus is on text extraction from images. Since the grocery product pack has text of different font styles and different angles, an advanced and accurate text extraction tool is required.

This web interfaced API is so powerful that it can read image text in different fonts and orientations (sideways). The API uses OCR for accurate extraction.Optical Character Recognition (OCR) is the process of electronically extracting text from images. pytesseract will recognize and read the text present in images. It can read all image types — png, jpeg, gif, tiff, bmp etc. It’s widely used to process everything from scanned images. OCR has two parts to it. The first part is text detection where the textual part within the image is determined. This localization of text within the image is important for the second part of OCR, text recognition, where the text is extracted from the image. Using these techniques together is how you can extract text from any image. The process flow in text extraction from image is shown in the figure 2.2.

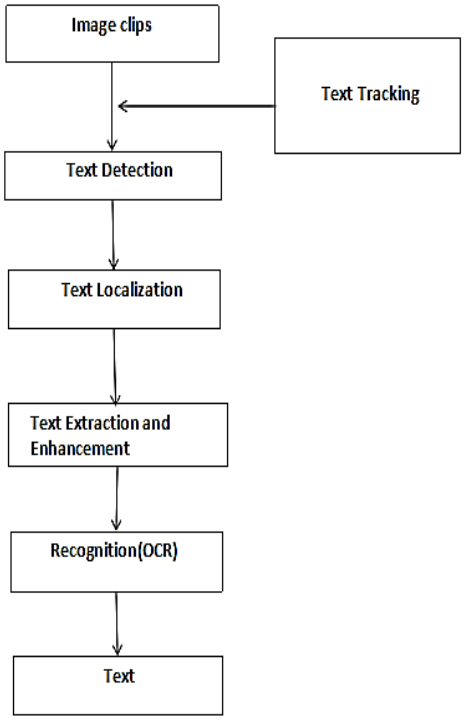


Figure 2.2. Text Extraction from Image using OCR

2.2.3 RETRIEVAL AND DISPLAY OF PRODUCT DETAILS

Once the text from the image is extracted using the web module, it is given as an input in html and the database querying occurs in the backend using php and MySQL commands. The extracted text may contain special characters and newline characters (to be removed to make it a single line as in database) which is removed using *preg_replace* command in php and **REPLACE** command in MySQL respectively. *Locate ()* function of MySQL returns the position of the first occurrence of a substring in a string. If the substring is not found within the original string, this function returns 0. Then executing the command *SELECT * from grocery_table where LOCATE (name_column_of grocery_table, extracted text)>0*, we can get the desired results which are displayed as a table. In the nutritional facts, some components have NULL value for certain grocery products. Hence in php the query result value is checked for NULL constraint and only if the value is not NULL it is displayed in the table.

2.2.4 STAR RATING SYSTEM

The 5-star rating bar allows the user to submit his/her feedback on whether the product is useful or not and also get a review on how others receive it thereby helping in acquiring suggestions on whether to buy it or not. This also gives the administrator a view of how well its item is performing so that they can increase the stock based on its reviews and acceptance by the customers. The star rating system here is built using PHP, ajax and MySQL. jQuery Bar Rating plugin is used to display the star ratings on the screen. Whenever the user changes the rating then send an AJAX request to save the user currently rating status on the MySQL database table with PHP. Using average command in MySQL the average ratings are also displayed for the product instantaneously. The ratings are particular for each product and to reduce the load on database only the current average rating is stored. Whenever a user provides a rating, the new average is calculated and updated in the database.

2.2.5 TEXT TO SPEECH CONVERSION

Using php, text to speech module is incorporated for the benefit of visually impaired and people who don't know to read the product name in English and understand to recognize it. The extracted text is given as an input to this speech module which speaks it out loud for the user to know. The base URL: *http://translate.google.com/translate_tts* converts written words into audio. It accepts GET requests. Here "file_get_contents" will retrieve all the data from the URL *(https://translate.google.com/translate_tts?ie=UTF-8&client=gtx&q='.$txt.'&tl=en-IN)* and will pass into $html. Language translation can also be done here accordingly by altering the &tl parameter in the URL. Now, after this we will convert all the data which we got from URL into audio using <audio> </audio> tags and then echo out the player.

```
$txt=rawurlencode($txt);
$txt=htmlspecialchars($txt);
$html=file_get_contents('https://translate.google.com/trans
late_tts?ie=UTF-8&client=gtx&q='.$txt.'&tl=en-IN');
$player="<audio controls='controls' autoplay><source
src='data:audio/mpeg;base64,".base64_encode($html)."'>
</audio>";
echo $player;
```

2.3 VIRTUAL TRIAL ROOM

For implementing virtual dressing room, we need to recognize the user in the image and superimpose the user with selected dress model. To identify the user, we use face detection algorithm using haar classifier. Haar classifier It is pre-trained classifier in OpenCV used for object detection which is very efficient and easy to use.

2.3.1 DETECTING AND SIZING THE BODY

First step of the proposed Online Virtual Trial Room method is the acquisition of the shape of the body, head or neck depending upon the wearable to get reference points. Reference points are then used to determine where to display the particular cloth or ornament. Here a detection methodology based on locating the face of the user, adjusting a reference point at his/her neck and displaying the wearable based on that point is used. For obtaining the size of the user, a similar automated body feature extraction technique is used. Gaussian blur (also known as Gaussian smoothing) is the result of blurring an image by a Gaussian function. It is used to reduce image noise and reduce detail. The idea is to set up the user in front of the camera and hold him at the beginning at a certain predetermined distance. The algorithm extracts points on the shoulders and lower region. Measuring the distance between these points and knowing the distance from the user to the camera, the size of the user can be obtained. When the image (video frame) is acquired, an edge detection filter is applied to obtain only the silhouette of the body. Finally, the distance between them is measured in the image and related to the distance from user to the camera to obtain the size.

2.3.2 FACE AND BODY DETECTION

As when the user comes in front of the screen, identification of face is the prime goal. So, to detect the face and upper and lower part of the body, we use Haar feature-based cascade classifiers. In haar classifier instead of using intensity values of the pixel, it uses the change in contrast values between adjacent groups of pixels. Then the variance difference between the pixel groups is used to determine the relative light and dark areas in the image. It is a machine learning approach. and the cascade function in the algorithm is trained from a lot of negative and positive images.

