THE USE OF VIRTUAL REALITY TECHNOLOGIES IN AUTOMOTIVE DESIGN

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ABSTRACT: A major part of world mobility depends upon automotive sector development. Currently, we are witnessing the shift from fossil fuels towards electric automotive sectors. Last decade has shown sharp developments in the field of computer and IT. The application of CAD softwares in design and development is increasing with every passing day. The visualisation of the designed data in softwares plays a vital role during design. One major limitation is visualisation of 3D geometry on a 2D monitor display. In this paper, an effort is made to use the VR technologies for the visualisation of design models of automotive sector. This paper discusses different strategies and methods to visualise CAD models in VR. An interface is developed between desktop computer and android phone to perform visualisation while using VR. This paper also talks about the bidirectional control of visualisation in Computer and android mobile. Furthermore, the benefits and challenges associated with the use of VR in the visualisation of the CAD model is brought to light.

Key words: Virtual Reality (VR); Automotive; Design; CAD; 3D technologies.

INTRODUCTION

Virtual reality (VR) is a computer generated and interactive experience that takes advantage of audio, visual, haptic and other types of feedback (Berg and Vance, 2017). A VR scene is based upon simulation carried out using different computer algorithms; the rendering is also performed using different computer algorithms. The virtual environment created with the help of computer computations can sometime be captivating comparable to the real world. For instance the work of (Mahboob *et al.*, 2017) mentions one such virtual environment. It is evident from the use of computer simulations in product development that it improves productivity, quality, reduces cost and development time to a great extent (Mahboob *et al.*, 2018).

Augmented reality is also among new emerging technologies that layers the virtual data over a live camera feed (Billinghurst *et al.*, 2015). These days VR is commonly available in the form of VR headsets which are widely available enabling a person to look around, maneuver about, and interact with the virtual artefacts of a virtual and computer-generated world.

A complete virtual reality hardware system may contain a visual display, tracking systems, handheld controllers and may also be a haptic devices (Laycock and Day, 2007).

Figure1: VR system inside CAVE.

Figure 2: Powerwall system and Hybrid HMD at John Deere (Berg and Vance, 2017).

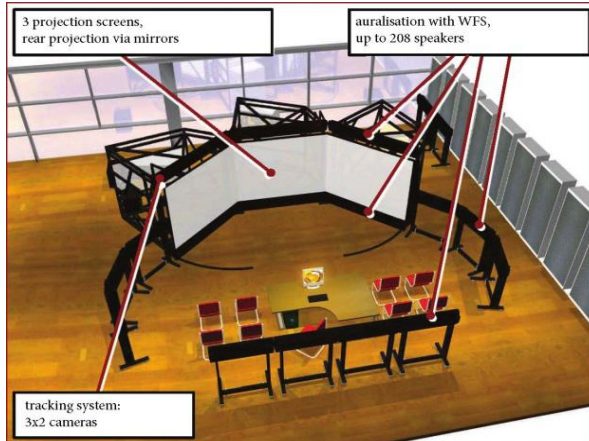[1] The geometrical model was obtained from GrabCAD.com

Figure 3: Audio-visual stereoscopic projection system.

Virtual reality can be used with different conceivable configurations that largely depend on the application at hand. For instance, VR facilities typically use one or more of the following, a large display (i.e. power wall), multiple walls connected together (Cruz-Neira *et al.,* 1993), desktop tracking and head-mounted displays (HMDs).

An audio system can comprise of a headset, a speaker or a complete surround sound audio system. Sound localisation can also simulate moving sound from a location within a virtual environment (Rummukainen et al., 2018).

