IOP Conf. Series: Materials Science and Engineering **263** (2017) 062053 doi:10.1088/1757-899X/263/6/062053

Butterfly valve in a virtual environment

Aniruddha Talekar, Saurabh Patil, Prashant Thakre and E Rajkumar
School of Mechanical Engineering, VIT University, Vellore - 632014,
Tamil Nadu, India.

Email: rajkumar.e@vit.ac.in

Abstract. Assembly of components is one of the processes involved in product design and development. The present paper deals with the assembly of a simple butterfly valve components in a virtual environment. The assembly has been carried out using virtual reality software by trial and error methods. The parts are modelled using parametric software (SolidWorks), meshed accordingly, and then called into virtual environment for assembly.

1. Introduction

Assembly of components in a specific order to get a product to perform the desired task is a critical process. Engineers are taking assistance of computers for easy assembly and disassembly of components in the form of CAD software. SankarJayaram [1] explained a good assembly process needs to take into account the factors like ergonomics, accessibility with other components, and safety for operator, requirement of tooling, etc. The computer based assembly tools existing nowadays mainly focuses on tolerance and clearance evaluation, geometry representation etc. A designer cannot interact in the CAD model with the whole assembly at a time to find out faults or defects if there are any. Various efforts are being carried out to overcome this issue. Such problems can be solved by application of new technologies to the design practices currently in use. This comprises all fields and phases of product development wherein the early stages face the most significant impact. R. Neugebauer et.al [2] proposed Evaluation as well as prototyping is the absolute necessary phases of current product development process. With the help of modelling and analysis software designing is easy, but building various kinds of prototypes is not only costly but also time consuming. To strengthen the industry through powerful decision making ability, Virtual reality has come up with more refined manner. T.S. Mujber et.al [3] has modified the views of engineers and scientists about looking towards computers for mathematical operations, visualization and decision-making abilities. A. K. Bejczy [4] explains the Virtual Reality is a technological module which integrates the computer and human interfaces to give a feel of actual presence and interaction with the virtual world through human actions to the end user. Abhishek Seth et.al proposed an idea [5] to allow the user to have an indiscernible interface with the virtual world created as one may get in the real world. These all features of virtual reality make it as an ideal tool for replication of tasks which needs regular as well as intuitive human interaction like in assembly prototyping methods.

In the product life, assembly plays a key role. The statistics available nowadays says that in the production process, the time required for assembly of the components of a product is about 50% to 60% of the total production time. Also, the assembly costs about 35% of the total cost assisted with the total production process. But with advancements in technology processing time is significantly condensed. Using one of the advancements, virtual assembly technique, generates an interactive environment to

create an assembly of a product.

In the present experiment, a butterfly valve is chosen for assembly purpose. A butterfly valve is a valve used for regulation/and isolation of a flow of fluid. It is closely similar in operation to a ball valve. Butterfly valves are usually preferred because they are lighter in weight hence they require fewer support. These valves are very low in cost also. The butterfly valve contains the following components as shown in table1.

Table 1. Components of Butterfly Valve.

Serial No.	Name of component
1	Body
2	Retainer
3	Arm
4	Plate
5	Washer
6	Shaft
7	Screw and Nut

The body of the valve is generally made up of cast iron, aluminium, stainless steel etc. Retainer is also made up of same material as that of body like cast iron, aluminium, stainless steel, etc. The disc is made up of ductile materials like ductile iron, ductile coated, and nickel plated materials. The disc is made ductile to accelerate according to the flow of fluid and provide an opposite force to stop the flow as the actuator is rotated. There are many types of actuators available for butterfly valve. Here Arm is the actuator we have chosen. The arm we use here is a manual handle. Except that, there are other types of actuators available like pneumatic, electrohydraulic, hydraulic, etc. Hence for the assembly of butterfly valve in the interactive virtual environment we have modeled the valve parts in a parametric software (SolidWorks here). Then the parts are called into Meshlab software for proper meshing of unstructured model. The meshed parts are then converted to collada file format and called into virtual reality software, Unity 3d. Then the components are then assembled in the created virtual environment using trial and error methods. Then the assembly has given some aesthetics like rendering, color, etc.

2. Methodology : The present project work follows the methodology as stated below :

Step 1 : The components of butterfly valve are created using a CAD software shown in figure 1.