A lot of negative images (images without faces) and positive images (images with faces) are shown to the classifier to train it so it can extract features from it. The main purpose of using OpenCV is that it makes it easier as it comes with pre-trained classifiers for face, eyes etc. It comes with a trainer and a detector; we can train it with our own classifier easily for any object detection. If it finds a match it returns Rect (x, y, w, h) implying coordinates for left, top, bottom and right. The use of haarcascade and the steps pertaining to the super imposition of outfits is shown in figure 2.3.

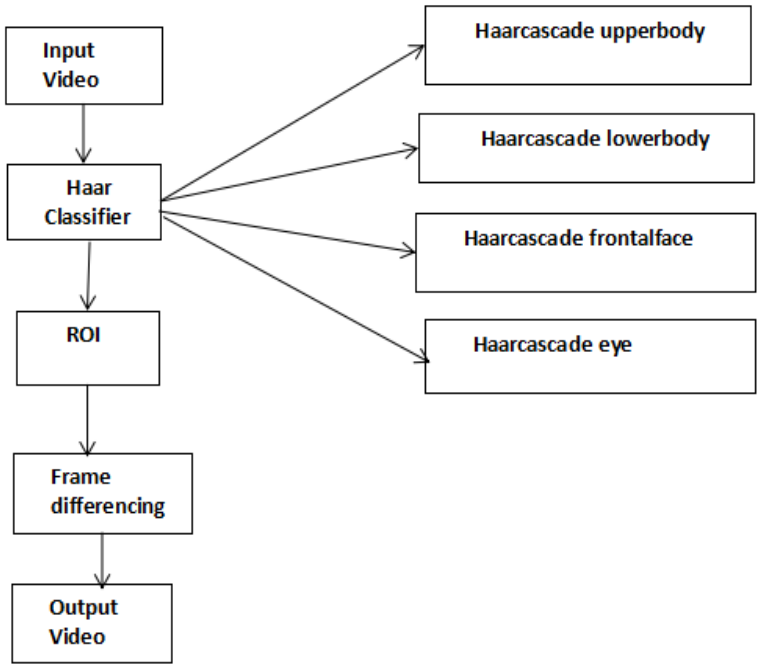


Figure 2.3. Use of Haar cascades in face and body detection

2.3.3. IMAGE MASKING

In this module the image masked has some of its pixel intensity values set to zero. In the image wherever the pixel intensity value is zero automatically the pixel intensity of the resulting masked image will be set to the background value which is normally zero. Or To define the mask the ROIs for each slice is used. If required, masking can be controlled on slice by slice basis in ROI toolkit. In ROI toolkit, masking operations does not affect a slice without ROI.

2.3.4. EDGE DETECTION

To perform this edge detection technique Gaussian filters are used. These filters cut out the noise in a digital image to prevent any false detection by the processor. This does the work of smoothening and reducing the effect of noise on the image for the proper functioning of the processor. With this the intensity gradients of the image are not found out. The edges in the image can point in various directions like horizontal, vertical and in diagonal edges, so this algorithm uses four filter to detect all kind of edges in blurred image. After this process non-maximum suppression is applied to make the edge thin. This suppression results in quite accurate edge pixels in reference to present real edges.

2.3.5. SCALING OF ATTIRE

Scaling means resizing of the image according to the circumstances. As when the user moves in front of the screen it should change the sizing and positioning of the outfit and place it on the body accordingly. When the user moves towards the screen the image size should be increased according to user. Thus, the overall view of the cloth should be increased or decreased accordingly. This is done by scaling method.

3. SYSTEM DEVELOPMENT

The project is implemented as Flask Web application with OpenCV a python module with HTML CSS in the frontend. The grocery shopping utility uses php and MySQL in the backend. The application works on devices with an inbuilt or attached camera, internet, and web browser.

3.1. PROTOTYPE ACROSS THE MODULE:

The input and output to each module of the system is described in this section.

Extraction of text from images and Retrieval – The query image is given as an input to the web-based OCR text extractor module which returns the corresponding details namely product ID, product name, food group, price, calories, nutritional facts, calorie weight and serving weight.

Star Rating System - As the user clicks the "Click to rate and view ratings" button it navigates to a mini window where the user can rate (1-minimum and 5-maximum) out of 5 stars and also can view average rating based on previous responses of ratings.

Text to speech module - Once the product details are retrieved, the extracted text from product front cover is automatically sent as input to the speech module. If the user wishes to hear and know the product, he/she can press the play button to hear it out.

Click and Try- On - The dresses and fashion accessories will be displayed on the website where the user can try them out virtually by clicking the try on button. This navigates the user to a new window (device camera switches on) where clicking on the selected dress, results in real time superimposition of the dress on the user.

Try combinations – The system also allows user to try combinations provided a set of tops for women and t-shirts for men on clicking the *MiX & MaTcH button*. The user can select and try different tops for different pants on themselves.

3.2 DEPLOYMENT DETAILS

The application as a whole uses HTML,CSS as the frontend. The virtual trial room is developed with Python Flask Web Application Interface. The deployment of the system requires python 3.7 and Flask along with packages like PIL, cv2(OpenCV), threading, os, dlib, NumPy, math, json, camera module and imutils. The user can view clothes and other wearables on the website and can try on the attire virtually. If the user wants to try on the wearables (necklace, crown, hats, earrings, headband) or dresses online then they must click on the *'Try ON'* button. This will run the test script.

Through OpenCV the video is captured via the device camera and the attire image is super imposed on the user's body in real time so that they can check whether it suits them or not. The grocery shopping utility has PHP and MySQL at the backend for database. Ajax, JavaScript is also used. The combined application as a whole is run on localhost using xampp server.

4. BACKGROUND WORK

The idea of virtual hyperstore emerged as a solution to the COVID-19 pandemic situation where contact with people and public property should be avoided to the maximum. This project focuses on satisfying people's basic needs of purchasing food and clothing via virtual and efficient safe methods thus providing maximum assistance to people. The virtual trial room is a pre-existing one but the proposed solution provides varied options of letting people try wearables and fashion accessories and also check on combinations of top and bottom wear. The integrated grocery shopping utility part now that emerged to assist people in their daily shopping in the new normal is a new idea which has not been proposed as an implemention till now. The idea was inspired from *Google AI blog: Recognition. Retaining.* Having this as a base idea, several other features such as text to speech, tabular display and rating system have been integrated to it to be more beneficial to users.

