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Tailoring Measurement and Virtual Try-on

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Abstract: Fashion coordination is one of the self-expressions which have been always in demands. Searching for perfect attire, is a time consuming task as well as many factors need to be kept in mind. In this paper we are introducing a "Tailoring Measurement and Virtual Try-on (TMVT)". This is an innovative Virtual shopping infrastructure, enabling customers to visualize themselves wearing garments present in traditional stores, as well as online (in internet shops). This is done by mining of the user image, alignment of models and skin colour detection of image (clicked from a fix distance).The major reimbursement of the TMVT include, saving time of the customer/user by avoiding don and doffing at the time of shopping, where both the virtual and physical worlds are combined. This application will be able to fill a big gap between customer and seller by showing clothes of varying size. Finally the model is superimposed on the user in real time with some manual adjustment.

Keywords: Tailoring Measurement and Virtual Try-on (TMVT), Haar Classifier, Virtual try-on, 2D-model.

I. INTRODUCTION

There is substantial, loss of time in don and doffing of clothes in stores which is one of the most time-consuming tasks. Usually long waiting periods have to be taken into account, for example, when standing in front of full fitting rooms. Even, additional time is lost while don and doffing, and also most consumers are hesitate to purchase garments from any online site or they are unsatisfied with their online shopping experience.

The description of a human body shape is a complex, application-dependent task. General anthropometric classifications (somatotyping) are based on specific sets of measurements with specialised instruments (the ordinary tape being just one of them). The somatotype classification of Sheldon [17] identified three extremes of human body shape types, namely endomorph, ectomorph and mesomorph. Any individual could be considered to be composed of each of these in various proportions. Further research in this field has usually been done for anthropometric or ergonomic purposes rather than for the fashion and textile industries.

Clothing descriptors of anatomical types are more varied and less scientific, e.g. "outsize", "flat-chested" or, "pear-shaped". Information to date on body shapes is largely anecdotal and most clothing is made to fit a small number of stands, which are hoped to represent "average" sizes. The justification is historic custom and practice, with little consistency in the market place and continuing customer concerns about fit.

Shape analysis allows the correct averaging of body shapes which fall into a particular size category, enabling improved mannequins (real and virtual) to be made. This, in turn, should give better sizing and a better fit for mass-produced clothing.

A number of recent studies identified the causes for consumer hesitancy, and of particular notes are the consumers overwhelming concern with fit and correct sizing, and the inability to try-on item. A survey conducted by the French company "Lectra" has shown that, about 30% of online garment, which have been purchased are sent back by consumers [8]. Even in web shops people are very sceptic buying clothes because a try-on of each and every cloth is not possible. Reducing this time and helping people to put on a large collection of garment in reduced time was a relevant motivation for this project.

The techniques discussed in this paper can enhance the shopping experience. In this paper we will introduce a Tailoring Measurement and Virtual Try-on (TMVT) system, which offers a solution for the mentioned aspects. This application is based on software which helps in representing output from the skeleton, extracted from image (taken from camera). If a person is standing in front of the camera, the person will be able to select desired clothes. Also in future we can extend our system to recommend some clothes which will suit on that particular person depending on his skin colour. The selected garment is then virtually superimposed with the image recorded by the camera.

Using this system is very advantageous to customer, some of the advantages are:

- It improves the ability to make the right choice for the size of clothes without actually trying it [4].
- Better opportunities for creative expression/experiment with clothing style.
- Using this 2D model technique a wide range of other services like jewelry, glasses and hair style recommendation can be done.
- Reduce the human effort for trying many clothes, which will in turn save a precious time.

We enable people to visualize them wearing a variety of garments at store. Thanks to this technology, we can virtually try on several styles of garment depending on our preference and dimensions.

In this paper extraction of user based on skin colour detection is shown in section 2. Detection of human body parts and features using Haar classifier is explained in detail in section 3. Section 4 gives us the results of experiments performed. Section 5 concludes the topic and section 6 shows the extent to which the topic can be expanded.

A. *Goals and Challenges*

The aim of the paper is to create a Tailoring Measurement and Virtual Try-on that realistically reflects the appearance and the behaviour of garment. It should further adapt to specific bodies of different persons depending on their body measurements. This will be one of the main challenges since the pieces of cloth should correctly fit to as many consumers as possible independent of their individual dimensions.

