AugDrobe3D - Kinect Augmented Reality Wardrobe

Cheow Yeong Chi

Rimi Aziz Ramidin

Sanath Sukumaran

Programming Project 1

May 22, 2013

Abstract

This paper presents an augmented reality fitting room application software which allows single user to try on virtual apparels or clothings. The user pose is tracked using the Microsoft Xbox Kinect sensor and the virtual clothes are mapped accordingly with the user silhouette and poses. Clothings moves and folds realistically and the lighting intensity of the cloth render is adapted to match ambient lighting conditions.

The presented application software improves on related augmented reality applications by adding full user pose tracking and by using 3D clothing models, combined with cloth simulation instead of 2D images. Skeletons are mapped accordingly onto the cloth models accordingly to the user's body size.

1 Introduction

Back in 2009, Microsoft developed the Kinect sensor under the codename 'Project Natal' and released it in the end of 2010 and started revolutionising the gaming industry.

The Kinect sensor has interesting capabilities such as allowing one to generate a depth image alongside an RGB camera image. It comes with tools that provide human pose detection and tracking as well. It is capable of simultaneously tracking up to six users, including two active players for motion analysis with a feature extraction of 20 joints per player. These abilities can be used to create an immersive virtual reality presence for the user such as Dance Central 3 and also to create augmented reality application in which virtual objects interact with the user and his surrounding environment.

1.1 Project Background and Description

AugDrobe3D is developed by a team of four students which is pursuing their Bachelor Degree of Computer Science by RMIT University. This application is developed under Windows Platform with the use of Kinect sensors. This application is using Kinect sensors to capture input and after processing, shown on a display.

It is a virtual wardrobe that provides user convenience to try on different apparels. It provides an estimation of how the apparel would be look like on the user. Besides, apparel matching, which is sometime a headache for someone could be done easily with least amount of time. This application allows user to change the color of the apparel or even the accessories with just a hover or a click. The user can save the time of taking off and putting the clothes and also the time taken for queuing to the fitting room. All the user needs is to do is to stand in front of the Kinect sensors and they can start trying on apparels of their choice. If the user likes the combination, they can even take screenshots of it and share to their Social Networking Service such as Facebook or Twitter.

The Microsoft Xbox Kinect sensor is used in this project to create an augmented reality wardrobe in which the user could try on virtual clothing and apparels. The silhouette of the user is tracked to allow the clothing to move and scale accordingly with the user and the depth image is used to create an avatar of the user that approximates the user's body shape.

Next, cloth simulation is applied to the virtual clothing to make it move and fold realistically based on the user's movements. The depth image from the sensor is used to compute the girth of the user's body to adapt the user avatar and recommend clothing sizes to the user. The RGB image is used as a background over which the clothing is projected and is displayed on the user avatar when it occludes parts of the clothing.

The user is segmented from the background and the intensity of this part of the image is calculated to adapt the lighting of the virtual clothes. This makes the clothing appear as if it is in the same room as the user by reacting to bright and shaded parts of the environment.

1.2 Problem Statement

People sometimes will meet the situation that waiting for a long queue to try on apparels. The reason of long queue normally is because the shop is lack of fitting room or it is during the weekend, public holiday and sales period. Even worst, there are always more than one size and color that they might want to test, this will make others waiting much longer to try their apparels. Some customer will just wait inside the fitting room and request the staff to change the size or color for them. When the customer losing their patient it will result the customer is not happy on apparel what they have choose.

1.3 Rationale

The increasing demand of clothes especially online shopping is evident. Abundant and fast access to latest styles and newest season of clothes has two main advantage: it enables people that are active in the fashion field access to all newest available apparels to try on immediately as it released; and increase of sales as people are more exposed to clothes imposes indirectly, to the increase of sales.

1.4 Project Objective

The AugDrobe3D project aims at bridging the gap between people and clothing by allowing people assessing and the "real-world" benefits without much hassle and reduces problems of unfitting or unsuitable clothing.