5. RESULTS AND DISCUSSION

5.1 DATASET FOR APPLICATION

For the grocery shopping utility considering as a small-scale application, about 100 grocery products with their description, price nutritional facts information is used. The query images are also restricted to the grocery products as given in the database. For the fashion store utility, about 10 images each for is, sunglasses and earrings are used and for mix and match combinations about 5 top wear and 2 bottom wears are used for instance.

5.2 OUTPUT OBTAINED IN MULTIPLE STAGES

5.2.1 TEXT EXTRACTION FROM IMAGES

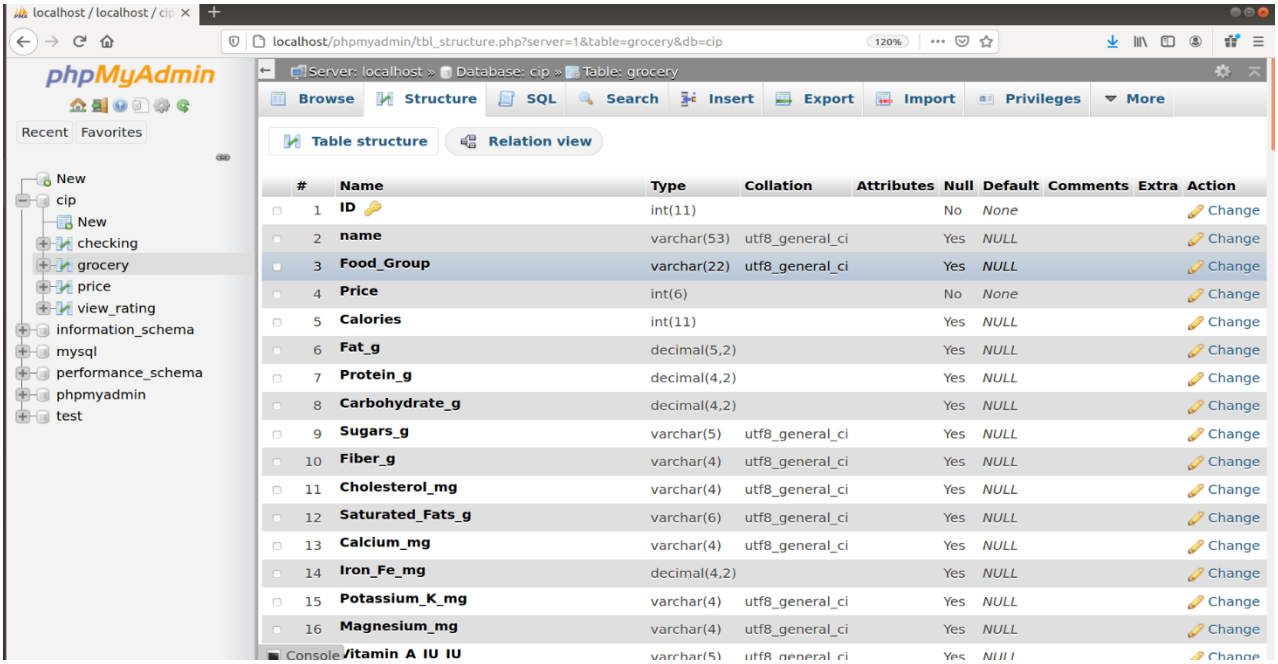


Figure 5.1. Grocery database with unique ID

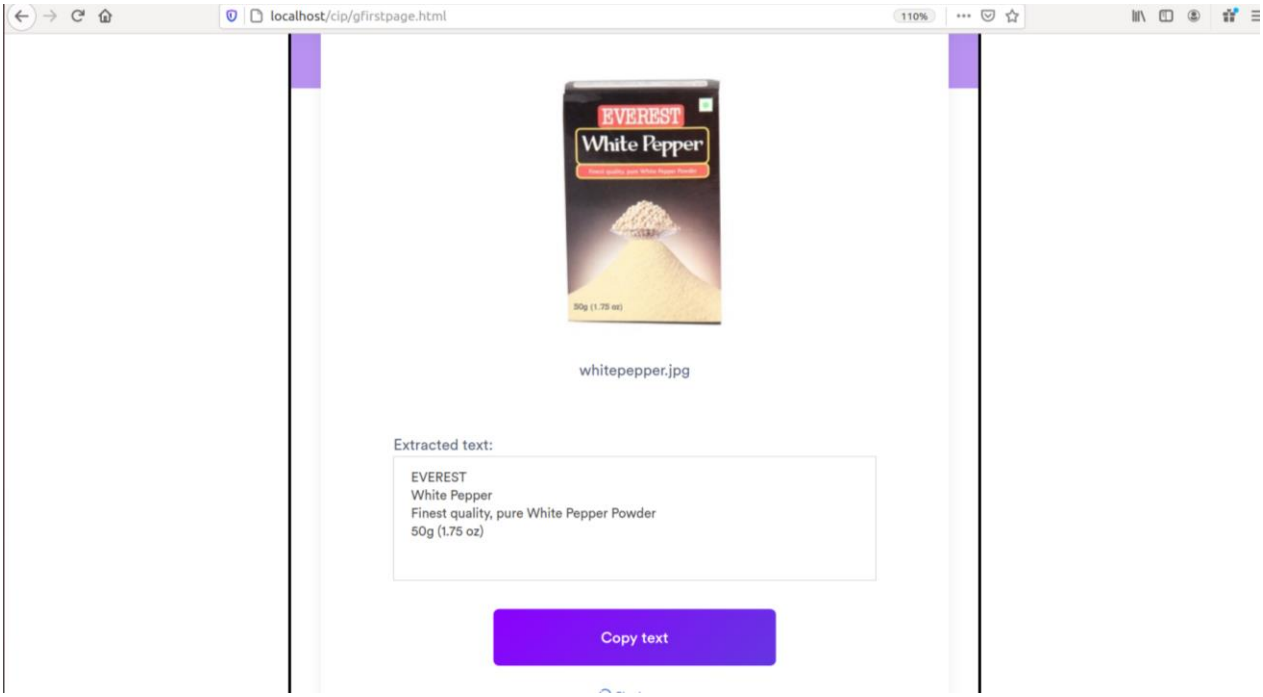


Figure 5.2. Text extraction from image

5.2.2 INFORMATION RETRIEVAL

Figure 5.3. Extracted text as input

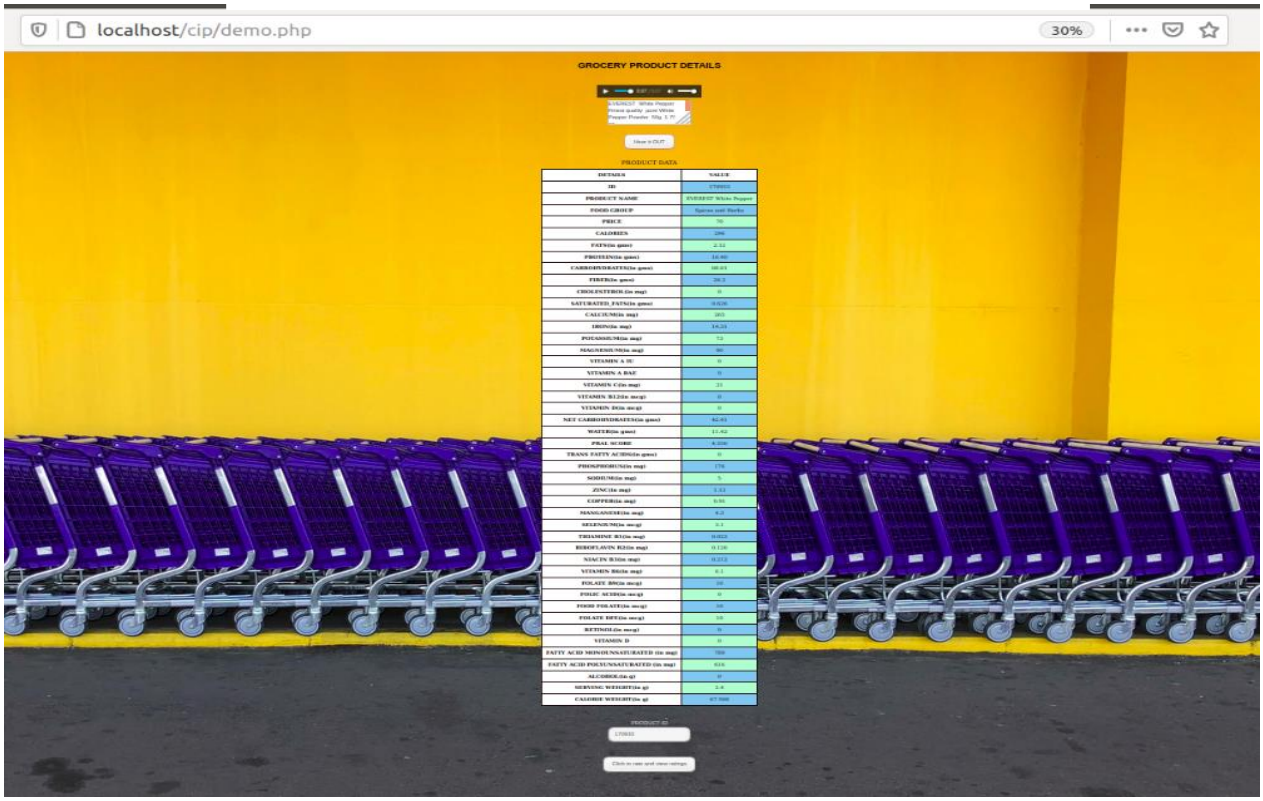
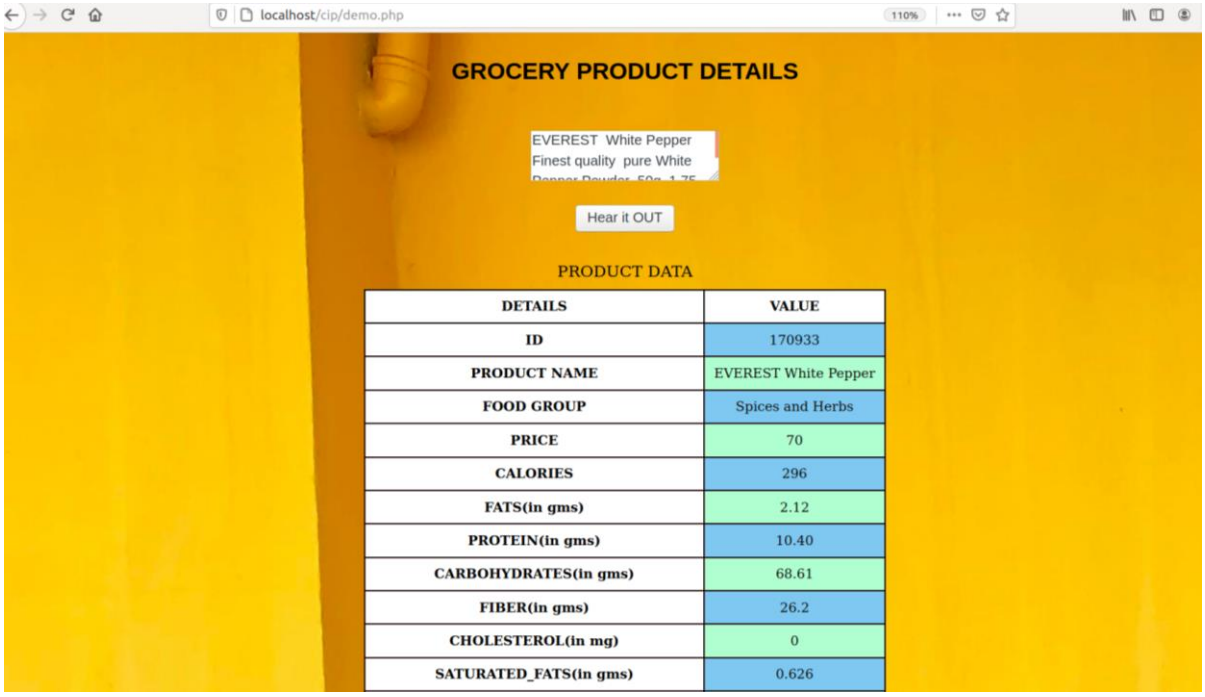