Virtual environment interaction is critical in many applications of virtual reality, it traces various media systems (optical, magnetic, ultrasonic, inertial, etc.), enables the location and orientation of physical objects to be calculated in real time within physical space (Bowman *et al.*, 2008). This becomes particularly valuable when calculating the correct display of user perspectives.
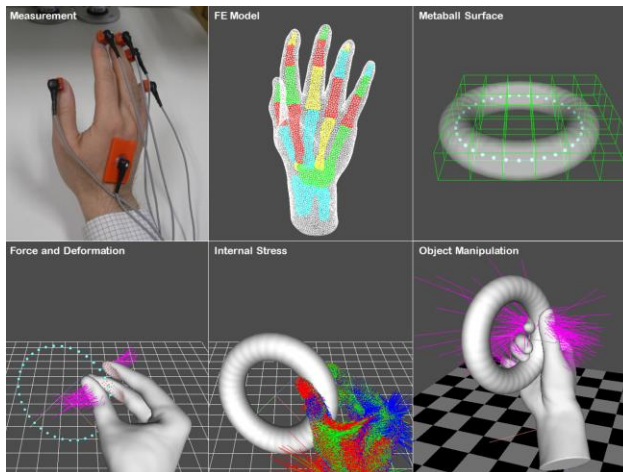

Figure 4: Interaction with virtual object using deformable hand (Hirota and Tagawa, 2016)
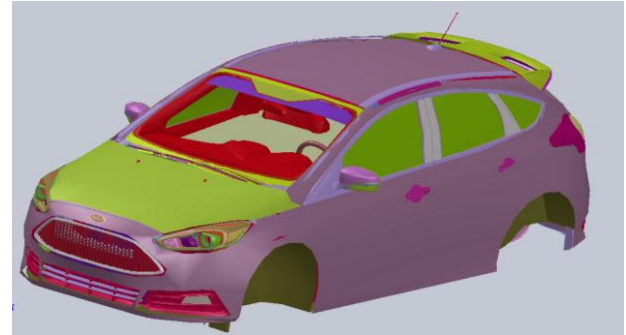

Figure 5: Automotive CAD model[1]

In addition to signal recognition algorithms, tracking systems allow natural body movements to be transformed into functional interaction techniques. The portable console allows users to navigate and manipulate objects in the virtual world to enhance interaction.

MATERIALS AND METHODS

Cad model development: The process of designing starts with the CAD modelling (Mahboob, Aslam, et al., 2018; Mahboob, Qaddus, et al., 2018). Surface and solid modelling is carried out using different CAD softwares like CATIA, Solidworks etc. Assembly of model is performed to have a view of final product.

Different connections are applied during the assembly processes, which are useful in body kinematics and understanding body physics.

CAD model can be saved and converted into different formats like prt, STEP, IGES, msh, obj etc. depending upon the utility.
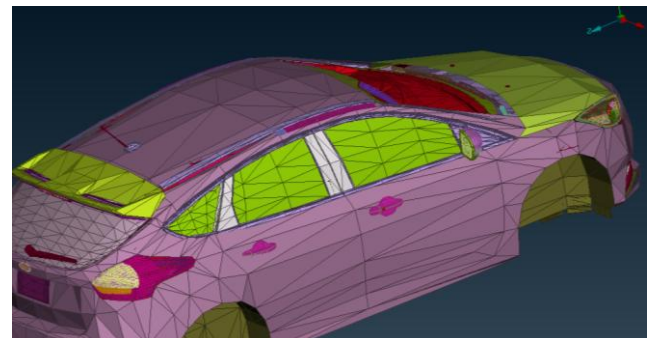

Figure 6: Automotive Object model

CAD TO VR: The main challenge in performing VR visualisation is the model preparation. As a matter of fact, VR cannot render the native CAD geometries. The CAD model has to be first exported as an exchange format and later imported in VR. The choice of one particular exchange format depends upon multiple factors e.g. the data format; mesh size, geometry, animations, kinematic and dynamic relationship. Furthermore, each exchange format carries different information as outlined in the

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work of (Lorenz et al., 2016). As our goal is to visualise a car in virtual reality, therefore, first VR model has to be prepared from the CAD geometry. This conversion process is described in next subsection.

