

# The Real-time Virtual Fitting Room: VFIT

D.M.S.P.K Dawndasekare<sup>1</sup>, V.S.C Subhasinghe<sup>1</sup>, K.H.S Hemendra<sup>1</sup>, Punsara Anuradha K<sup>1</sup>, Dr Aruni Niroshika<sup>1</sup>

<sup>1</sup>*Sri Lanka Institute of Information Technology.*

*\*Corresponding Author: su.nethra.990@gmail.com*

**Abstract**— Augmented reality has been used for many aspects of human life since it was introduced in late 1960s. It has been used in many industries such as military, medical and space exploration. The most recent practice of AR is used for marketing and entertainment purposes. Compared to other industries, apparel industry has made considerable advancement in using AR for entertainment purposes. With the advancement in augmented reality, now consumers can visualize what the outfit will look like on them without physically wearing them. This concept is titled as Virtual Fitting Room (VFR) and it start emerging since 2005 and was reported massively during 2010. Today VFRs are widely used by increasing number of prominent retailers in their web stores and apparel stores. There are many different types of technological approaches used for VFRs. But the most recognized and reliable technologies are size commendation facilities, body scanners, 3D customer's model, Fitting room with real 3D simulation, Dress-up dummies, mix-and-match, Photo-accurate virtual fitting room, augmented reality and real models. Amongst these technologies augmented reality and 3D clothing models have been used for the real time virtual fitting room: VFIT. Body scanning technologies are available in two separate flavours. They are scanners that use technologies such as webcams, phone cameras, or Microsoft's Kinect device and scanners that use more urbane technologies which requires the customer to travel to the scanner. The more refined scanners that use laser or millimetre wave detector technology, or multiple arrays of Kinect sensors, are too massive and expensive to be used in most stores. Therefore they are located only in shopping malls or in large department stores. For the VFIT system, a single Kinect device is used which enables it to be used in most apparel stores with lesser room and also for a less cost compared to those mentioned above.

**Keywords**— *Augmented reality, Clothing Simulation, Cloth models, Kinect, Virtual fitting*

## I. INTRODUCTION

Shopping for clothes has become a very time consuming and annoying task now a days. Also it is a boring experience for some people. To buy single dress or an accessory, people tend to fit on so many clothes and this is a very time consuming task. Sometimes there are very expensive clothes at shopping malls that are not allowed to fit on before buying. When people buy these clothes and after wearing them if they find out that the clothing does not suits them well, it become a total waste of time and money. There are many other drawbacks of fitting on clothes at shopping malls. Some of them are hygiene problems, security and privacy of the customer and the security of expensive clothing. The need for a virtual fit on room has arisen among modern day people because of the above mentioned

matters. Surveys show that most of the customers would like to have a virtual fit on experience where they do not have to waste time or money on shopping for clothes. Also they expect shopping clothes to be a fun experience rather than a boring and annoying task. VFRs or virtual fitting room concept has made a huge advancement with the expansion of augmented reality. [13]

Augmented reality (AR) can be described as a live conventional or unintended view of a real-world environment whose features are augmented by sensory input generated by computer. These input can be sound, video or graphics. AR is connected to a more general concept which is called mediated reality. In mediated Reality, an interpretation of reality is modified by a computer. This technology functions by enhancing one's current insight of reality. By contrast, virtual reality replaces the real world with a simulated one. Augmentation is usually in real-time and in semantic context with environmental elements. With the assistance of advanced AR technology the information about the surrounding real world of the user becomes interactive and digitally manipulable. [5][14]

VFRs depend greatly on Augmented Reality (AR). It hires specific software and hardware to combine the digital and the physical worlds. This is done by immersing digital information into real video to generate convincing looking sights in real time. Modern Virtual Fitting Rooms combine AR technologies with depth and color data in order to provide strong body recognition functionality and effectively address the fit and suit features of shopping. Further, promising platforms offer real-time video simulations. This allow customers to visualize products as part of their current garments. Also they can view them from multiple angles. These platforms are powerful decision tools for on-line shopping as well as they increase the entertaining aspect for in-store shopping. The present article reviews successful examples of VFRs and discusses important technologies behind some of these shopping and advertising tools. Many of these tools employ full body scans to offer only pieces of clothing with a satisfactory fit and at the same time facilitate the styling and matching aspects of shopping. [2][15]

Most virtual dressing room solutions which use augmented reality are worked by overlaying the 3D model or picture of a clothing within the live video feed of the customer. The overlaid 3D model or picture of the clothing will then track to movements of the customer. Therefore it appears in the video view as if the customer is wearing the virtual item. Augmented Reality Virtual Dressing Rooms typically require

a smartphone camera, desktop webcam, or 3D camera such as Kinect to function. [3][4]

V-Fit is a real time virtual fitting room which is designed to avoid the drawbacks of actual fit on rooms as mentioned above. It can be deployed in modern shopping malls to help customers to choose clothes without actually fitting them on.