Technically speaking, the fitting room will be based on the camera, a very renowned technology which provides a new way of interaction between humans and the computer. From the image of the camera the skeleton is extracted and the position and orientation of the cloth are adapted in regard to the joint positions and body measurements. 2D models of the cloth will be overlaid with the colour image from the camera to obtain the function of a virtual mirror. To achieve a realistic simulation of the cloth, a physical simulation is performed on the garment. Providing a useful connection between the camera and all the other parts of the application will be another ambition.

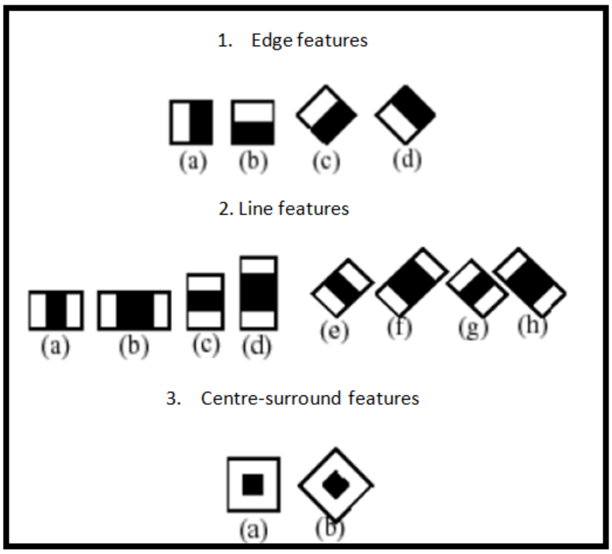

Fig. 1. Common Haar features

II. PRE-PROCESSING

A. *User Extraction*

Extraction of user allows us to create an augmented reality environment by isolating the user area from the image and superimposing it onto a virtual environment in the user interface. Furthermore, it is here a useful way to determine the region of interest that is also used for skin detection which is explained in further section [4].

The camera provides the image. When the device is working, image is segmented in order to separate background from the user [7]. The background is removed by blending the RGBA image with the segmented image for each pixel by setting the alpha channel to zero if the pixel does not lie on the user. The background removal is illustrated in Figure 2.

B. Skin Segmentation

Since the model is superimposed on the top layer, the user always stays behind the model which restricts some possible actions of the user such as folding arms or holding hands in front of the t-shirt. In order to solve that issue skin coloured areas are detected and brought to the front layer [12]. HSV and YCbCr colour spaces are commonly used for skin colour segmentation. In this work we preferred YCbCr colour space and the RGB images are converted into YCbCr colour space by using following equations:

$$C_b = 128 - 0.169R - 0.33G + 0.5B$$

$$Y = 0.299R + 0.587G + 0.114B$$

$$Cr = 128 + 0.5R - 0.419G - 0.081B \quad (1)$$

Fig. 2. Background removal. Depth image (left), color image (middle), extracted user image (right)

Chai and Ngan reports that the most representative colour ranges of human skin on YCbCr colour space [5]. A threshold is applied to the colour components of the image within the following ranges:

$$77 < C_b < 127$$

$$133 < Cr < 173$$

$$Y < 70 \quad (2)$$

Since we have the extracted user image as a region of interest the threshold is applied only on the pixels that lie on the user. Thus, the areas on the background which may resemble with the skin colour are not processed. The skin colour segmentation is illustrated in Figure 3.

Fig. 3. Skin colour segmentation. User image (left),segmented image(right)

TABLE 1
STANDARD BODY PARAMETERS for FEMALE

Size	Height (In/Cm)	Weight (Lbs/Kgs)	Chest (In/Cm)	Waist (In/Cm)	Hips (In/Cm)
4	5.4 - 5.6 162 - 167	95 - 105 42 - 47	29 - 31 73 - 78	24 - 26 60 - 66	32 - 34 81 - 86
6	5.5 - 5.7 165 - 170	105 - 115 47 - 51	31 - 33 78 - 83	26 - 28 66 - 71	34 - 36 86 - 91
8(1)	5.6 - 5.8 167 - 172	115 - 130 51 - 58	33 - 35 83 - 88	27 - 29 68 - 73	36 - 38 91 - 96
8(2)	5.8 - 5.1 172 - 177	120 - 135 54 - 60	33 - 35 83 - 88	27 - 29 68 - 73	36 - 38 91 - 96
10(1)	5.7 - 5.9 170 - 175	125 - 145 56 - 65	35 - 37 88 - 93	30 - 32 76 - 81	38 - 40 96 - 101
10(2)	5.9 - 5.11 175 - 180	130 - 140 58 - 63	35 - 37 88 - 93	30 - 32 76 - 81	38 - 40 96 - 101
12(1)	5.8 - 5.1 172 - 177	135 - 150 60 - 67	37 - 39 93 - 99	32 - 34 81 - 86	40 - 42 101 - 106
12(2)	5.6 - 5.8 167 - 172	130 - 140 58 - 63	37 - 39 93 - 99	32 - 34 81 - 86	40 - 42 101 - 106
14(1)	5.9 - 5.11 175 - 180	145 - 155 65 - 69	39 - 41 99 - 104	34 - 36 86 - 91	42 - 44 106 - 111
14(2)	5.7 - 5.9 170 - 175	140 - 150 63 - 67	39 - 41 99 - 104	34 - 36 86 - 91	42 - 44 106 - 111