AugDrobe3D will provide a platform of the techno-economical environment and provide detailed roadmaps and guidelines on how to easily use and manage your personalized digital wardrobe, and also provides a channel to try on and even, buy a piece or two that you really like and put it in your collection, virtually and in the real world, of course.

It also aims to create an augmented reality dressing room. This requires real-time tracking of the user pose as well as realistic virtual clothing. For the pose tracking the Kinect is used which gives more complete and accurate tracking of the user pose than the marker based or image feature based tracking which is traditionally used in augmented reality applications. For the clothing we created a set of 3D models which are skeleton-binded which that can be rendered into the scene. The focus of this project is on realistic interaction between the user and the virtual clothing. To achieve this the clothing needs to at least satisfy the following basic conditions:

I. be aligned and fit in correctly with the user silhouette and pose

II. move and fold realistically.

III. be realistically rendered into the environment.

1.5 Stakeholders

Definition

There are many definitions of 'stakeholder' and an oft-quoted definition of 'stakeholder', taken from a key reference is: 'A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives.' A much broader definition, which has also been attributed to Freeman, is that a stakeholder is 'anything influencing or influenced by' the firm, but this definition is problematic because it leads to the identification of a very broad set of stakeholders.

Project stakeholder

The definition of project stakeholder is a person group or organization with an interest in a project. Therefore, the stakeholder definition is narrowed down to project stakeholder which focus on the one who is/are interested on our project. Beside that, Information (IS) Researches also taken up the ideas of stakeholders and in software engineering fields, stakeholders have been defined as 'Stakeholders are people who have a stake or interest in the project'. Therefore, what we concern about stakeholders are the clients or the customers who are interested on our project and the potential users in the future.

Clients

The potential clients and customers can be divided to the two difference fields which are the supplier and the users. The suppliers are mainly the fashion supplier who using this product to advertise their fashion apparels and the users are the group of people who use the product to test, buy and share their fashion apparels.

1.6 Project Scope

Assets (3D Models)

Limited to shirts, jackets, and hats only with few differences sizes available on each model. Each model would be able to changes their view and able to have momentum(small movements like rotating) according to user's movements.

Kinect

Limited to single user at each time. Therefore, only need to handle one user and only single user is allowed to use at each time.

2 Research

The idea of trying on virtual clothing is not pioneer. With the massively growing interest in augmented reality, applications appeared in which it was possible to try on clothes by overlaying an image of clothing over the image captured by a webcam or digital camera. Like every other technique the virtual fitting room evolved from very simple to more intuitive solutions. The differences in these solutions can be largely reduced to two dimensions: the alignment of the clothing with the user and the realism of the clothing.

2.1 Findings of Similar Developed System

The creators project has been implemented on Topshop in UK with limited function such as browsing its Topshop's catalogs fashion.

2.1 Academic Result

2.1.1 Language

To ev

2.1.2 Motion Sensing software development kits

We first used the built-in skeletal tracker of Kinect SDK which is also used in Kinect gaming platform. Kinect SDK has some advantages over OpenNI namely per-frame initialization and recovery which provides continuous user tracking with occasional flickers. OpenNI on the other hand, requires a calibration step to recognize the user and initialize the tracking. If at any point user gets out of the scene or obscured by an object for a

brief time it is required to do the calibration again with the calibration pose. Thus, we preferred to use the Microsoft Research Kinect SDK (will be referred as the Kinect SDK in the rest of the paper) due to its robust and practical skeletal tracking algorithm.