Schematic of CAD model to VR conversion: As the model is in CAD software and it has to be transferred to VR (Unity) for virtual reality visualisation. Currently available VR softwares mainly support geometric exchange formats e.g. JT, OBJ, STL, VRML etc. In our application Unity is used as VR rendering software, the CAD model is first converted to OBJ model. After starting new project and setting the background environment inside Unity, the OBJ file is placed in the asset directory of the unity project. This file is then pulled in Unity for further processing. Fig. 7 briefly describes the overall conversion process.
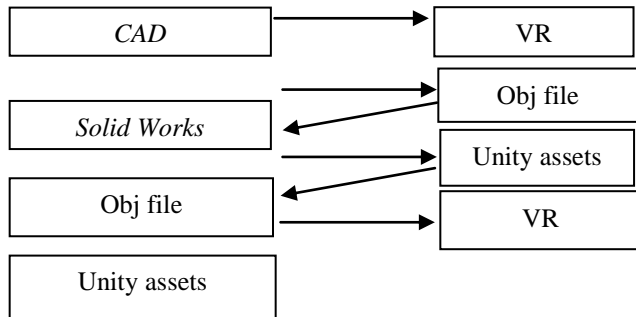

Figure 7: CAD to VR conversion

Environment variable adjustments: After placing the imported model into new environment, different parameters need to be adjusted. Imported model parameters can be changed/adjusted e.g. material, colour, size, position etc. Also variables of the room or place where model is to be placed are adjusted accordingly. Light and camera effects related to visualisation in VR are also adjusted.
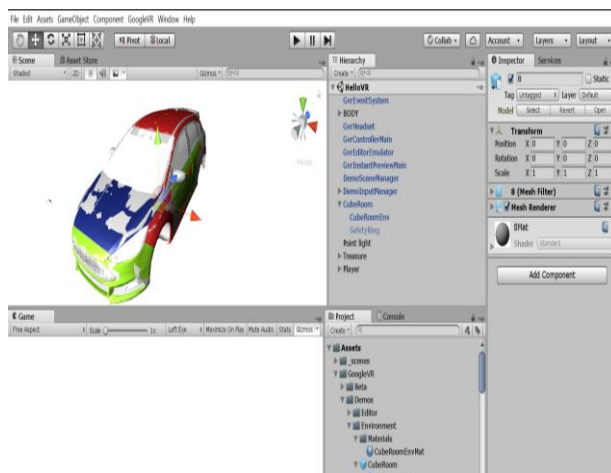

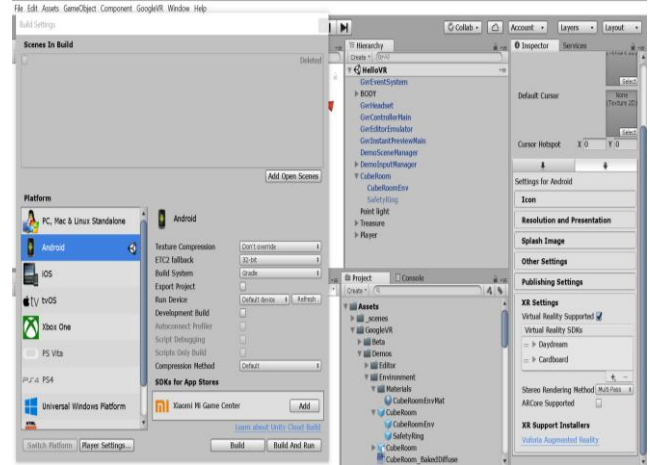**Figure 8: Environment setting in Unity**

Figure 9: Android settings in Unity

Android build settings in Unity: We want to use an android phone for the visualisation; it requires build settings in Unity to be changed to android platform. PC settings are changed to android and player settings are also changed. After finalizing the setting, app is pushed in the android mobile for visualisation. App push is performed by connecting the phone to computer and then by building the project in unity.

Visualisation of CAD model into VR:
1) 2D visualisation
Initial visualisation of the model in the 2D environment can be seen in the camera rendering window by using "build and play" option inside Unity. Maximizing the window can help in better 2D visualisation.
2) 3D visualisation
For 3D visualisation, two different techniques can be used. First technique involves visualisation using 3D screen with polarized glasses e.g. in CAVE type VR system or in power wall. Other method is use of VR headset or Google cardboard. By placing the model in the VR better 3D visualisation can be achieved.
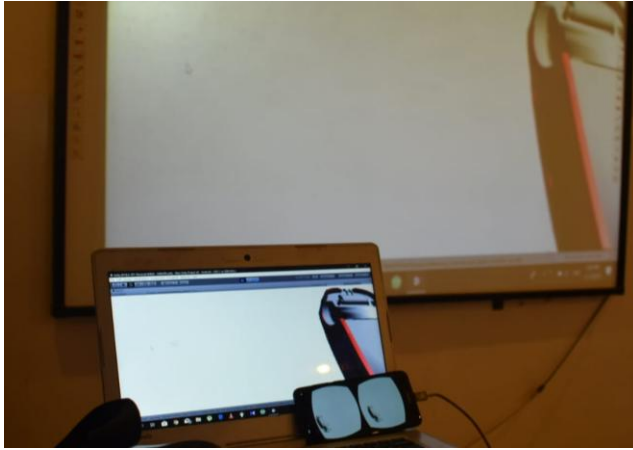

