A Project Based Seminar Report

on

3D Modelling

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by

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CERTIFICATE

This is to certify that the project-based seminar report entitled **"3D Modelling"** being submitted by **Parimal Mahindrakar (T150058615)** is a record of Bonafide work carried out by him/her under the supervision and guidance of **Prof. Seema Chandak** in partial fulfillment of the requirement for **TE (Information Technology Engineering) – 2015 course** of Savitribai Phule Pune University, Pune in the academic year 2020-21.

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(Students Name & Signature)

Abstract

With the large-scale virtualization of essential and non-essential services in today's world, it has become imperative to develop an efficient and all-round online shopping system which stimulates the shopping experience while avoiding physical contact.

The current pandemic situation has forced us to think of innovative methods to stimulate physical contact using various virtualization techniques, and through that we have devised a real-time online shopping tool, which while most importantly helping the customer avoid physical contact, still provides him/her with a near-identical shopping experience.

Through augmented reality techniques like facial landmark detection, pose estimation and 3D modelling, we can replicate the appearance of various clothing accessories on the customer in real-time, stimulating the entire physical experience of shopping. Furthermore, we will be integrating machine learning into this project as well.

Primarily, we will be using a facial expression recognition system to gauge the emotional reactivity of the customer to a certain product. These reactions will act as automatic feedbacks, which apart from internal use, can be fed to an innovative recommendation system. Through this system we can use these facial feedbacks extremely effectively for recommendation and marketing purposes. Therefore, using a combination of augmented reality and machine learning techniques, our project aims to provide the customer with a holistic online shopping experience which parallels a physical experience for the same.

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INTRODUCTION TO 3D MODELLING

1.1 Introduction to Project

The complete deployed project aims at developing a platform based on augmented reality that will bridge the gap between physical and virtual shopping by letting users try the fashion and beauty products on them so that user satisfaction is established. Furthermore, the project aims at incorporating a recommender system to enhance the shopping experience.

1.2 Motivation behind project topic

- We have all heard all augmented reality, it can do things that we cannot imagine and completely changing the world of gaming, education, and world of online shopping as well.

- The main motivation behind our project is to visualize the future of today's technology being used to interact with the users throughout their day. We have never been closer to being able to seamlessly integrate technology into one's lifestyle to enhance the user's experience.

- Today's consumers are seeking ways for their technology to simplify their lives and help them be more productive. Real time data flow creates the clarity for the user and enhances the safety, improves cost efficiency, and help to select the products the customer needs.

1.3 Aim and Objective(s) of the work

Project aims: Our aim is to make a platform that will bridge the gap between physical and virtual shopping by using state of art machine learning algorithms and integrate it with different augmented reality tools. We hope that through our project, we can help people buy products online in a way through which they feel much more confident that they have bought the product which is right for them.

Project objectives: The objective is to create an interface that will offer real-time experience to break the barrier of reality and augmented reality. We aim to keep our project as light as possible but in the meantime provide maximum features to increase the customer engagement. The main objective is to run the different algorithms simultaneously so that the user can perform multiple tasks at the same time for which we need to use the multiprocessing and pipelining features provided by the OS. Our project aims to deliver an end system through which the buyer can try-on the product virtually but will get a feel of reality such as virtual makeup, jewellery, t-shirts, watches etc.

1.4 Introduction to **3D Modelling**

Technology is transforming nearly every industry, and construction is no exception. The term "3D modeling" refers to the process of creating a three-dimensional representation of an object using specialized software. This representation, called a 3D model, can convey an object's size, shape and texture. You can create 3D models of existing items, as well as designs that have not yet been built in real life.

CHAPTER 2

LITERATURE SURVEY OF 3D Modelling

1. **Introduction:** A multitude of computer vision-based techniques reconstruct and model 3D objects or scenes from photographs or video footage captured in 2D or 3D. Many of these techniques and approaches reconstruct objects or scenes with automatic algorithms from image sequences. Alongside to these academical approaches a growing number of commercial software products have been presented in the last years like Agisoft, Autodesk, etc.