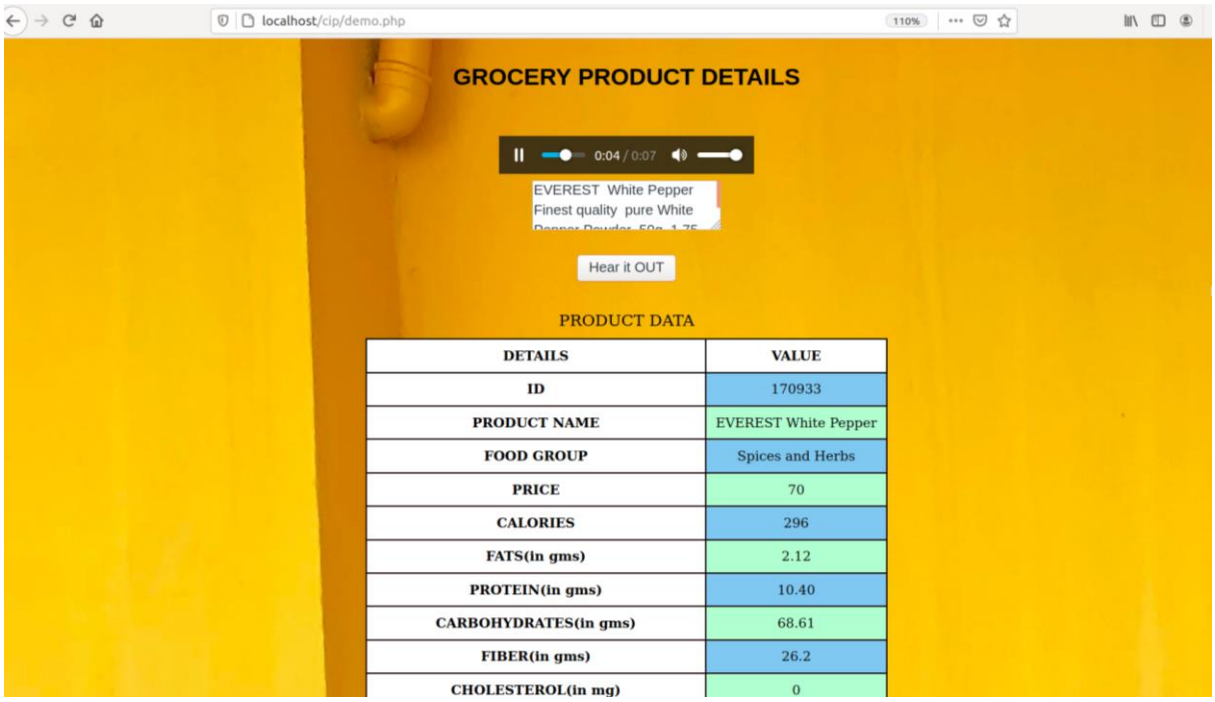
Figure 5.4. Display of product details from database

5.2.3 TEXT TO SPEECH CONVERSION



DETAILS	VALUE
ID	170933
PRODUCT NAME	EVEREST White Pepper
FOOD GROUP	Spices and Herbs
PRICE	70
CALORIES	296
FATS(in gms)	2.12
PROTEIN(in gms)	10.40
CARBOHYDRATES(in gms)	68.61
FIBER(in gms)	26.2
CHOLESTEROL(in mg)	0
SATURATED_FATS(in gms)	0.626

Figure 5.5 Text to speech- extracted text as input



DETAILS	VALUE
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PROTEIN(in gms)	10.40
CARBOHYDRATES(in gms)	68.61
FIBER(in gms)	26.2
CHOLESTEROL(in mg)	0