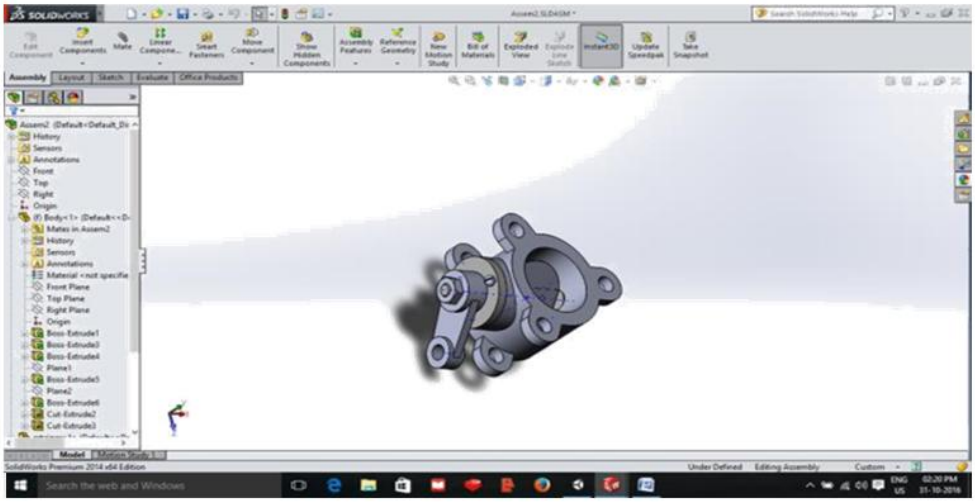

Figure 1. Butterfly valve assembly in SolidWorks.

Step 2: The components modeled in CAD are then saved as.STL extension file format.
Step 3: The .STL files are then imported into Meshlab. Meshlab is used for processing as well as management of unstructured meshes which provides a collection of tools for inspecting, rendering, and conversion of these kind of meshes into desired finer format. This is shown in figure 2.
Step 4: In unity, a virtual environment is created using built in assets shown in figure 4.

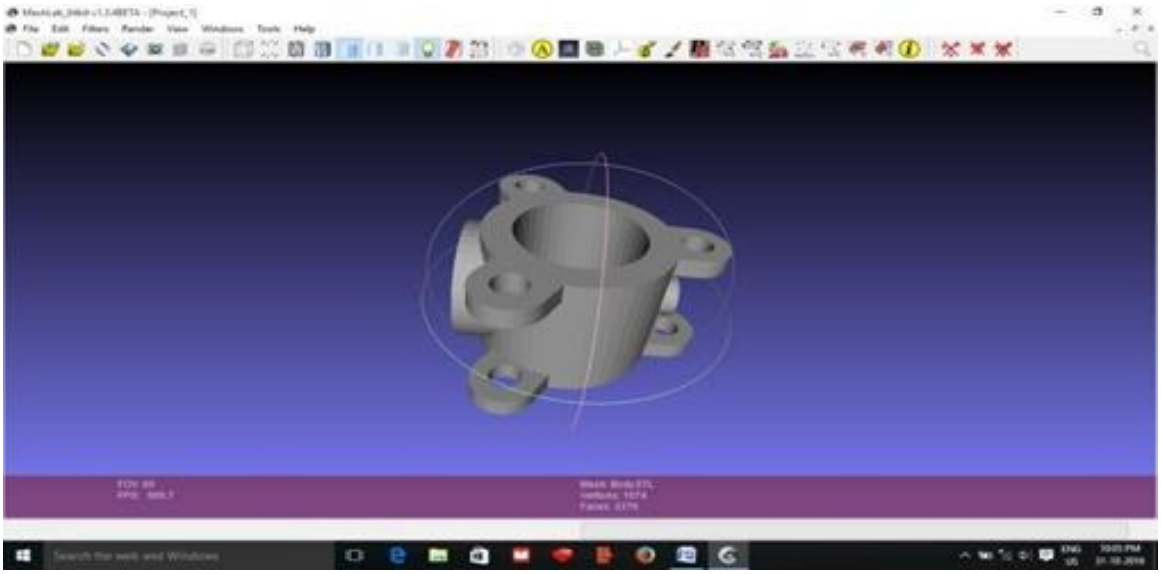

Figure 2. Imported part from Solidworks to MeshLab in .STL format.

