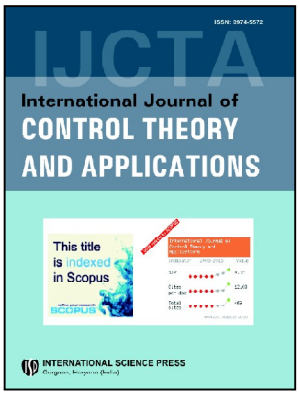

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Designing Interactive 3D Modelling of Virtual Welding System from CAD to VRML

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Abstract: The great challenge is to use a right design tool to convert final Computer Aided Model (CAD) model into virtual model, this model is computed to obtain interactivity between CAD welding model and Virtual Reality (VR) tools in Virtual Reality Modelling Language (VRML). VR has an inbuilt potential of influencing peoples mind with a best 3D experiences. Using 3ds max 9, three dimensions (3D) welding model and its visualization with high quality can be viewed in virtual environment. The 3D virtual welding model satisfies user both practicality and interactivity with a 360 degree viewer VR headset. This paper focuses on designing interactive modelling of metal arc welding setup using 3ds max 9 tools and techniques such as scene model, code generation, interactive programming based on controlling viewpoints, communication between VRML and scene model., also highlights the features of VR headset for a better 3D experience in virtual world.

Keywords: Virtual Reality, 3ds Max, VRML, Modelling, Aura VR Pro

I. INTRODUCTION

Virtual Reality is a computer simulated technology used to create objects in an interactive 3D environment. VR provides the effect of real existence without actually having a real existence [1]. The basic difference between conventional 3D computer graphics and VR is computer graphics works on picture of things while VR works on things itself [2]. Interaction between the objects and the software to obtain perfect interaction is one of the important characteristic of virtual environment [3]. VR satisfies the user by providing sound and tactile feedback with immersions of vision. VR is an innovative form of human machine interaction which is beyond touch screen, mouse and keyboard. Interaction can be obtained with full visual immersion using VR. There are two major components of immersion i.e. depth of information includes quality, resolution and effectiveness of audio and video and breadth of information includes sensors [4]. Implementation of VR uses helmets, gloves, goggles as interactive devices [5]. The principle of Virtual Reality system is to track the physical movements in the real world, then a rendering computer redraws the virtual world to reflects those movements and the updated virtual world is sent to the output (i.e. user in the real world). In this case, the output is sent back to a head mounted display. Hence, the user feels "immersed" in the virtual world as if user is in the real world itself. The rendering movements of both hands with VR gloves in the virtual world as shown in Figure 1.

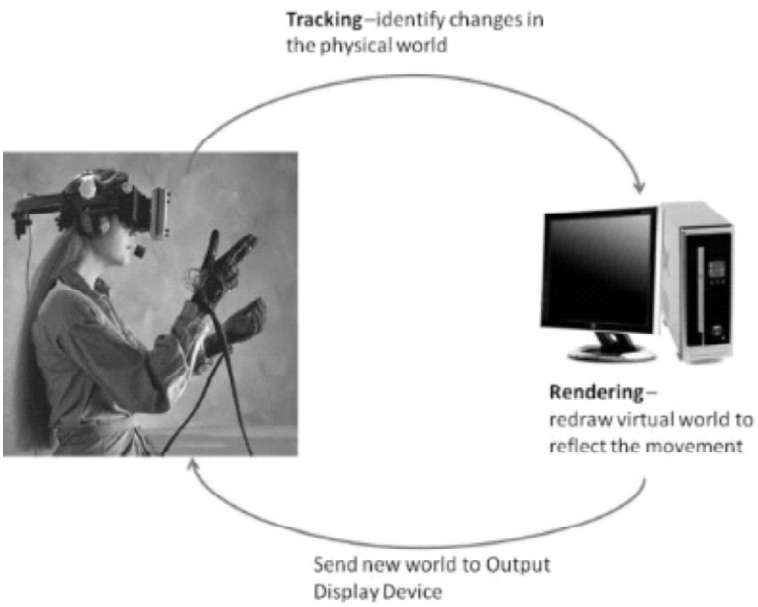


Figure 1: Virtual Reality Systems

The aim for virtual reality programmer is more interaction, more realism creates demand compared to an average computer programming developers [6]. Modeling VR world by programmers and users concentrate more on optimizing the code that describes virtual environment for recurrent demands. [7]. VR modeling process is more than a creative challenge thereby programmer must think various methods to reduce the modeling process time and correspondingly to achieve the necessary level of interaction. The best forthcoming solution for achieving interactivity is to combine the use of various VR tools with the creation of high quality models [8]. 3ds max 9 is a tool that gives exposure for modeling in lesser time compared to other CAD tools and also helps in achieving interactivity in 3D models where Virtual Reality Modeling Language (VRML) world database can be generated.