Figure 5.6 Extracted text converted to speech

5.2.4 RATING SYSTEM

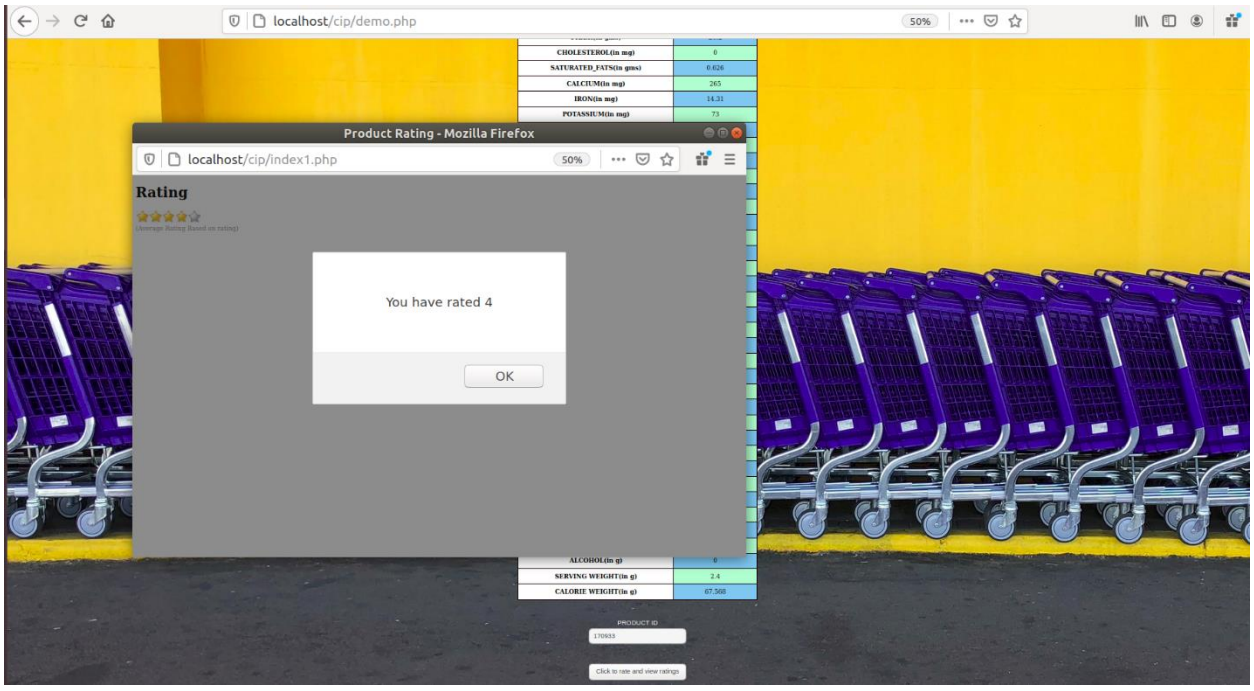

Figure 5.7. User Rating Option

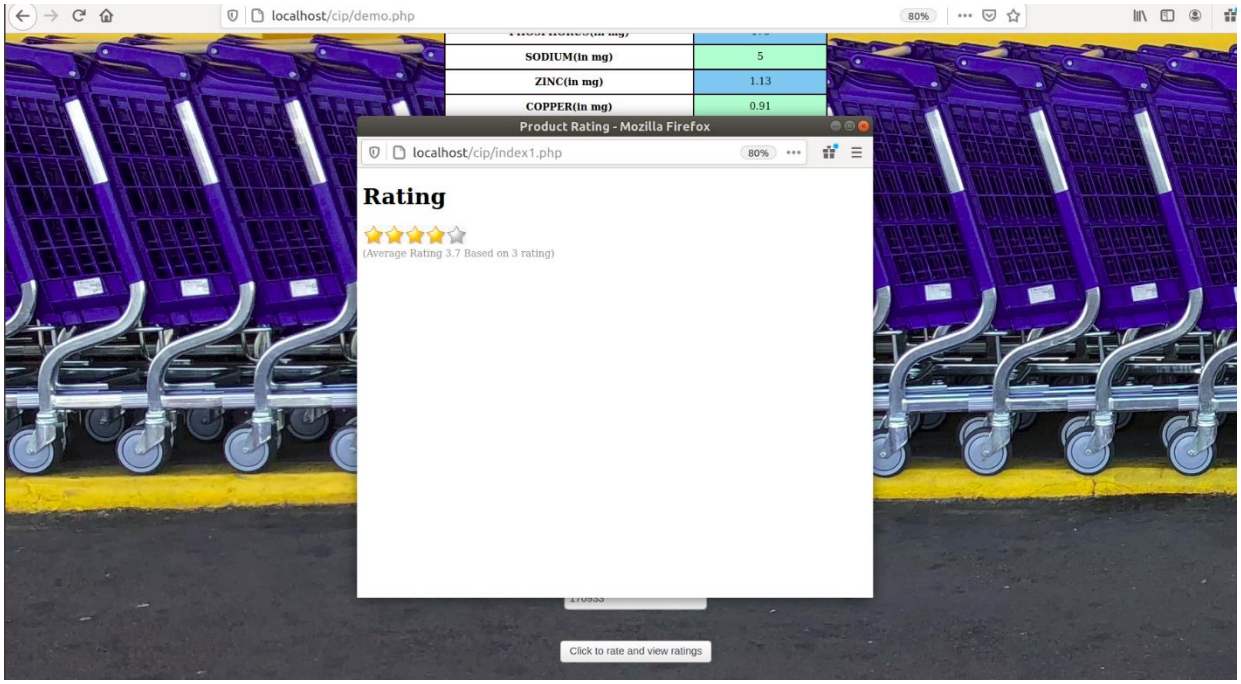

Figure 5.8. Display of average ratings of the particular product

5.2.5. CLICK AND TRY-ON

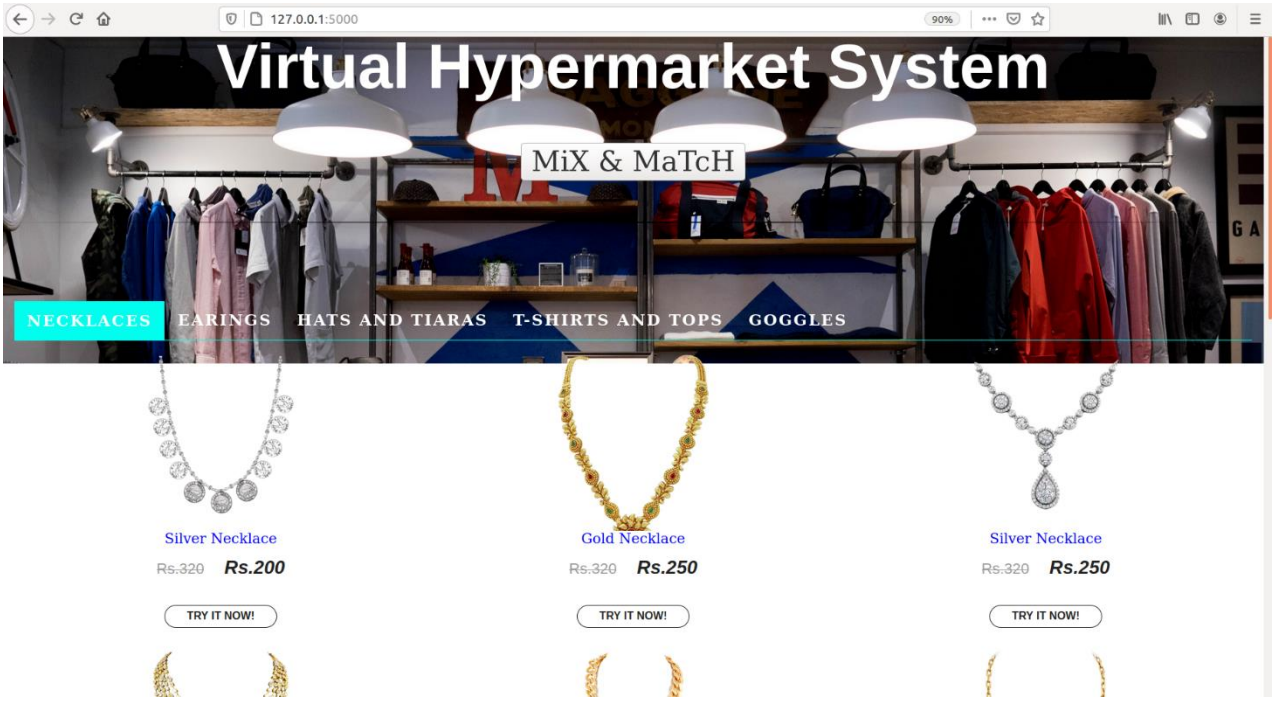

Figure 5.9. Users provided option to try on necklaces, earrings, hats, tiaras, t-shirts, tops and glasses