Figure 3. GUI of Unity 3D

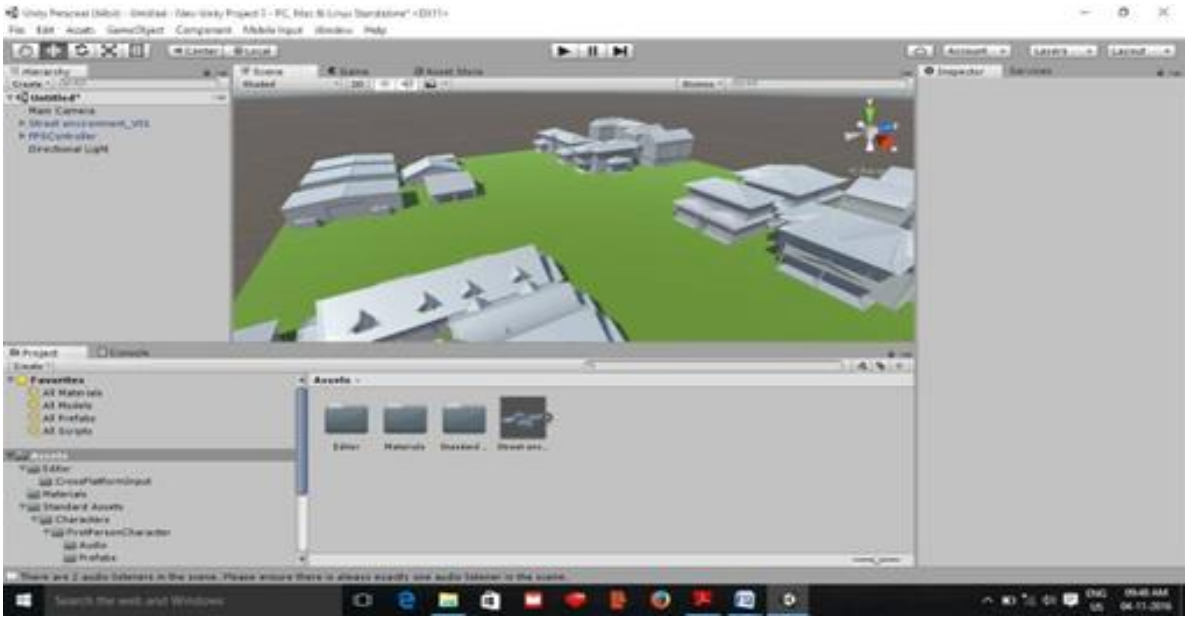

Figure 4. Imported environment in Unity 3D

Step 5: Then the components of the assembly are brought one by one and are carefully assembled according to their respective co-ordinates. The parameters such as rigidity, weight, material etc are also provided to each component. This is shown in figure 5.

Figure 5. Imported components in .DAE format in Unity 3D

*Step 6***.**Complete the assembly and adjust the camera and the light. Figure 6 shows the final assembly

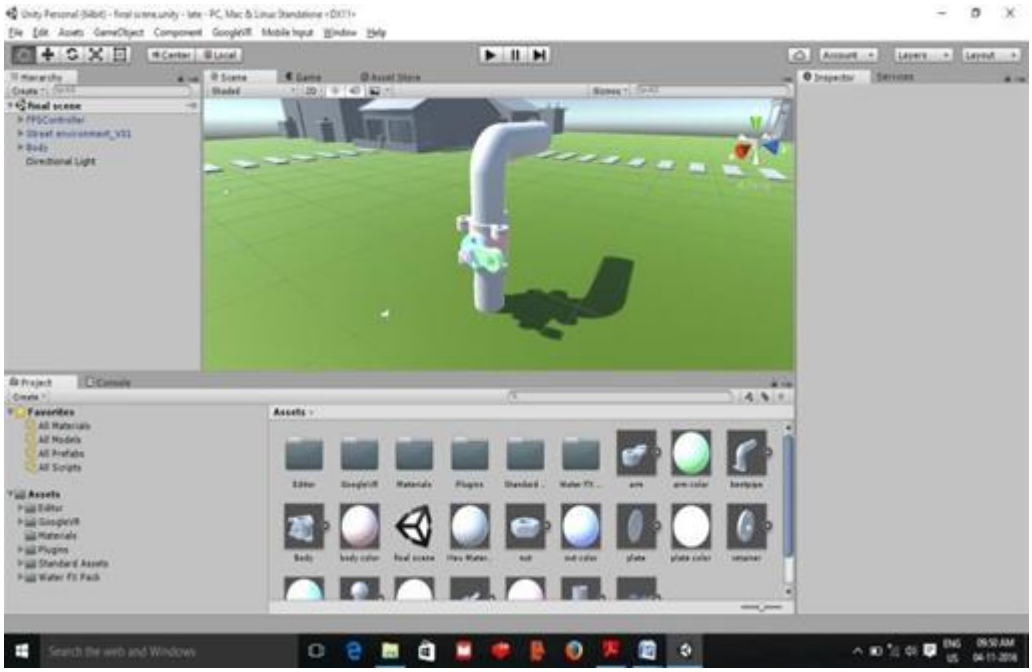

Figure 6. Final assembly view in Unity 3D

3.Results and Discussion

a) .SLDPRT: This is the in- built image file extension used with SolidWorks. SLDPRT means SolidWorks Part file. It not only contains the 3D part, but also the corresponding attributes of it. Two or more such 3D parts can be used to combine together to form an assembly in SolidWorks. This is shown in figure 8.