But at the later stage while the production moved onto Unity3D apparently Kinect SDK does not support up to version 4 and above, its feature of only supporting Windows platform makes us shifts to OpenNI, where the whole system begun to develop in. As OpenNI framework is a multi-platform open source API which supports:

I. Voice and voice command recognition
II. Hand gestures
III. Body Motion Tracking

2.1.3 WPF

2.1.4 Unity3D

2.1.5 OpenNI with PrimeSense and NITE

2.1.6 Autodesk 3Ds Max

2.2 Secondary Result

2.2.2 DirectX 10

2.2.2 HLSL

2.2.3 Kinect

2.2.4 Maya Model

2.2.5 Microsoft Blend

Microsoft Blend is normally used on creating storyboard(animation) for WPF for GUI purposes.

3 System Analysis

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Praesent egestas diam non arcu consequat tempus. In tempus lacus mattis tortor semper vulputate. Integer eget neque augue, ac pulvinar ipsum. Nulla facilisi. Cras iaculis tincidunt ipsum, a dignissim elit gravida ac. Quisque vitae elit urna. Nullam aliquet scelerisque eros, sit amet elementum diam congue vitae.

3.1 Language

C++

C++ is a statically typed, free-form, multi-paradigm, compiled, general-purpose programming language. It is regarded as an intermediate-level language, as it comprises both high-level and low-level language features. Developed by Bjarne Stroustrup starting in 1979 at Bell Labs, C++ was originally named C with Classes, adding object oriented features, such as classes, and other enhancements to the C programming language. The language was renamed C++ in 1983, as a pun involving the increment operator.

The need of C++ is evident as it is needed to build DirectX application where we would need to render the various model of clothing.

C#

C# is a multi-paradigm programming language encompassing strong typing, imperative, declarative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines. It was developed by Microsoft within its .NET initiative. C# is one of the programming languages designed for the Common Language Infrastructure.

XAML

Extensible Application Markup Language (XAML) is a declarative XML-based language created by Microsoft that is used for initializing structured values and objects. It is available under Microsoft's Open Specification Promise. The acronym originally stood for Extensible Avalon Markup Language - Avalon being the code-name for Windows Presentation Foundation (WPF).

3.2 Library

DirectX10

Microsoft DirectX is a collection of application programming interfaces (APIs) for handling tasks related to multimedia, especially game programming and video, on Microsoft platforms. The DirectX software development kit (SDK) consists of runtime libraries in redistributable binary form, along with accompanying documentation and headers for use in coding. DirectX 10 ships with and is only available with Windows Vista and later; previous versions of Windows such as Windows XP are not able to run DirectX 10-exclusive applications. Programs that are run on a Windows XP system with DirectX 10 hardware simply resort to DirectX 9.0c code path.

DirectX10 is the main API in our program, it is using to import and render costume's 3D models to the program. It is also used to manipulate and control the 3D models to follow the skeleton's movement which detected by Kinect. The reason we are using DirectX instead of OpenGL because our program target operating system is Windows and the Kinect is working more stable on the Windows Operating System, so DirectX will be our first choice to use.

DirectX 10 is the main API in the program, it is using to import and render costume's 3D models to the program. It is also used to manipulate and control the 3D models to follow the skeleton's movement which detected by Kinect. The reason using DirectX instead of OpenGL because the program target operating system is Windows

and the Kinect is working more stable on the Windows Operating System, so DirectX will be the first choice to use. The version 10 is selected because the difference between 10 and 11 is pretty small, since some hardware on the market currently still cannot fully support version 11 so the version 10 still is the best choice for most users.

Direct3D HLSL (High Level Shader Language)

Direct3D is a low-level API that you can use to draw triangles, lines, or points per frame, or to start highly parallel operations on the GPU. Direct3D is available for Microsoft Windows operating systems (Windows 95 and above), and for other platforms through the open source software Wine. It is the base for the graphics API on the Xbox and Xbox 360 console systems. Direct3D is used to render three dimensional graphics in applications where performance is important, such as games. Direct3D also allows applications to run fullscreen instead of embedded in a window, though they can still run in a window if programmed for that feature. Direct3D uses hardware acceleration if it is available on the graphics card, allowing for hardware acceleration of the entire 3D rendering pipeline or even only partial acceleration. Direct3D exposes the advanced graphics capabilities of 3D graphics hardware.

