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Thy Ensemble: A Virtual Dressing Room for e-shopping using Augmented Reality

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Abstract- Augmented Reality combined with new algorithms and social media technologies have started a revolutionary shift away from the classic desktop paradigm and into the direction of intuitive, "natural interaction" where people interface with the technological world through hand gestures, speech and body language. The virtual dressing room will make use of Human Computer Interface and Augmented Reality and it will be used for online shopping. This will facilitate the shopping experience by letting customers to try-on the apparels without being physically present in the retail shop. These platforms are not only powerful decision tools for the on-line shopper, but also contribute to the fun factor of in-store shopping. The system gets the data of custom body sizes to construct virtual fitting model through photos already uploaded. The model then tries on different costumes and the system shows the fitting effect. Augmented Reality virtual dressing room works by superimposing the model or picture of a garment or accessory within the live video feed of the customer. In addition, omnipresent social networking features allow sending photos or videos of the shopper wearing the apparel for quick feedback. The proposed project can achieve real-time, high-fidelity cloth simulation and provide encouraging online virtual fitting experiences.[1]

Index Terms— Augmented Reality, Superimposition, Computer Vision, Gesture recognition, Human-Computer Interaction, Motion tracking.

I. INTRODUCTION

Research done by reliable agencies has proven that by 2020, ecommerce is going to be a gold mine for business and entrepreneurs. Here's a graph that explains this predicted growth clearly: [2] We express our deepest gratitude to Persistent Systems Ltd. for sponsoring our project and Mr. Anand Purandare for providing us with his valuable guidance.

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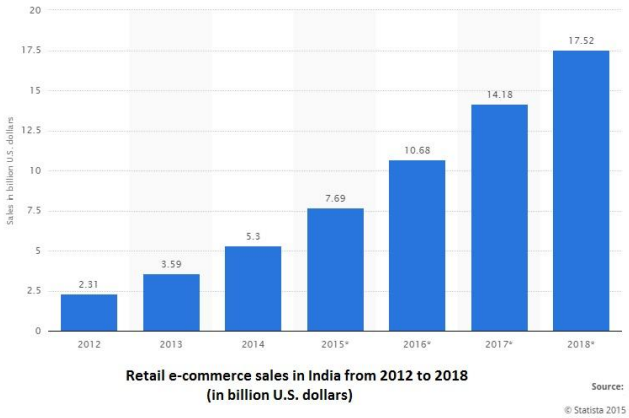

Fig 1: Retail e-commerce sales in India from 2012 to 2018 [3]

This definitely indicates that online shopping is going to get bigger with every year. Up until 2013, it seemed like travel was the most popular category in e-commerce. It was predicted that the ecommerce boom will be led by Fashion Apparel and Electronics though. This already seems to be coming true. Recent statistics that came in during the Great Online Shopping Festival suggest that Electronics and Fashion are leading categories that customers wish to purchase. So it is quite evident that people wish to purchase clothes, probably trendy accessories and all types of affordable electronics. [2]

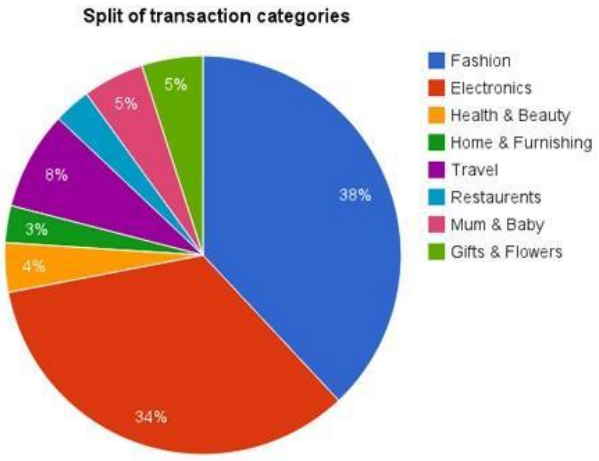

Fig 2: Split of e-shopping transaction categories [4]

According to Paco Underhill, a retail consultant, while 36% of the store browsers wind up buying something, 71% of shoppers who try on clothes in the fitting room become buyers.

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Yet the typical fitting room isn't always inviting: Only about 28 per cent of shoppers even walk into a dressing room of a typical clothing chain. [5] A unique shopping experience excites consumers and will more likely lead them to purchasing. The use of integrated new technologies into the industry has been making big waves within the bespoke customer!