VFIT consists of a large screen which acts as the digital mirror which displays the user's live video feed detected by Kinect camera. The user has to stand in front of the screen and the user's movements will be tracked using Kinect sensors. User can select clothes and accessories to be fitted on and can be seen how it looks on him from the screen which acts as a digital mirror. The user can turn around 360 degrees, bend and move around and see how he looks on that clothing. The motion of the user is tracked and displayed on the screen real-time. Further the unique feature of VFIT is that the user can customize clothes according to his needs. The patterns of 3d clothing models can be altered as desired as well as the colour of the clothing can be altered from an available range of colours. Also the size of the clothing can be changed accordingly. Many other customizations for clothing models are possible with VFIT, such as adding a text to the clothing and adding a shining to the material. Finally if the user is satisfied with his modified clothing, he can order it or if he is not satisfied he can reset the changes to the clothing and start over again.

VFIT consists of many positive traits when compared with other virtual fitting applications available in the world. Most of the available virtual fitting applications are web applications which uses a web cam to capture user. These applications capture the 2D image of the user and overlay 2D images of clothes over the image of user where VFIT captures the mirror image of the user with depth details and overlay 3D cloth models over the mirror image. Some of such web applications are Fits.me, aplique.com, customink.com and constrvct.com. Even though there are other existing virtual fitting applications in apparel stores such as Fitnect, they have very limited features and have poor motion tracking of users and clothing models. Also these applications overlay a 2D image of clothing over the mirror image of the user and it does not display as the user is actually wearing that particular clothing. Unlike these systems, VFIT uses real-time motion tracking using IR sensor of Kinect and displays as the user is actually wearing the clothing model. [34][35][36][37][38]

## II. RESEARCH METHODOLOGY

Kinect for Windows SDK 1.5 is used to track the movements of the user. Using this, human skeletons can be fully tracked when the depth sensor is set to near range. Skeletal tracking for near range is provided in two modes. They are seated and default modes. Given that the field of view is limited when the user is close, the seated mode is more frequently used. In this situation applications can ensure that the user's head, torso, and arms are visible and is tracking only the user's upper body. Kinect is capable to recognize people and follow their actions

using skeletal tracking. Kinect can identify up to six users in the sensor's field of view. The infrared (IR) camera is used for

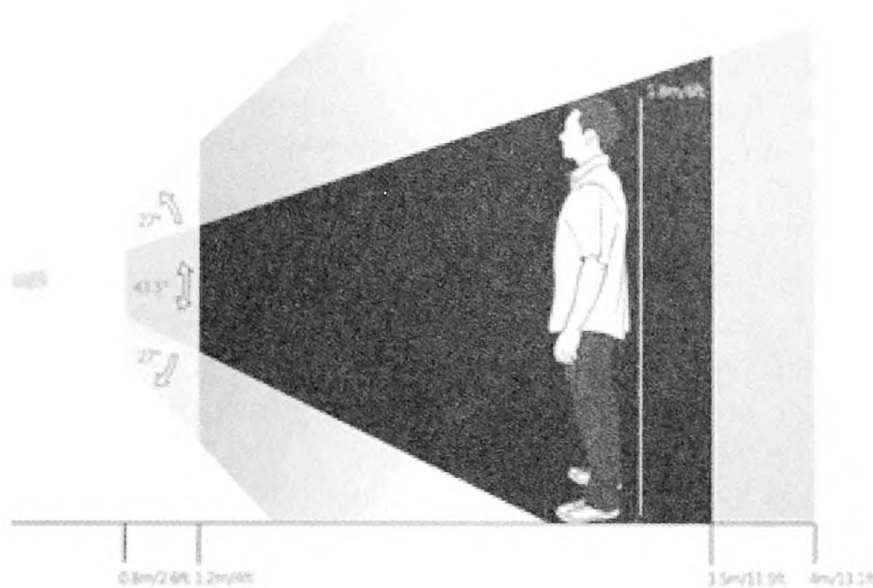


Figure 1. The Kinect vertical Field of View in default range.

this purpose. Out of these users, up to two users can be tracked in detail. [7]