The HLSL (High Level Shading Language) is a proprietary shading language developed by Microsoft for use with the Microsoft Direct3D API. Using HLSL, we can create C like programmable shaders for the Direct3D pipeline. In our program, we will use HLSL to code vertex and pixel shader.

3.3 Algorithm

The main function of this application is to render the apparels on the user's body. Hence there are few algorithm used to calculate the user's body height and width. Besides, there is also calculations needed to calculate the model with respect to the distance of the users and the Kinect sensors.

3.4 Model and Texture

UV Mapping Basics

This process projects a texture map onto a 3D object. The letters "U" and "V" denote the axes of the 2D texture because "X", "Y" and "Z" are already used to denote the axes of the 3D object in model space.

UV texturing permits polygons that make up a 3D object to be painted with color from an image. The image is called a UV texture map,but it's just an ordinary image. The UV mapping process involves assigning pixels in the image to surface mappings on the polygon, usually done by "programmatically" copying a triangle shaped piece of the image map and pasting it onto a triangle on the object. UV is the alternative to XY, it only maps into a texture space rather than into the geometric space of the object. But the rendering computation uses the UV texture coordinates to determine how to paint the three dimensional surface.

As UV mapping can be generated automatically with 3D model software. Hence, it is included in our model assets.

Modeling and texturing an object

3D modeling is the process of developing a mathematical representation of any three-dimensional surface of object (either inanimate or living) via software.

Texture mapping is a method to add details like colors into a 3D model. Therefore, normally a complete 3D model is build from 3D structure first such as coordinate points and then texture mapping other value or details such as image, color, to the 3D model.

Euclidean Transformation

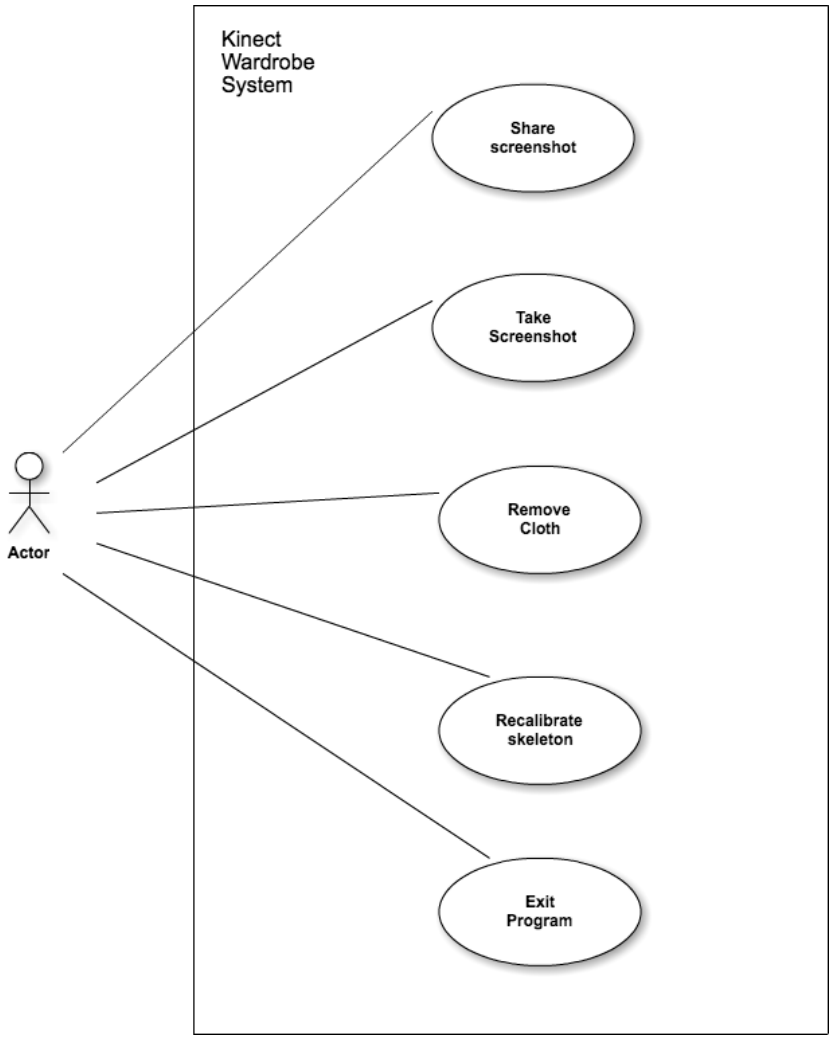
This is basically normal transformation such as rotation, transition but in 3D spaces.