III. HAAR CLASSIFIER

The core basis for Haar classifier object detection is the Haar-like features. These features, rather than using the intensity values of a pixel, use the change in contrast values between adjacent rectangular groups of pixels. The contrast variances between the pixel groups are used to determine relative light and dark areas. Two or three adjacent groups with a relative contrast variance form a Haar-like feature. Haar-like features, as shown in Figure 1 are used to detect an image [5]. Haar features can easily be scaled by increasing or decreasing the size of the pixel group being examined. This allows features to be used to detect objects of various sizes.

A. *Integral Image*

The simple rectangular features of an image are calculated using an intermediate representation of an image, called the integral image [9]. The integral image is an array containing the sums of the pixels' intensity values located directly to the left of a pixel and directly above the pixel at location (x, y) inclusive [11][12]. So if A[x,y] is the original image and AI[x,y] is the integral image then the integral image is computed as shown in equation 1 and illustrated in Figure 4.

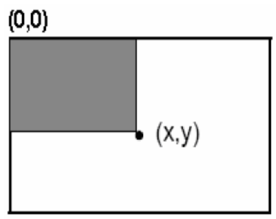

Fig. 4. Summed area of integral image

B. *Classifiers Cascaded*

Although calculating a feature is extremely efficient and fast, calculating all 180,000 features contained within a 24 × 24 sub-image is impractical [Viola 2001, Wilson 2005]. Fortunately, only a tiny fraction of those features are needed to determine if a sub-image potentially contains the desired object [6]. In order to eliminate as many sub-images as possible, only a few of the features that define an object are used when analysing sub-images. The goal is to eliminate a substantial amount, around 50%, of the sub-images that do not contain the object.

Haar classifiers continue, increasing the number of features used to analyse the sub-image at each stage. The cascading of the classifiers allows only the sub-images with the highest probability to be analysed for all Haar-features that distinguish an object. It also allows one to vary the accuracy of a classifier. One can increase both the false alarm rate and positive hit rate by decreasing the number of stages. The inverse of this is also true. Viola and Jones were able to achieve a 95% accuracy rate for the detection of a human face using only 200 simple features [9]. Using a 2 GHz computer, a Haar classifier cascade could detect human faces at a rate of at least five frames per second [5].

IV. Experiments

The result of the experiment is evaluated by the average error rate of 10-fold cross validation of each data set for 10 runs. 10-fold cross validation is a process which divides the data set into 10 blocks.9 blocks are merged for training data and the rest for the testing data. We test every data set for ten times and then calculate the average accuracy. Every time we randomly choose the training data and testing data.

V. Conclusion

After an introduction, the related work was presented; starting with cloth selection and virtual try-on, cloth recommendation system is also available. Subsequently a closer look on the technologies and frameworks that were used for the implementation, like Haar classifier algorithm, of the Tailoring Measurement and Virtual Try-on was taken. After this the different aspects of the design process up to the constructionof the garment models were highlighted. This is followed by the implementation, for instance.