2. **Methods:** 3D reconstruction and modeling techniques based on computer vision show a significant improvement in recent decades. Despite the vast variety, most of these techniques depend on specific photographic collections or video footage. For example, most are designed for large data collections, overlapping photos, captures from turntables or photos with lots of detectable features such as edges. If the input, however, does not fit the specification, most techniques can no longer create reasonable 3D reconstructions. We review the work in the research area of 3D reconstruction and 3D modeling with a focus on the specific capabilities of these methods and drawbacks. Within this literature review, the practical usability with the focus on the input data — the collections of photographs or videos — and on the resulting models are discussed. Upon this basis, we introduce our position of interactive 3D reconstruction and modeling as an opportunity of lifting current restrictions from these techniques, which leads to the possibility of creating CAD-ready models in the future such as Blender.

   - **Collections of photographs:** A well-known technique that uses a collection of photographs as input data is *Photo tourism*. This tool uses an unstructured collection of photographs of a scene, e.g., acquired from the internet, and converts them to a sparse 3D model of the scene. Thus, the user can browse, explore, and organize large photo collections in a 3D model of the scene. A robust structure from motion algorithm for 3D structure estimation is the backbone of *Photo tourism.*

   - **Single photograph:** Photo collections acquired according to guidelines for 3Dreconstruction are rare. Single photos or small collections of photos are more common. In the interactive modeling phase, the user selects block elements and aligns their edges with visible edges in the input images. The system then automatically computes the dimensions and locations of the blocks along with the camera resection.

- **Video footage:** An automatic 3D reconstruction method from video footage produces a dense, geo-registered 3D model of an urban scene in real-time. The video footage is captured by a multi-camera system in conjunction with INS (Inertial Navigation System) and GPS measurements. To achieve real-time, they decouple the problem into the reconstruction of depth maps from sets of images followed by the fusion of these depth maps, a simple and fast algorithm that can be implemented on GPUs. It yields a compact and geometrically consistent representation of the 3D scene. Generating dense 3D maps of indoor environments using a RGB-D camera has been proposed by Henry et al. (Henry et al., 2014), despite the limited depth precision and field of view such cameras can provide. This technique effectively combines the visual and shape information of a RGB-D camera. Aligning the current frame to the previous frame with an enhanced iterative closest point algorithm combines the RGB and the D information. The resulting feature point cloud in 3D is visualized in surfels (surface patches).

3. Algorithm:

- ***Introduction:*** Three-dimensional (3D) face modeling is a challenging topic in computer graphics and computer vision. Unlike 2D face models, 3D face models can realistically express face deformation and pose variation with depth information. With these advantages, 3D face models have been applied to various applications, including movies, 3D animation and telecommunications.

    - Three-dimensional modeling systems can be categorized into active and passive vision systems.

    - An active vision system calculates 3D information by measuring a beam of light radiated from an external device such as a beam projector or laser.

    - Passive vision-based system means a system that needs no light-emitting devices and estimates 3D information from 2D images. In passive vision-based 3D face modeling, 3D information can be calculated by analyzing camera geometry from corresponding features in multiple views.

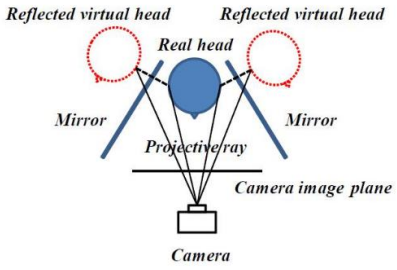
- ***Preliminary Study:*** In this section, we address previous works and the fundamental concept of the proposed 3D face modeling method. We categorize them into two groups:

    - Corresponding feature-based 3D face modeling.
    - Statistical model-based 3D face modeling.