Thy Ensemble is an augmented-reality based virtual dressing room system (VDR), an innovative retail and marketing solution for fashion retailers. The web-camera is used to take the live video-feed of the customer wherein the dresses are virtually superimposed on the user. This enables shoppers to virtually try on clothes before making their final selection for purchasing clothes, without the tedium to dress and undress in shops. The consumer can not only easily change in and out of 100s of garments in a minute's time but also purchase garments securely on this devise. This system will prove to be an advantage to the numerous e-retailers present in the market resulting in an increase in their sales. Using Augmented reality in *Thy Ensemble* is very interesting as it would combine the real world with the virtual dresses superimposed on it. The necessary steps in the design of the VDR are as shown in Fig. 3

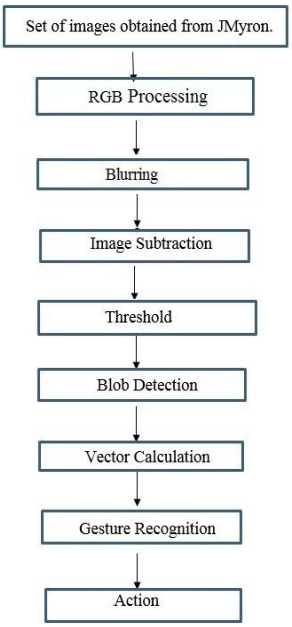

Fig 3: Steps used in the Virtual Dressing Room

II. Problem Definition

'*Thy Ensemble*' aims to build a system which will enhance the e-shopping experience and provide greater user satisfaction, by giving the user access to the VDR. Here, the user can choose from a variety of products. The selected products are superimposed on the user's body in the live video feed using augmented reality. Thus, assisting the users to visualise themselves in the particular attire and also switch between various available attires, hence enabling them to make the right choice according to their preferences in a secure environment.

Through *Thy Ensemble*, a user can have an adequate idea of how various outfits appear on themselves and that too in the comforts and confines of their own homes.

III. System Architecture

The High level system architecture is shown in *Fig.4* below. The first and most important step is to take in the data as input from the webcam. The best part of this software is that any webcam can be used to take input namely any laptop webcam. The input consists of a video stream taken at real-time. Once the live video feed is obtained, each frame of the video feed undergoes RGB processing, followed by thresholding. The threshold value is variable and can be set by the user or the programmer. Based on the user gestures the selected attire is superimposed. This data flow and data processing is hidden from the user. The user can only view the live video feed with the attire superimposed. The various available attires are placed in the database. The selected attire is loaded from the database to the user viewable window.

IV. Implementation

Augmented Reality (AR) is a variation of *Virtual Environments* (VE) or Virtual Reality. AR allows the user to see the real world, with virtual objects overlaid upon or composited with the real world. [6] Therefore, AR add-ons reality and proves to be a great avenue to pursue for the implementation of *Thy Ensemble*.

The necessary modules needed for the execution of the virtual dressing room are:

- Grabbing the real time video feed
- Image Processing
  - i. RGB Processing
  - ii. Blurring
  - iii. Image Subtraction
  - iv. Thresholding
  - v. Blob Detection and Gesture Recognition
- Superimposition using Augmented Reality
- Database

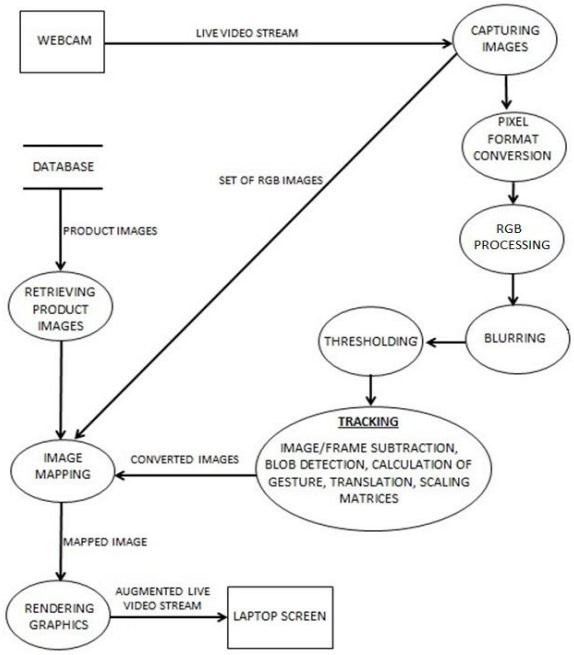

Fig 4: High level system architecture

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A. Grabbing the Real time Video Feed

For *Thy Ensemble* to fulfill its purpose the most essential entity is its input. The input as stated before will be the video feed of the user which will be taken in real time using JMyron library. This functionality can be provided by any simple webcam. This makes *Thy Ensemble* very easy to use and available to common man as every laptop has an inbuilt webcam in today's world.