TABLE 2
STANDARD BODY PARAMETERS for MALE

Size	Height (In/Cm)	Weight (Lbs/Kgs)	Chest (In/Cm)	Waist (In/Cm)	Hips (In/Cm)
XS	5.4 - 5.7 16[illegible] - 169	120 - 145 54 - 66	33 - 36 84 - 91	27 - 29 68 - 73	32 - 35 81 - 88
S	5.6 - 5.9 167 - 175	135 - 155 61 - 70	34 - 37 86 - 94	28 - 31 70 - 78	34 - 37 86 - 94
M	5.7 - 5.11 170 - 180	150 - 175 68 - 80	37 - 39 94 - 99	29 - 33 73 - 83	35 - 39 89 - 99
M-L(1)	5.1 - 6 177 - 183	170 - 195 77 - 89	38 - 42 196 - 106	32 - 36 81 - 91	38 - 42 96 - 106
M-L(2)	6 - 6.2 183 - 188	175 - 200 80 - 91	38 - 42 96 - 106	32 - 36 81 - 91	38 - 42 96 - 106
M-L(3)	5.1 - 6 177 - 183	180 - 205 82 - 93	40 - 44 101 - 111	32 - 36 81 - 91	40 - 44 101 - 111
L	6 - 6.2 183 - 188	185 - 210 84 - 96	40 - 44 101 - 111	34 - 37 86 - 94	41 - 44 101 - 111
L-XL(1)	6 - 6.4 187 - 193	195 - 220 89 - 100	41 - 44 101 - 111	34 - 37 86 - 94	42 - 44 101 - 111
L-XL(2)	6 - 6.2 183 - 188	200 - 230 91 - 105	42 - 46 106 - 116	34 - 37 86 - 94	43 - 47 109 - 119
XL	6.2 - 6.4 187 - 193	210 - 240 96 - 109	42 - 46 106 - 116	37 - 40 94 - 101	43 - 47 109 - 119
XL-XXL	6.2 - 6.4 187 - 193	200 - 250 100 - 114	44 - 48 111 - 121	37 - 40 94 - 101	45 - 49 114 - 124
XXL	6.3 - 6.5 190 - 196	235 - 265 107 - 121	44 - 48 111 - 121	39 - 43 98 - 109	45 - 49 114 - 124

In the last section the tests were executed, also discussing the output, the appearance and the interaction with the Tailoring Measurement and Virtual Try-on.

Overall, the presented Virtual Dressing Room seems to be a good solution for a quick, easy and accurate try-on of garment. In this system compared to other technologies like augmented reality markers or real-time motion capturing techniques no expensive configurations and time-consuming build-ups are required. From this point of view it is an optimal addition for a cloth store.

TABLE 3
SHOWS THE ACCURACY of CLASSIFYING MALE DATA SET and FEMALE DATA SET.

	MALE	FEMALE
Test 1 accuracy	80.13%	86.13%
Test 2 accuracy	79.27%	70.22%
Test 3 accuracy	74.12%	76.23%
Test 4 accuracy	72.22%	63.87%
Test 5 accuracy	77.93%	73.46%
Test 6 accuracy	66.71%	72.33%
Test 7 accuracy	71.53%	71.53%
Test 8 accuracy	88.30%	78.61%
Test 9 accuracy	77.43%	77.12%
Test 10 accuracy	70.02%	80.59%
TOTAL	74.56%	75.08%

Beyond that a simple setup of the system can also be assembled at home since the minimum requirements are a computer with a screen and a Camera. This can also result in an additional feature for a web shop, for instance. It would allow a virtual try-on of clothes before people are buying it online, taking a closer look at the garment and even conveying the actual behaviour of the real cloth. This demonstrates a huge advantage over the common web shopping experience.

Our approach can be summarized as follows:

- Extraction of the skeleton from the image of user by using depth and user label data.
- Positioning of the 2D cloth models by using the skeletal tracker.
- Calculate the distance between the body joints and distance of the user from the camera.
- Skin color detection in order to prevent unwanted occlusions of body parts and the model [13].
- Super-imposition of the model (clothes) on the user. By using "Haar Classifier algorithm" we can detect face and body part. Cloth recommendations on basis of skin colour [4].

VI. FUTURE WORK

In this paper, we have developed a methodology, to put on some clothes on the image from our database in 2D module. This is just a small step toward the Tailoring Measurement and Virtual Try-on (TMVT) application. Here we have, front image for each dress which is superimposed on the user and the 2D graphics of the product seem to be relatively satisfactory and practical for many uses such as jewelry, glasses, hair style, fitness, and gaming.

There are many possible implementations regarding the model used for fitting. It is possible to apply a homographic transformation to the images rather than the simple scale-rotate technique in order to match multiple joints altogether although it would require more computation. 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. Second approach would also make it possible to implement a physics engine to go along with the model.

The 2D patterns can be generated from the personally sized garments or by using the generic body measurements as shown in table 1 and table 2. These 2D measurements could be directly sent to the cloth manufactures. The speed optimization for on-line calculation comes from wide use of generic database of bodies and garments [3].

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