5.2.5 MIX AND MATCH

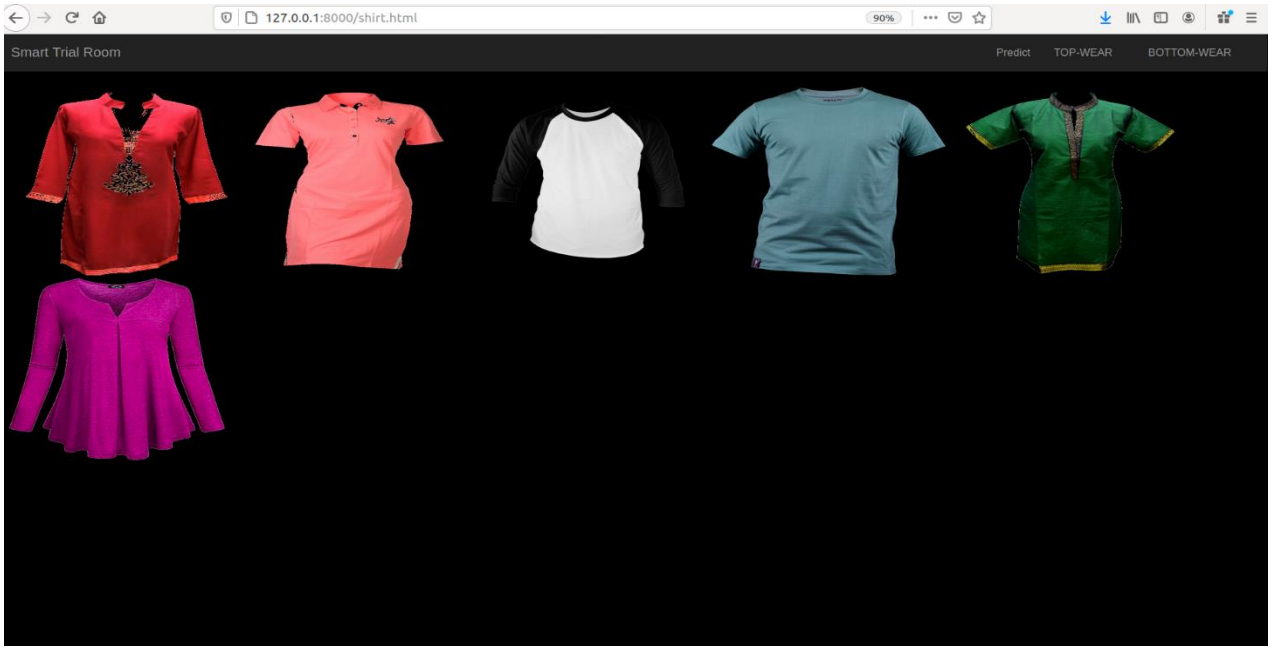

Figure 5.10. Mix and match-top wear options

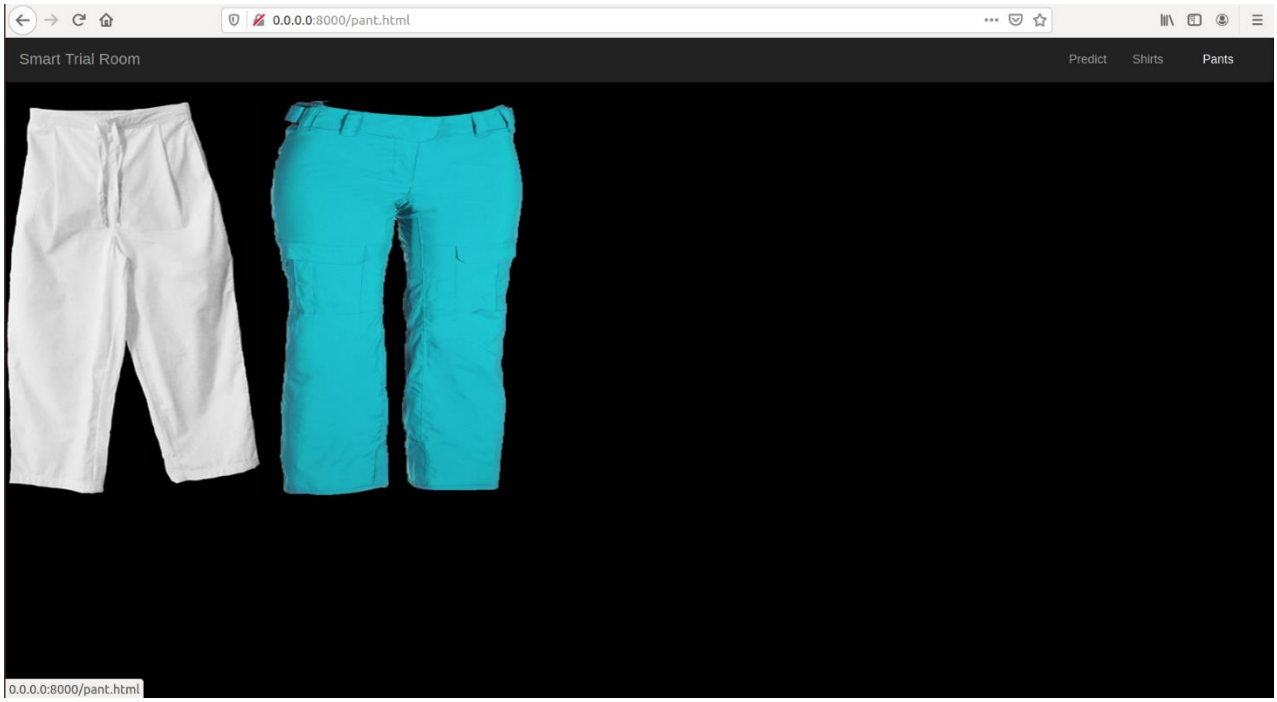

Figure 5.10. Mix and match-top wear options

5.3 PERFORMANCE EVALUATION

5.3.1 ACCURACY OF SUPERIMPOSITION

Accuracy of super imposition is the first concern of a virtual trial room and is very essential as it decides the accuracy of the whole system. The accuracy highly depends how whether or not the application's algorithm is able to find the user in the video frames or not. There are two major ways we can do this, first is using neural networks to train our algorithm to find the human body in the frame and the second is to use a marker like an RGB color to pinpoint the user in the frame using this color pixels. The later one is not very user friendly and luckily OpenCV already has a trained algorithm designed to recognize body parts like face, upper body and lower body and hence gives accurate results. The application accurately superimposes necklaces, hats, tiaras, bands etc. The dresses are also super imposed accurately to a considerable extent. The earrings are superimposed on the ears and not hanged from the ear but it cannot be considered to be accurate as it is also beneficial in checking whether the earring suits or not and doesn't make a difference.