The webcam grabs the video which is then provided to the system for further processing.

B. Image Processing

The webcam provides a video input to the system which cannot be used raw without further processing. Hence, the video is taken frame by frame and image processing is applied on each frame. Also the image grabbed by the web-camera is the mirrored image of the user. Therefore we again mirror back the image by traversing the pixels from right-upper corner and then saving it in a pixel array to be used for actual image processing operations. [7]

i. RGB Processing

RGB processing is a very necessary step for the virtual dressing room. The RGB image is scanned and stored into an array of pixel values. On every pixel, processing is carried out, wherein each R, G and B values are separated.

ii. Blurring

This step reduces the noise present in the image. The algorithm we used for this operation is called as '3x3 window blurring'. [8] Here,

1. A pixel is selected.
2. We start with the pixel present in row 2 and column 2 of the image as left and upper line of pixels are needed for averaging purpose in 3x3 window.
3. The color values of the 8 pixels surrounding the current pixel are averaged.
4. The final calculated values are assigned to the current pixel.
5. This is done for all the other remaining pixels.

With this algorithm, we accomplish blurring of each frame obtained.

iii. Image Subtraction

Image subtraction is a process in which the numeric value of the whole image is subtracted from another image. This is done for detecting the changes between those two images.

In our project we have used this technique to detect the movement of the user for one of the two reasons – to map the apparel on to his body perfectly and to recognize his hand gesture for carrying out required operations.

There are various methods to implement this procedure. Some of them are frame differencing, mean filter, running Gaussian average, and background mixture models. [9] The first algorithm gives us the best results with minimum complexity as compared to later ones. Hence we are using Frame Differencing method in our project.

Here, we update the base image first which is used as a reference to detect the movement of the user. Then we separate the red, green and blue component of the live image as well as the base image and subtract the base image from the live video feed using their RGB components. Hence after this operation, only the part which deviated from the base i8mage will be detected which further helps to detect the user's gestures.

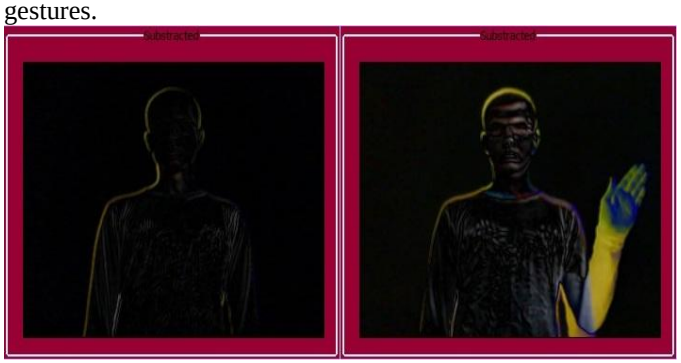

Fig 5: Image Subtraction

iv. Thresholding

Thresholding is the simplest method of image segmentation [10] which converts an image into a binary image. It replaces each pixel in the image with a black pixel if the pixel intensity $I_{i,j}$ is less than some fixed constant T, i.e. $I_{i,j} < T$ (also called as threshold constant), or a white pixel otherwise.

Thy Ensemble uses the thresholding operation to first differentiate between the background and the foreground that is the user's hand by selecting an appropriate threshold constant and assigning white pixels to it. Rest of the image pixels are assigned with black value. Hence it becomes easy to recognize the gestures when the user's hand moves over the buttons. Here the RGB images are converted into blurred images, subtracted from the base-image and then thresholded using the threshold constants derived from the maximum value of color component of subtracted image and value according to the human skin color.

Fig 6: Thresholded image

v. Blob Detection and Gesture Recognition

Blob detection is used to obtain regions of interest for further processing. These regions could signal the presence of objects or parts of objects in the image domain with application to object recognition and/or object tracking. [11] Following is the algorithm used:

1. A vector table is constructed of the form $V(x_1, x_2, y)$ to store the coordinates of the blob.
2. The image is scanned row wise until a white pixel is found. Its x value is stored in the vector table as x_1.