AuraVR Pro is a high quality VR headset 3600 viewer device from the pioneers of Virtual Reality. This VR headset is used for enjoying VR Games, Videos, 3D Movies, photosphere images and VR content on android smart mobile phone. The design and quality material is used for immersive viewing even the single ray of the light is not allowed to seep. It also have different face structures, some have round while others may have oval or oblong so that Aura VR headset fits. Lenses can be adjusted according to individual eye sight and face structure using Inter Pupillary Distance (IPD) controller and distance adjuster. The AuraVR Pro Virtual Reality gear is stimulated by google cardboard and certain features of oculus rift and also offers superior durability and technical specifications compared to google cardboard, VR Box, gear VR and loop VR. The Aura VR headset has an integrated head tracking system, making the movements quite untethered and permits a user to see 3D or digital content as shown in Figure 2.

Figure 2: Aura VR headset

II. MODELLING OF VIRTUAL WELDING SYSTEM USING 3DS MAX

2.1. Motivation

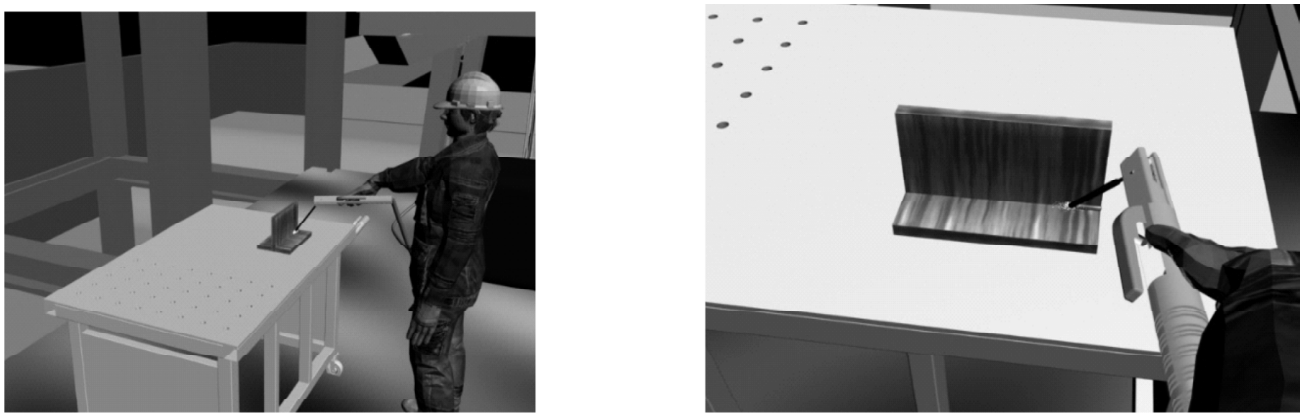
Modelling is the first part for a user to create VRML world and there are three ways to do the same. First, is to visually create and edit the virtual environment using 3ds max tool. Second is to create and edit VRML code using notepad. Third is to make use of combining tool and the editor. The main objective is to create high quality interactive 3D virtual welding platform model in virtual environment using 3ds max tool which helps in minimizing modelling time, debugging time in coding and also increased the quality of the model in VRML world [9].

2.2. 3ds max

3ds max is an integrated environment for creating a photorealistic still images and professional quality 3D models which supports and creates beautiful suitable background for various kinds of 3D objects. The tool can create varieties of objects and characters in an environment where animated setting is obtained which performs motion and at the same time forms the basis of a scene model where entire virtual world can be captured as a film sequence. The greatest advantage of 3ds max tool is to create a wide range of modelling techniques starting from simple polygon models to modelling complex features to mesh modelling in less modelling time [10].

The present work consists of three steps to create VRML code for interaction of virtual world to real word they are:

(1) Design of basic geometry of VR welding platform. (2) Different textures are used for improving user's perception of reality in the model. (3) To complete the scene model, various light sources are to be used for illumination of the model. Cameras from the software can be fixed to obtain various viewpoints of the VR welding model. Figure 3(a) shows a virtual reality welding platform model created in virtual environment including the modelling of worktable, welding machine, wire, electrode and electrode holder with a human model with rendering all the features of human being for realistic experience in virtual world. Figure 3(b) shows the virtual model of workpiece for welding created using 3ds max tool.