- ***Corresponding feature-based 3D face modeling:*** The simplest and fastest way to generate a 3D face model using the corresponding features cis to use orthogonal views. In this method, the 3D coordinates of the features can be easily calculated from manually selected feature points in two orthogonal views of the face. This method is quite easy to implement, but orthogonality between the two views is necessary.

- ***Statistical Model-Based 3D Face Modeling:*** In 3D face modeling using statistical model, the 3D morphable face model suggested by Blanz, and Vetter is the most well-known. To generate a 3D morphable face model, they construct a database including the 3D coordinates and skin texture from a real human face captured by a 3D laser scanner. Then, statistical analysis is carried out to determine control parameters for the 3D face shape and skin texture deformation. During the modeling procedure, the model parameters are iteratively adjusted in order to fit the model to the input image. This gives remarkably realistic results, but the computational cost is very high.

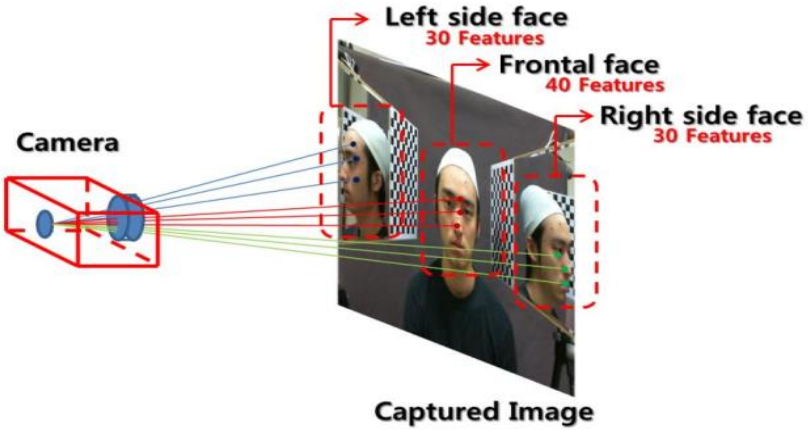
- ***3D Face Shape Estimation Using the Mirror System:***



  - Our proposed face modeling system consists of two mirrors placed on either side of the face and a camera in front of the face. Frontal and lateral face images are captured simultaneously, and the pre-defined feature points are extracted from the captured image.

  - After feature extraction, the 3D FSM fitting procedure is carried out to calculate 3D coordinates from the extracted 2D feature points. During the fitting procedure, the 3D FSM parameters are adjusted to match the landmarks of the 3D FSM with the extracted feature points.

  - This can be thought as least square optimization problem, and then the sum of the distances between the projected landmarks and objective feature points can be the cost function to be minimized.



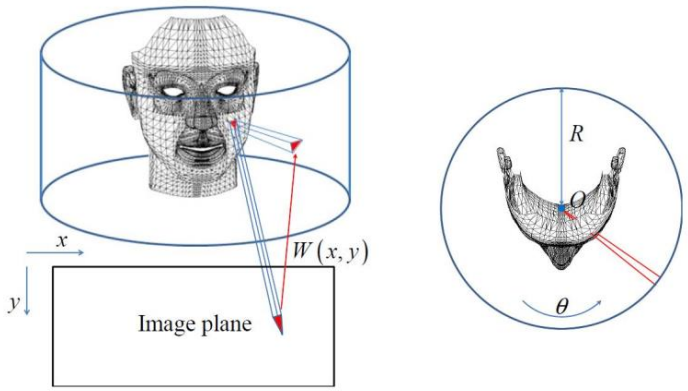
- ***Texture Map Generation and Mapping:*** In this section, we introduce cylindrical mapping and address the stitching method using a seamless cloning method.

  - ***Texture Extraction Using Cylindrical Texture Mapping:***

    - ✓ To map textures on the 3D face model, a texture map is created by extracting the texture directly from the captured face image. For the sake of simplicity, cylindrical mapping is applied.

    - ✓ In common cylindrical mapping methods, mesh vertices that are intersected with the ray passing through the center of a cylinder are projected onto the image plane after a virtual cylinder is placed around the 3D face model.