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3. The scan then continues until the last white pixel is found in the same row. Its x and y values are stored as x_2 and y respectively.
4. The y coordinate does not change in a row that is also the reason that we are storing value of y coordinate in the vector table only once.
5. Then the scan continues for the remaining rows till the last row.
6. If the algorithm previously made two vectors for two different blobs which are connected below, then a single vector is maintained by merging the two vector's values. Unwanted blobs are removed.
7. The min and max values of x and y coordinates are taken from the vector table and the blob is detected.

This helps in gesture recognition. If the blobs are detected on the buttons provided, the related gesture is performed.

Fig 7: Gesture recognition

vi. Pseudo Code

1) Initialize biScaled, biBase and biThreshold objects using BufferedImage class provided in Java library
2) For each (pixel in image) {
   a) Initialize sumR, sumG, SumB to 0; /* to store the sum of R, G and B value for blurring */
   b) For each (surrounding pixel) /* scan all the adjacent pixels to the current pixel and separate R, G and B */
   - col = biscaled.getRGB(x , y);
   - sumR += (col>>16) & 0xFF;
   - sumG += (col>>8) & 0xFF;
   - sumB += (col>>0) & 0xFF;

   end For;
   c) r = sumR/9; /* store the average value in r, g and b */
   g = sumG/9;
   b = sumB/9;
   d) col = ((r<<16) | (g<<8) | b); /* regenerate the blurred color pixel and assign it to pixel array */
   e) For each (pixel in baseimage)
   - col = biBase.getRGB(xx , yy);
   - rBase += (col>>16) & 0xFF; /* Separate R, G, B component */
   - gBase += (col>>8) & 0xFF;
   - bBase += (col>>0) & 0xFF;
   - rSub = Math.abs (r - rBase); /* Subtract base image from continuous frames of live video feed*/
   - gSub = Math.abs (g - gBase);
   - bSub = Math.abs (b - bBase);
   - gsSub = Math.max(rSub, Math.max(gSub , bSub)); /* find the max value among rSub, gSub, bSub */
   - if gsSub < threshold /* threshold is some preselected default value */
     then col = 0;
   - else
     col = 0xFFFFFF;
   - biThreshold.setRGB(xx , yy , col); /* regenerate the thresholded image */

   end for
3) end for

C. Superimposition using Augmented Reality

The selected ensemble has to be superimposed on the user which will hence provide the user an idea of how he will appear in it. Successful implementation of this module is the main aim of *Thy Ensemble*. As the user stands in front of the webcam we process the frame and calculate the vectors obtained from blob detection. The gestures made by the user are detected through gesture recognition. [12] The corresponding action is identified and carried out. The vectors of the user will then be used to superimpose the attire on the user by overlaying the image of the attire [13] obtained from the database onto each frame of the live-video. This is done through g2DOverlay, a feature available in Java library.

Fig 8: Superimposed attire on the user

D. Database

The database is a collection of the various attires the user is provided with to try on virtually through *Thy Ensemble*. These attires are stored in a file which is traversed using a parser to send the relevant details and image on receiving a request.

V. Abbreviations and Acronyms

1. VDR : Virtual Dressing Room
2. AR: Augmented Reality
3. VR: Virtual Reality
4. VE: Virtual Environment
5. RGB: Red Green Blue

VI. Results

With *Thy Ensemble*, it has encouraged as many shoppers to use the virtual dressing room. It only takes a few seconds for shoppers to use it, and the statistics show that we improve conversion significantly when can persuade people to check the fit. Thy Ensemble is also overwhelmed by feedback left by customers that have used the fitting room. "No less than 44% of people who use the dressing room tell us that they would not have bought anything without it."

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VII. Conclusion and Future Work

More and more people are buying clothing online, which is leading to increased volume of returns because of the online fit problem: the impossibility for people to try garments on before buying.[14]

Returns are very damaging to profitability and what we may be seeing is that retailers are reaching some kind of tipping point, forcing them to address the issue. [15] We are experiencing a great deal of not just interest in our virtual dressing room, but real intent. In our view we could see 2015 being the year in which virtual dressing rooms came of age. In this work we introduce a virtual dressing room application which only requires a front image for each product to superimpose it onto the user and the 2D graphics of the product seem to be relatively satisfactory and practical for many uses.

Another alternative could be using many pictures at different angles so that it would be possible to create more realistic video streams. One could achieve a similar effect using 3D models and rendering them according to the current angle and positions.

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