(a) (b)

Figure 3: (a) Virtual Reality Welding Platform (b) Enlarged view of workpiece model in virtual environment

In the present virtual reality welding model, lots of helper objects are used to make the complex scene model. Construction site are created using elementary shapes such as boxes and cylinders. Other virtual models are handled with live photographs where the textures are used. In human model textures are imported from an external source to achieve high level of realistic feeling in virtual environment.

2.3. Implementation Methodology

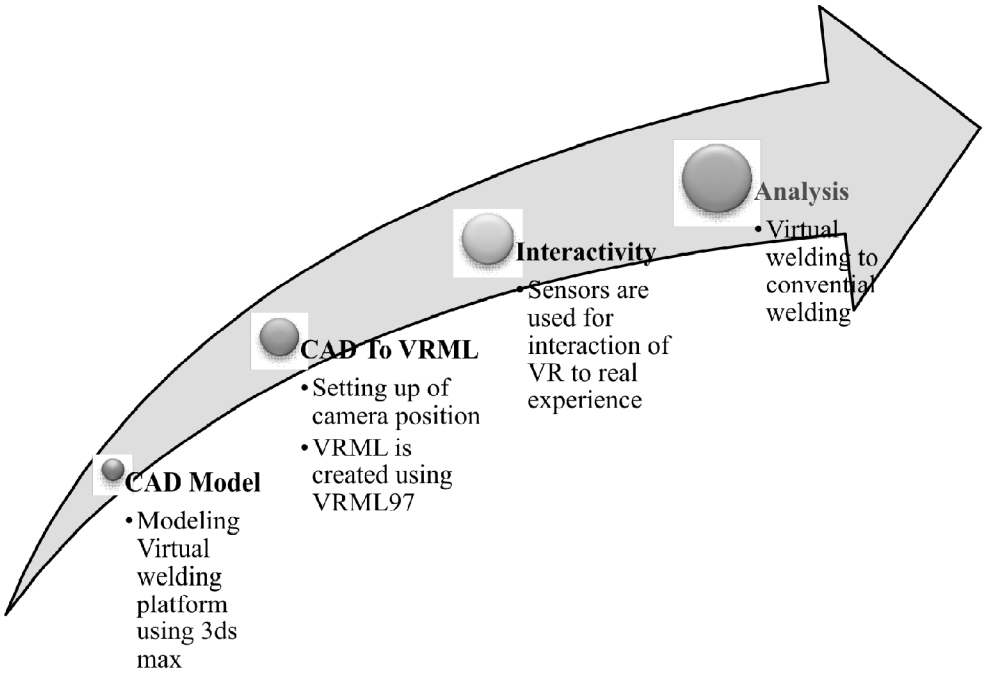


Figure 4: CAD to VE Approach

III. VIRTUAL REALITY MODELLING LANGUAGE

3.1. Introduction to VRML

VRML is an ASCII based open language which is adopted by International Standardization Organization. VRML97 supports animation, spatial sound, scripting, sensor and collision detection. VRML file is used in virtual reality consists of mutiple tree of nodes. The other name for VRML is Virtual Reality Markup Language. VRML follows human space where the 3d space defines the ways to move in, recognise and interact with virtul environment [11]. The first part of VRML, virtual reality, describes the geometry which creates the objects and space to move in around with light, texture and sound effect from different positions that are the essential things for making the virtual world. The second part of VRML, modelling language, describes the process of making a virtual world for metal arc welding. VRML browser is used to view scripted VRML where the programs for the 3d models are designed and created in a graphical format which finally constitutes virtual world. The advantage of VRML is VRML browser renders the modelling language in real time and turns the code into perceptible space to interact. The importance of 3ds max tool is to produce high quality 3D models in a modelling environment and interactivity using VRML helper objects. The VRML helpers helps in creating 3D scenes and dragging at the desired location with interaction using Virtual Reality Markup Language [12]. The predefined helper objects with functions are as follows:

- Anchor helper which specifies a click-to-play trigger in the scene which function the triggering effect to a currently existing object in the scene.
- Proxsensor helper creates a ProximitySensor node that sets up a rectangular region in space for animating.
- Navinfo helper creates a Navigation Information node that helps to navigate around the virtual world.