The VFR application can find the joints of the tracked users in space and track their movements. For this, users simply need to be in front of the sensor and make sure the sensor can see their head and upper body to be recognized by the Kinect sensor. No exact pose or calibration action needed to be taken for a user to be tracked. The settings of the IR camera determines the Kinect field of view of the users. These settings are set with the DepthRange Enumeration. When Kinect is in default range mode, Users has to be standing between 0.8 meters and 4.0 meters away from it, as that is the range where Kinect can see people standing. In near range mode, it is capable to see people standing between 0.4 meters (1.3 feet) and 3.0 meters (9.8 feet). Figure (1). [1]

The infrared emitter of a Kinect sensor projects a pattern of infrared light. This pattern of light is used to calculate the depth of the people in the field of view. This allows the recognition of different people and body parts. IR depth sensor reads these infrared patterns projected by the IR emitter. The algorithms of Kinect for Windows SDK performs the calculation of depth of people in the field is done by. If more than one Kinect sensor is used to irradiate the target area, the accuracy and precision of skeletal tracking can be reduced. This is due to interference with the infrared light sources. In order to reduce the possibility of interference, only one Kinect sensor (or infrared light source) is used to point to the field of view where skeletal tracking of the users is being done.

The skeletons in a frame can have one of two tracking states. The two tracking states are "tracked" or "position only". A tracked skeleton delivers detailed information about the position of twenty joints of the user's body in the camera's field of view. A skeleton with a tracking state of "position only" provides information about the position of the user. It does not

provide details about the joints. The application uses the tracking ID to decide which skeletons to track [1][7]  
 The Kinect camera captures the visual input of the user. Kinect consists of an RGB camera which stores three channel data in a 1280x960 resolution. The captured live video stream of the user is rendered frame by frame on the screen. Frame rate (depth and colour stream) of the Kinect is 30 frames per second (FPS).

The VFIT system consists of a special feature which makes it unique from other VFRs currently available. It is the ability to modify an existing clothing as user desires. The clothing models are available in the system to choose. These clothing models are created using 3ds Max and Maya 3D modelling software. For customization of clothing models Unity 4.6 game engine was used with mono Develop IDE. C# with Mono Framework is used as programming language to develop customization features.

*E. Main Features*

- i. *When the user stands in front of the Kinect, it starts capturing the user's skeleton.*

Kinect gets several points of user's skeleton as input when user stands in front of it.

There is a line drawn on the floor for user to stand on. Also there is a static white background behind the user to avoid any disturbances. The light of the room should be properly controlled.

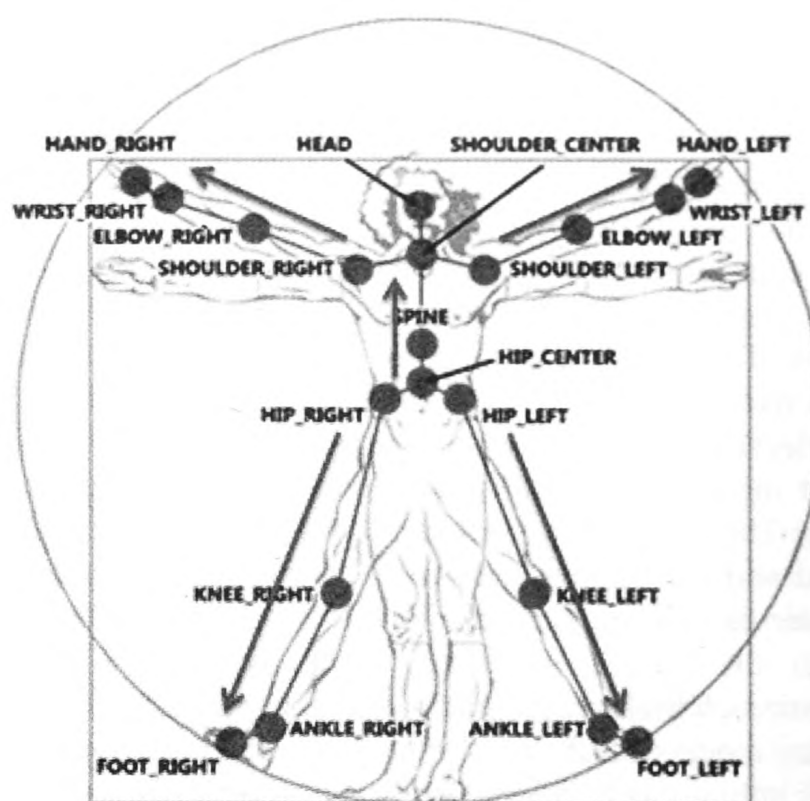
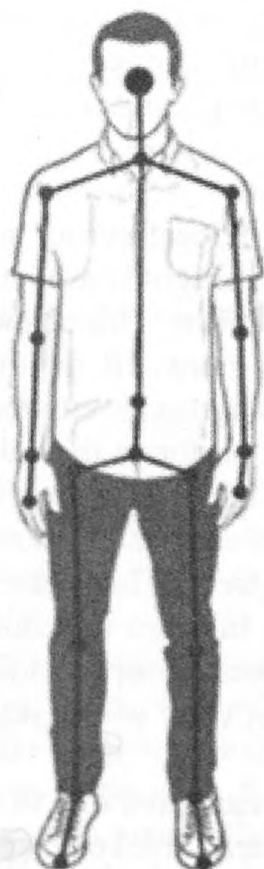