    - ✓ Then, the colors of the corresponding pixels in the image are extracted and mapped to the texture map. However, this is time consuming because the positions of the vertices on the face mesh must be calculated.



- ***Texture Map Generation Using Modified Image Stitching Method:***

  - ✓ A texture map of the entire face can be created by stitching each face texture parts. Generally, gradient-domain blending techniques are more efficient at reducing photometric inconsistencies than is general image-domain blending.

  - ✓ To implement the seamless cloning method, the entire texture image is first divided into three parts along the boundaries Then, overlapping regions are created by expanding both parts by 1 pixel at the encountering region.

CHAPTER 3

SOFTWARE AND TOOLS

3D modeling is the creation of digital, three-dimensional graphics. There is a variety of 3D Modelling software available that helps the users in sculpting, texturing, and designing 3D models. The art of 3D modeling is based on mathematics, and there are multiple techniques, workflows, and modeling software options to choose from.

Types of Modelling:

- ***Box modeling:*** In box modelling, we start with some primitive object, such as a cube or sphere, and we use classic modeling tools to create a shape from it.

- ***Polygon modeling:*** It is quite like box modelling. The difference here is that we usually start with a single vertex or simple shape without and depth to it. Then we build our model piece by piece.

- ***Digital 3D sculpting:*** Sculpting is used with character, animal, or creature design. It uses vertices, faces, and edges, just like box and polygon modeling.

- ***Photogrammetry:*** Photogrammetry is yet another completely unique way of generating 3D models. With this technique we use a camera and photograph an object multiple times from all angles in a lighting condition that is as even as possible. Then we feed these images into a program that interprets them and generates a 3D representation of the object.

- ***Boolean modeling:*** With Boolean modeling we start with a model and cut away or add other object to it to create a new shape. This is closely tied to box modeling, and we often use the two techniques together. Normally we model basic shapes with box modeling and then combine different shapes with Boolean operations. The operations we have to work with are:
    - Difference
    - Union
    - Intersection

- ***Kit bashing:*** Kit bashing is another type of modeling where we start with a kit of objects that we combine into more detailed objects. Kit bashing is also common when creating solid surface objects.

Software Available:

- ***Blender***
- ***Adobe Dimension***
- ***ZBrush ,etc.***

Why Blender?

Blender is the free and open-source 3D creation suite. It supports the entirety of the 3D pipeline-modeling, rigging, animation, simulation, rendering, compositing and motion tracking, even video editing and game creation. It is cross-platform and runs equally well on Linux, Windows, and Macintosh computers. Its interface uses OpenGL to provide a consistent experience. To confirm specific compatibility, the list of supported platforms indicates those regularly tested by the development team.

Blender also provides Python3 API to customize the application and write specialized tools. It provides modules such as ***bpy*** and ***mathutils*** to the embedded interpreter so they can be imported into a scripted and give access to Blender's data, classes, and functions. Blender modules loaded at startup require register() and unregister() functions. These are the only functions that Blender calls from your code, which is otherwise a regular Python module.

- ***Advantages:***
  - ***Blender's modeling tools include:***
    - ✓ Keyboard shortcuts for a fast workflow
    - ✓ N-Gon support
    - ✓ Edge slide, collapse, and dissolve
    - ✓ Grid and Bridge fill
    - ✓ Python scripting for custom tools and add-ons
  - ***Blender allows for:***
    - ✓ Fast Cube, Cylinder, Sphere and Camera projections
    - ✓ Conformal and Angle Based unwrapping
    - ✓ Painting directly onto the mesh
    - ✓ Multiple UV layers
    - ✓ UV layout image exporting
- ***Disadvantages***
  - Only the dearer models can crush and grind hard items effectively.
  - Take up bench space.
  - Messy to clean.
  - Noisy.