This is necessary when a 3D model is rotating, changing camera view and transforming. For example in this project, while the user is moving front and end hence affect the camera view of the 3D Model. Therefore, euclidean transformation is needed.

4 Requirement Specification

4.1 Functional Requirement

4.1.1 Use case diagram



4.1.2 Use case specification

Use Case ID	UC01
Use Case Name	Share Screenshot
Description	The user can choose to share the screenshot that they have taken.
Author(s)	Choo Kok Hong
Last Updated By	Choo Kok Hong
Date Created	22 April 2013
Date Last Updated	24 April 2013
Actors	Users
Status	Pathway Defined
Priority	2
Assumption(s)	Kinect is connected , Internet connection is active
Pre-Conditions	✓ Screen shot is taken ✓ User login to SNS
Post-Conditions	

Use Case ID	UC02
Use Case Name	Take Screenshot
Description	The user can take a screenshot with a timer of 5 sec.
Author(s)	Choo Kok Hong
Last Updated By	Choo Kok Hong
Date Created	22 April 2013
Date Last Updated	24 April 2013
Actors	Users
Location(s)	
Status	Pathway Defined
Priority	**2**
Assumption(s)	Kinect is connected
Pre-Conditions	**User must be present at the camera frame**
Post-Conditions	

Use Case ID	UC03
Use Case Name	Remove Cloths
Description	The user can remove the apparel that he or she is applied.
Author(s)	Choo Kok Hong

Last Updated By	Choo Kok Hong
Date Created	22 April 2013
Date Last Updated	24 April 2013
Actors	Users
Location(s)	
Status	Pathway Defined
Priority	2
Assumption(s)	Kinect is connected
Pre-Conditions	✓ User must be present at the camera frame ✓ User must be applied apparel
Post-Conditions	

Use Case ID	UC04
Use Case Name	Recalibrate Skeleton
Description	The user can recalibrate the skeleton which can provide a more accurate stimulation.
Author(s)	Choo Kok Hong
Last Updated By	Choo Kok Hong
Date Created	22 April 2013
Date Last Updated	24 April 2013
Actors	Users
Location(s)	
Status	Pathway Defined
Priority	2
Assumption(s)	Kinect is connected
Pre-Conditions	
Post-Conditions	

Use Case ID	UC05
Use Case Name	Exit Program
Description	User click this button to exit the program.
Author(s)	Choo Kok Hong
Last Updated By	Choo Kok Hong
Date Created	22 April 2013
Date Last Updated	24 April 2013
Actors	Users
Location(s)	
Status	Pathway Defined
Priority	2

Assumption(s)	Kinect is connected
Pre-Conditions	✓ Application is started
Post-Conditions	

4.2 Non-functional requirements

Operating System: Window

CPU: Intel core i5 2550 and above

GPU: Nvidia GTX 360 and above

Memory: RAM 2GB and above

Hardware: Kinect Sensor

Environment: C++ runtime environment is present

DirectX 10 is installed.