Figure 10: 3D VR headset visualisation

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Figure 11: Control through computer or mobile

RESULTS AND DISCUSSION

VR control: Visualisation in the VR can be controlled using the input from computer key board, computer mouse or from attached android mobile.

Build and Run: In "build and run" computer push the program to a Smartphone. Smartphone is then placed in the VR headset and viewed by moving head in different directions for visualisation.
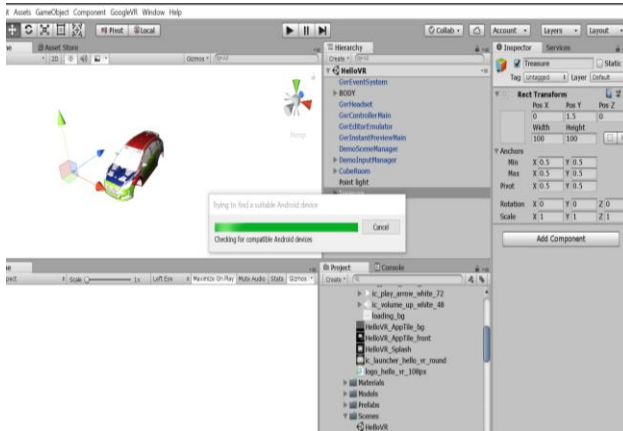

Figure 12: 3D VR headset visualisation

Unity Remote: In instant preview, Smartphone is connected with computer and unity remote 5 android app is installed in the Smartphone. After that Smartphone automatically installs instant preview and visualization is started.

1)   Computer control:
GvrEditorEmulator prefab from GoogleVRCore is used in unity to split the visualization screen in two parts. Computer control is turned on in Unity. By pushing the play button, project can be seen on the Smartphone and it is controlled through computer.

2)   Smartphone control:

For Smartphone control GvrEditorEmulator is turned off and GvrControllerMain is turned on. In this case, the project data can be visualized on Smartphone and computer but it will only be controlled from Smartphone.
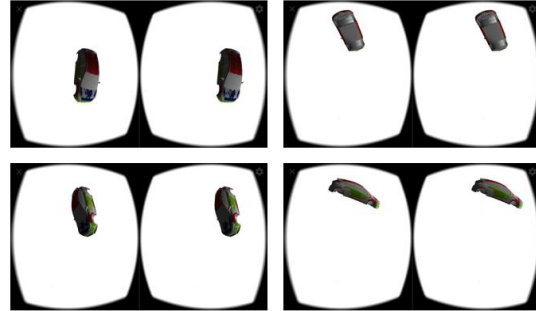

Figure 13: Different views using unity remote

Model variation for visualisation: Since geometric model is transferred from CAD to Unity, for quick visualisation model is rotated. This will help in visualizing the model from different point of views without incorporating the controls.

Figure 14: 2D VR visualisation

Conclusion: This article has discussed VR technologies and their applications in detail. It is evident from this research that VR technologies can be used effectively in the automotive design process. By using VR headset, a 3D method is developed that is quite cost effective. Moreover, visualisation using VR can render the scene quite closer to the reality. As quick transition from conventional to electronic automotive is happening, VR technologies will enhance the efficiency in designing process by reducing the errors that may arise during development and manufacturing. In the end it is concluded that future design and development processes can be reshaped by the use of the VR technologies. It is recommended that model finish should be of high resolution so that a perfect visualisation is to be achieved.

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