5.3.2 ACCURACY OF MATCHING AND RETIVAL

As locate command is used here it looks for exact match of the words with same order to return correct results although it is case insensitive. The system does not produce the expected result if the extracted string contains any special characters other than a-z and A-Z. Thus, special characters are removed prior to pattern matching. Thus, if special characters and new line characters removed from the extracted string and then processed from the query, expected accurate results are obtained.

5.4 RESULT ANALYSIS

Virtual trial room application can also be implemented by following steps like pose estimation, human parsing and virtual fitting using 3D vision and pose estimation using monocamera and SwapNET. But this implementation can encounter problems in upload the program to server as the storage requirements for models are more than 2.5GB and also powerful server is needed, more than that given in of AWS/Azure. Whereas the proposed application doesn't demand any such requirements and is storage efficient.

Another approach of using grabcut foreground segmentation to extract the outline of the outfit from the input image rather than real time video processing has certain limitations to the kind of user images that the code can process. And it also resulted in the lower rate of growth in the IOU (intersection over union-an evaluation metric) and there is a possibility of mislabeled points creating small holes and discontinuities in the segmentation mask.

An alternate approach of using Xbox Kinect as a sensor to detect body movements and gestures requires laptop with high graphic quality which demands at least 4GB graphic card.

Whereas the proposed application of using OpenCV and haar cascade classifiers doesn't demand any such requirements and is cost and storage efficient. OpenCV is much faster and pretrained to detect user body on which we will super impose the cloth hence saving their time while providing them with excellent user experience.

Product recognition using computer vision has traditionally been solved using local image features extracted by the SIFT algorithm. These non-ML-based approaches provide fairly reliable matching but are storage intensive per index image (typically ranging from 10KB to 40KB per image) and are less robust to poor lighting and blur in images. Additionally, the local nature of these descriptors means that it typically does

not capture more global aspects of the product's appearance.

While the approach of running an optical character recognition (OCR) system over the query image and database images to extract the text present on the product packaging has a number of advantages and would always be recommended in terms of ease of implementation ,efficiency and accuracy.

6. CONCLUSION

6.1 SUMMARY

Buying wearables online is always a risky process as there is always a doubt whether how the item will look on oneself. Also, buying clothes or ornaments through shops offline requires a lot of time as we have to first look for a shop and then try each and every cloth by going inside the trial room and since we are amidst the covid-19 pandemic trying on clothes others tried is not recommended. The proposed solution will help users save their time in trying out the wearables by digitizing the process and also reduces exchange and return rates. It also eradicates the possibility of abuse of women without giving chance for placing hidden cameras in trial rooms. The user will get results in real time i.e. the output with the wearable superimposed will be provided simultaneously while taking the input by catching every frames of the video and applying the attire on the user's body in that video frame and then returning the frame back which will give user the feeling that the results are displayed in real time. It enables users to make right choice for the size of cloths without wearing it actually and offers a platform for experimenting different cloth styles. The grocery product utility would be of great assistance while shopping in a supermarket especially during the COVID-19 pandemic. Most of the grocery products share the same packaging, such as boxes, tins, bottles and jars, and only differ in the text and imagery printed on the label. However, the ubiquity of smart applications provides an opportunity to address such challenges using image processing and database querying. The shopping assistance tool displays the details of the products in a particular store arranged in the rack just by capturing it thereby avoiding contact with those products handled by many along with a 5-star rating system to give feedback and see others reviews. People who are visually impaired and people unable to read and understand the product names in English can also use the optional text to speech module for assistance. Thus, the application is of great help for shopping in a hyperstore offering combined utility for dress and wearables shopping and grocery shopping.

6.2 CRITICISM

The grocery shopping utility is incapable of displaying the details such as manufacturing date and expiry data since it varies for different packs of the same product and thus database cannot be maintained for each and every pack of product in a particular store. The virtual trial room facility has tried on facility but does not have buy add to cart since the application is built as an assistance tool for choosing the outfit that suits and not as an e-commerce website.

6.3 FUTURE WORKS

- The virtual trial room facility can have further add-ons like rings on hand, contact lens for eyes, lipstick, nose rings.
- The system can be further built to superimpose sarees with fleets on the user and allows the user to try blouse combinations on the desired sarees.
- The system can be further built as full-fledged e-commerce website with recommendations of outfits based on the users purchases along with search by image (reverse image search).
- In grocery shopping utility, visualization of nutritional information using bar charts can be done.
- Moreover, product comparison and product recommendation can be integrated with the application.

REFERENCES

1. Masri and M. Al-Jabi, "Virtual Dressing Room Application" 2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT), Amman, Jordan, 2019, pp. 694-698.
2. Nikita Deshmukh, Ishani Patil, Sudehi Patwari, Aarati Deshmukh, Pradnya Mehta ‘Real TimeY. Liu, B. Liu and Y. Chen, "Research on Image Recognition of Supermarket Commodity Based on Convolutional Neural Network," 2019 12th International Symposium on Computational Intelligence and Design (ISCID), Hangzhou, China, 2019, pp. 171-174.
3. Amit Thakur, Suraj Virkar, Prof. Jyoti Gaikwad, “Online Virtual Trial Room Implementation using OpenCV Python”, International Research Journal of

Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 05 | May 2020.
4. Nikita Deshmukh, Ishani Patil, Sudehi Patwari, Aarati Deshmukh, Pradnya Mehta “Real Time Virtual Dressing Room “, IJCSN International Journal of Computer Science and Network, Volume 5, Issue 2, April 2016.
5. M. Sawaki and N. Hagita, "Text-line extraction and character recognition of document headlines with graphical designs using complementary similarity measure," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 20, no. 10, pp. 1103-1109, Oct. 1998.
6. https://adaptabiz.com/convert-text-to-speech-using-php-easiest-method/
7. https://www.spaceotechnologies.com/star-rating-in-php-jquery-ajax-css/
8. https://ai.googleblog.com/2020/07/on-device-supermarket-product.html
9. https://www.slideshare.net/Nasreen39/virtual-dressing-room