Figure 3. Detected points of human body by the Kinect.

- ii. *Overlay the clothing on the skeleton using necessary points of the skeleton.*

Ex. To map a shirt – shoulder left and hip right points

To map a cap – head point

To map a hand bag – wrist right/left point

- iii. *The user can customize the selected clothes and virtually fit on.*

The models of the clothes available in the shop are stored in the system. The user can customize a selected cloth and see how it looks on him.

The patterns of the clothing can be altered within a range of patterns available in the system. The color of the clothing also can be altered by selecting a necessary color from the color picker available. Also the size of the clothing can be increased or decreased as user's desire. Further the user can write some text on the clothing. There are other customizations also available such as adding a shining to the clothing material. [16]

III. RESEARCH FINDINGS RESULTS AND EVIDENCE

A. Research Findings

The principle outcome of this project was a fully functioning virtual fit on room with ability to customize available clothing models. The system is capable of identifying the person standing in front of it and virtually fitting on clothes on him when he selects clothes from the menu. This VFR takes less than one second to change between clothes. The customization feature allows user to customize a garment and design it

Figure 2. The detected skeleton of the user by Kinect. (Kinect can recognize six people and track two)[1]

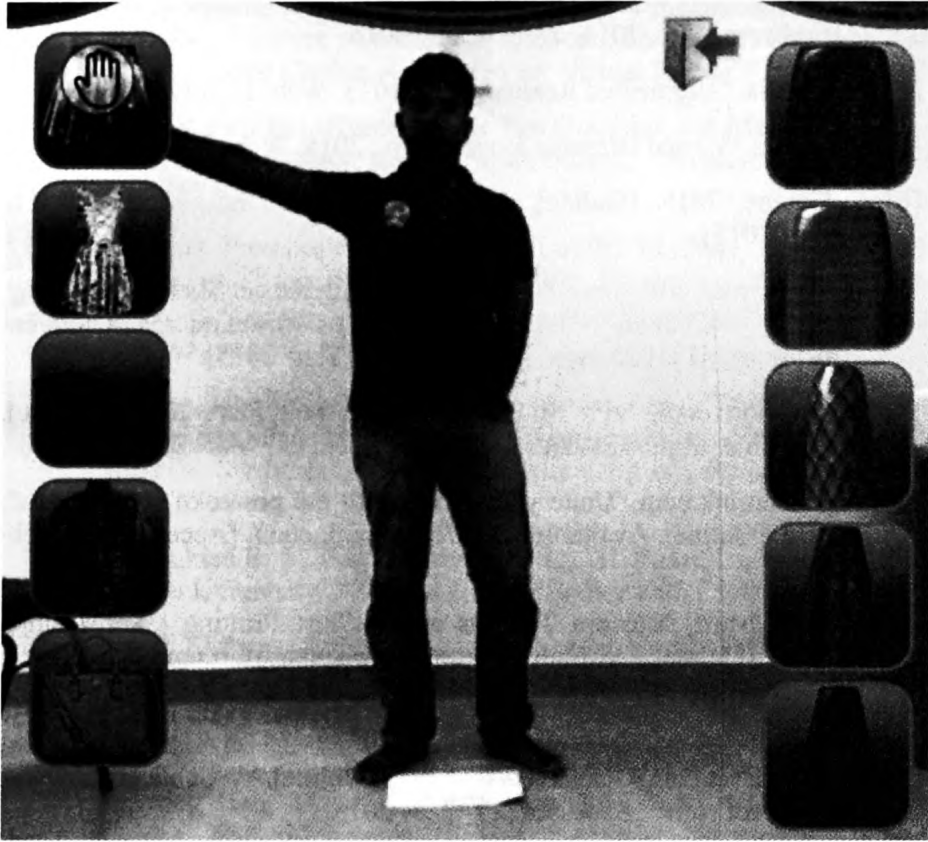


Figure 4. The clothing models are displayed after identifying the user by the Kinect

according to their requirements and desires. It was revealed in this project that using a virtual fit on room rather than a traditional fit on room is more time effective and entertaining.