4.3 Gantt Chart

References

1. The Creators Project (2011). The Kinect Invades Dressing Rooms [Finally] | The Creators Project. [online] Retrieved from: http://thecreatorsproject.vice.com/blog/the-kinect-invades-dressing-rooms-finally [Accessed: 23 Apr 2013].
2. YouTube (2000). Kinect Virtual Fashion, the Future of Shopping at Home, Retail, and on Smartphone. [online] Retrieved from: http://www.youtube.com/watch?v=s0Fn6PyfJ0I [Accessed: 23 Apr 2013].
3. YouTube (2000). Try On Clothes VIRTUALLY With Xbox 360 Kinect Using Swivel By Face Cake (CES 2012). [online] Retrieved from: http://www.youtube.com/watch?v=WwUa14mNNhY [Accessed: 23 Apr 2013].
4. Josuttis, N. M. (2012). The C++ standard library: A tutorial and reference. Upper Saddle River, NJ: AddisonWesley.
5. Meyers, S. (2005). Effective C++: 55 specific ways to improve your programs and designs. Upper Saddle River, NJ: Addison-Wesley.
6. Stroustrup, B. (2000). The C++ programming language. Boston: Addison-Wesley.
7. Schildt, H. (2010). C# 4.0: The complete reference. New York: McGraw-Hill.
8. Dalal, M., & Ghoda, A. (2011). Xaml developer reference. Sebastopol, Calif: O'Reilly Media
9. Microsoft.com (n.d.). Kinect Sensor Setup, Requirements, Support | Kinect for Windows. [online] Retrieved from: http://www.microsoft.com/en-us/kinectforwindows/purchase/sensor_setup.aspx [Accessed: 23 Apr 2013].

10.Msdn.microsoft.com (n.d.). Kinect Fusion. [online] Retrieved from: http://msdn.microsoft.com/en-us/library/dn188670.aspx [Accessed: 23 Apr 2013].

11.Microsoft.com (n.d.). Kinect for Windows | Voice, Movement & Gesture Recognition Technology. [online] Retrieved from: http://www.microsoft.com/en-us/kinectforwindows/ [Accessed: 23 Apr 2013].

12.Pterneas, V. (2011). How-to: Successfully Install Kinect on Windows (OpenNI and NITE) - CodeProject. [online] Retrieved from: http://www.codeproject.com/Articles/148251/How-to-Successfully-Install-Kinect-on-Windows-Open [Accessed: 23 Apr 2013].

13.Podila, P., & Hoffman, K. (2010). WPF control development unleashed: Building advanced user experiences. Indianapolis, Ind: Sams.

14.Yosifovich, P. (2012). Windows Presentation Foundation 4.5 cookbook. Birmingham, UK: Packt Pub.

15.Rastertek.com (2011). DirectX 10 Tutorials. [online] Retrieved from: http://www.rastertek.com/tutdx10.html [Accessed: 23 Apr 2013].

16.Taking Initiative (2011). DirectX10 Tutorials. [online] Retrieved from: http://takinginitiative.net/directx10-tutorials/ [Accessed: 23 Apr 2013].

17.Rastertek.com (n.d.). Tutorial 4: Buffers, Shaders, and HLSL. [online] Retrieved from: http://www.rastertek.com/dx10tut04.html [Accessed: 23 Apr 2013].

18.Microsoft.com (n.d.). Kinect Tutorials | Kinect for Windows. [online] Retrieved from: http://www.microsoft.com/en-us/kinectforwindows/develop/tutorials.aspx [Accessed: 23 Apr 2013].

19.Creativecrash.com (2006). Maya Tutorials, Maya 3D Tutorials, Tutorials for Maya. [online] Retrieved from: http://www.creativecrash.com/maya/tutorials/ [Accessed: 24 Apr 2013].

20.Msdn.microsoft.com (n.d.). Learn Microsoft Expression Blend: videos, tutorials, whitepapers. [online] Retrieved from:http://msdn.microsoft.com/en-us/expression/cc197141.aspx[Accessed: 23 Apr 2013].