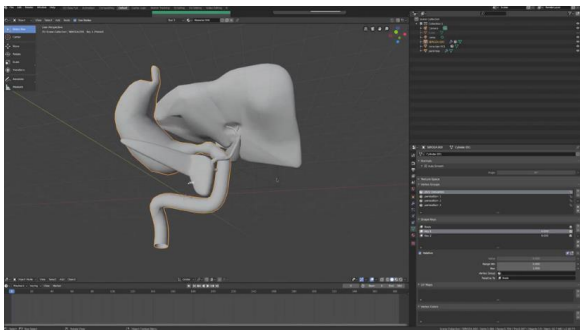
CHAPTER IV

Applications of 3D Modelling

- ***Medical Field:***

- In the past, 3D printing was used mainly by major manufacturers that could afford expensive printers and materials. Over the years, 3D printing technology has evolved and become more affordable, making it a viable option for a wide variety of industries.

- Medical professionals are beginning to use 3D printing to improve their practices and offer more customized and affordable healthcare options for their patients.



- ***Gaming Field:***

    - Animators and game developers use it to get a realistic look at their ideas and assess their viability. Architects, interior designers, and engineers use it for planning and designing. Films and television shows use it for special effects, speeding up production, and reducing costs.

    - For instance, the top-rated HBO show, Game of Thrones used 3D modeling with animation before filming each episode. It is used in the medical industry to represent human anatomy in interactive ways.

    - Industrial products are modeled using it to run tests before commercial production or client presentations. It is used in a set or stage design in media shows and events.

- ***Films Industry:***

Film and gaming industries have become increasingly dependent on computer generated imageries to make them look exceptionally authentic and stunning at the same time. No matter how much creative one can be, the tools and techniques used to bring such dramatic content for the audience play an imperative role to make it look more believable. These days, 3d modeling in movies has become too common owing to the same reason. Compared to the impact it can create, the costs incurred is quite reasonable.

CHAPTER V

PRECISE PROBLEM STATEMENT

Problem Statement: This seminar has resulted in the complete study of the project topic and understanding of its feasibility. We have identified feasible areas of potential work. Thus, a potential problem statement for the B.E. project is: "Building an Augmented Reality Based Application for Fashion and Beauty Makeover."

We intend to use 3D Modelling in our project by using Blender which is a 3D modelling tool as it gives extremely high efficiency, open source, platform independent.

CHAPTER V

CONCLUSION

This seminar was undertaken to understand the methodologies of 3D Modelling, analyze the features essential for modelling, sculpting and compare the various techniques and methods. This study shall help us to implement the AR dependent system in Ecommerce field thereby comforting users need and adding the enhancements. Thus, I conclude the following from the reputed papers published in the domain of machine:

[1]: Blender is the 3D Modelling software tool consisting of high efficiency, open source, platform independent. Blender also give stronger accuracy and it has the full capabilities we would find in any 3D application like rigging, texturing and animation.

[2]: Digital 3D Sculpting is very fine work on 3D models that we have created. It offers tools to smooth, push, pull the models.

REFERENCES

[1] Journal article – 3D Face Modeling Using the Multi-Deformable Method Jinkyu Hwang, Sunjin Yu, Joongrock Kim and Sangyoun Lee, 09/2012.

[2] Zhang, Z. Flexible Camera Calibration by Viewing a Plane from Unknown Orientations. In Proceedings of the 7th IEEE International Conference on Computer Vision, Greece, 09/1999

[3] The Photogrammetric Record 21(115): 269–291 (September 2006) IMAGE-BASED 3D MODELLING Sabry El-Hakim, Fabio Remondino National Research Council, Ottawa, Canada

[4] FACSHuman a Software to Create Experimental Material by Modeling 3D Facial Expression, Isabel Urdapilleta, Samuel Demarchi, Michaël Gilbert, 11/2018

[5] Immersive 3D modeling with Blender and off-the-shelf hardware, Tuukka M. Takala, Meeri Mäkäräinen, 03/2013.

[6] Remondino, F.; El-Hakim, S. Image-based 3D modeling: A review. Photogram. Rec. 2006, 21, 269–291.