b) .STL: STL stands for "Stereo Lithography". It is also sometimes called as "Standard Triangle Language". The STL file format is widely supported by many software packages, and hence it is mainly used for computer aided manufacturing, rapid prototyping (RPT) and 3D printing. Since STL file represents a raw unstructured triangulated surface, hence it does not contain different attributes like color, texture, and other such common characteristics.

Figure 7. Imported components in .DAE format in unity 3D

c) .DAE: The DAE extension stands for "Digital Asset Exchange". Collada files are identified by .dae extension format. Collada stands for "Collaborative Design Activity". This format is used to exchange digital properties within numerous graphics software's to avoid incompatibility of different formats and acts as a common format between them. It is shown in figure 7.

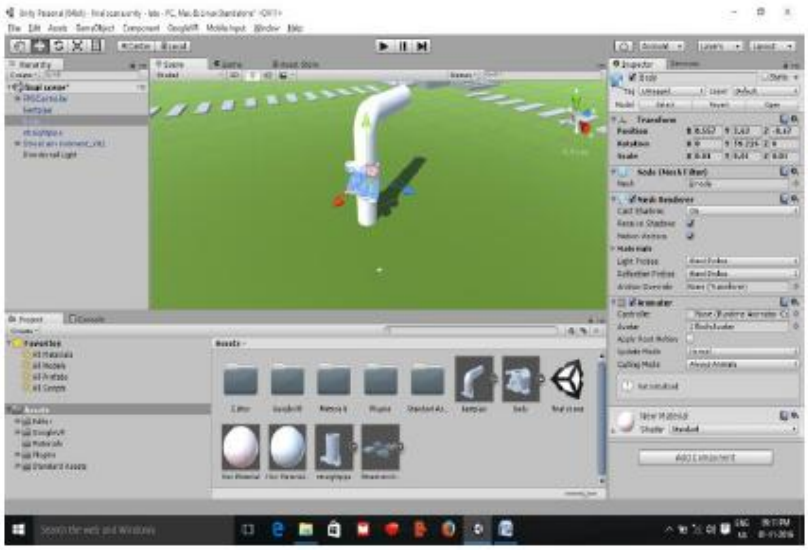

Figure 8. Assembly process.

d).UNITY: The scene created in unity software is stored as .Unity file extension. Assembly process is shown in figure 8.

4. Future Scope for virtual reality

Virtual reality is a far developed aspect when it comes to gaming and entertainment platforms. It is rapidly spreading to manufacturing, training, product development and process planning related activities. Any new inventions or approaches can be first implemented in virtual world to get a glimpse of how it will reflect in the real world. Hence it will reduce the wastage of material, cost and time

required associated with these activities.

5. Conclusion:

In this paper we have created an artificial environment and assembled the components of butterfly valve and simulated by using Unity Software. This would leads to reduce in lead time of Industrial product development and give more customer satisfaction. Using the VR headset and other hardware we can actually interact with the virtual world and get the feel as well as make any required changes to the assembly.

References

[1] Jayaram, S., Connacher, H.I. and Lyons, K.W., 1997. Virtual assembly using virtual reality techniques. *Computer-aided design*, ***29*****(8)** 575-584

[2] R. Neugebauer ·D.Weidlich · H. Zickner · T. Polzin , R. Neugebauer · D.Weidlich · H. Zickner ·T. Polzin , "Virtual reality aided design of parts and assemblies". International Journal of Interactive Design and Manufacturing ,4, **2** 15–20 (2007)

[3] T.S. Mujber, T. Szecsi, M.S.J. Hashmi "Virtual reality applications in manufacturing process simulation". Journal of Materials Processing Technology, 7, No 4, pp 155–156 (2004).

[4] A. K. Bejczy , *Virtual reality in manufacturing*, SpringerScience+Business Media Dordrecht pp 48-60 (1997).

[5] Abhishek Seth, Judy M. Vance, James H. Oliver, *Virtual reality for assembly methods prototyping: a review*. Virtual reality **4(2)** 5–20 (2011)