*B. Results and Evidence*

When the user stands in front of the Kinect camera, the skeleton of the user is captured by the IR sensor of the Kinect. The video output of the user is rendered on screen as 5 layers: background view layer, camera view layer, UI view (buttons) layer, 3D view layer, error view layer.



Figure 5. The selected clothing model and accessories will be overlaid on the user

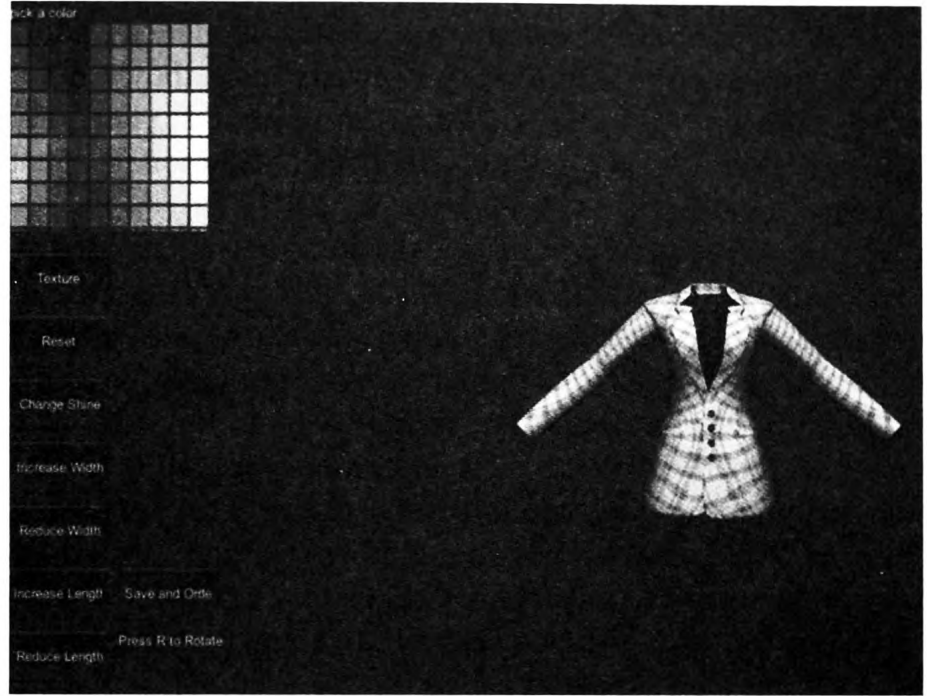


Figure 6. A clothing model before modifications

When the user is captured by the Kinect, the clothing models will be displayed on the screen. The user can select clothing models by hand gestures. Figure (4).

The clothing models can be selected from categories for customization and necessary customizations can be performed on selected clothing models.

IV. CONCLUSIONS AND FUTURE WORKS

Fitting on garments in traditional fitting rooms in shopping malls is an unpleasant experience which majority of shoppers are faced today. To try on a garment before buying it, consumers use fitting rooms several times. Thus there are long queues for fitting rooms in shopping malls. This is a waste of time for customers. Sometimes it is hard to decide which clothing to buy after fitting them on. So customers ask opinion from mall staff or their friends. After buying a dress, if they find



Figure 7. The clothing model in figure 5 after changing color and adding a shine. (Rotated)

out that the dress does not suits them well, then it becomes a total waste of money. There are other issues related with this scenario. Some garments are very expensive that they are not allowed to fit on before buying them. So when customers buy them and if the dress does not suits well the money spent become a huge waste.

The solution to all the problems raised above is included in the real-time virtual fitting room V-Fit. This saves the time of the customer since it takes less than one second to change from one dress to another. Also customer does not need anyone else's opinion since he can decide for himself what to buy and what not to buy. There is no cleanliness matters regarding clothes since customers do not actually wear them. The interesting feature of VFIT is customizing clothes feature. It enables customer to customize an existing dress and create a whole new design of a prevailing dress. Therefore shopping becomes an interesting task for adults as well as for kids. This gives a competitive advantage for shop owners too. Also since they can sell customized clothes to a higher price than the normal price, the profit they would earn in the long run would be greater than the basic expenses they would make.

Even though VFit system allows the customers to do a greater deal of customizations for existing dresses, there are some limitations that were not possible to overcome with the available resources and knowledge. The main limitation that was presented was that it was not possible to transform the shape of a dress freely for the user. As this would generate tailoring issues and other dress making issues in the practical scenario, this issue was not addressed and there is a need for further research on this matter.

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