- Fog helper specifies the color and range of fog that can simulate atmospheric effects by blending objects with a color based on the objects' distances from the viewer in virtual worl and to obtain the best visual results, the background should be the same color as the fog. The Sound helper represents ambient sounds in a scene.
- Level of Detail (LOD) helper is used to specify objects with varying face counts that are appropriate for different viewing distances.
- TouchSensor helper represents an area of sensitive space that when touched by user.
- TimeSensor helper provides time-based animation controls, such as the start and end frames for a particular object's animation and looping.
- Background helper has Sky Color, Ground Color, and Images rollouts which uses rollouts to specify colors and images for the sky and ground in virtual world.
- AudioClip helper specifies the name and characteristics of an audio file.
- Billboard helper helps in creating geometry that is camera-aligned in the VRML browser.
- Inline helper functions at brower level only where one can obtain instant objects.

3.2. Exporting 3d objects from 3ds max tool to VRML

The final process to obtain virtual reality model for interactivity is to export 3d virtual metal arc welding model to VRML file. i.e once the model scene is created and corresponding cameras are in place, the virtual welding model scene is ready to export to VRML file. 3ds max has an inbuilt capability to create corresponding VRML file (.wrl) which is compatible with the VRML97 standard [13]. Figure 4 shows the VRML97 exporter for camera 02 position with respect to quadrilateral (Quads) polygons.

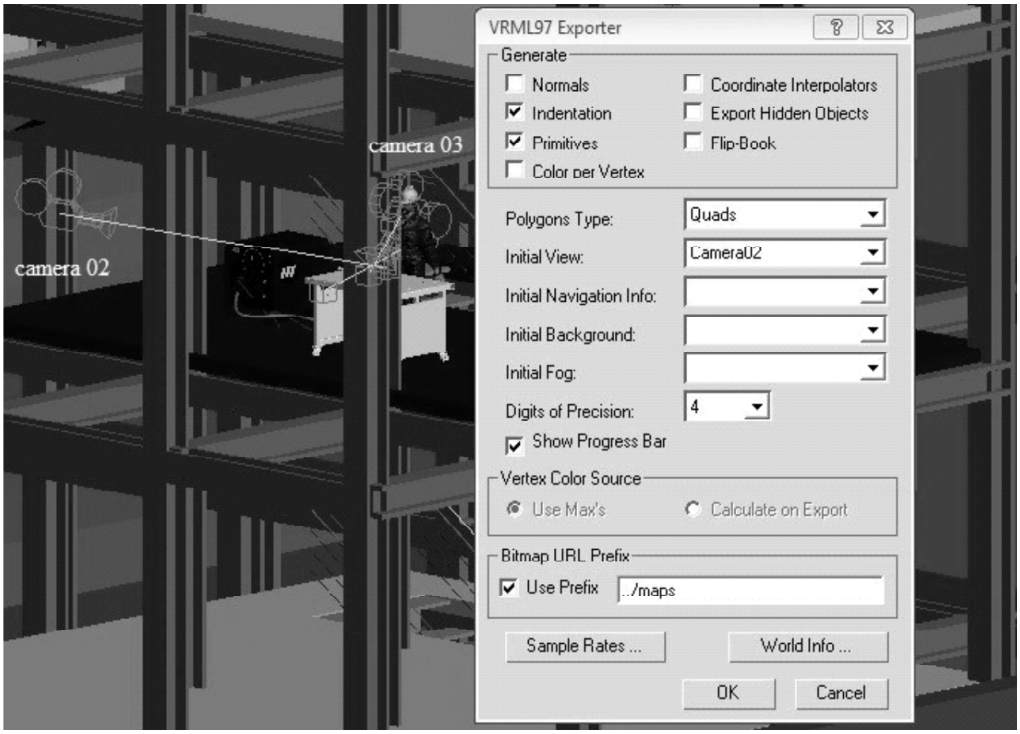


Figure 5: Exporting 3d VR Welding Model to VRML

The user has an opportunity to configure a number of important parameters in the VRML97 Exporter dialogue box while exporting to VRML which is explained as follows:

- Normals – It generates real normals for welding workpiece to obtain smoothing effect.
- Coordinate Interpolators – It helps in exporting animation effects that involve actual modifications of the mesh objects.
- Indentation – It indents the VRML97 code to read in a easier way.
- Primitives – By using primitives it reduces the file size as it is very simply defined.
- Flip-Book – It helps in exporting the model scene to multiple files.
- Polygons Type – it is very important while exporting the model to VRML97 exporter which determines how geometric faces are written out as VRML97 IndexedFaceSet nodes such as Ngons writes faces with as many edges as possible, Quads uses quadrilateral faces where possible, Triangles uses only triangular faces and visible edges breaks faces at internal edges that are marked as being visible.
- Initial View - Sets camera 2 for the capturing scene and controls what first appears in the browser and sets default viewpoint if camera is not placed.
- Initial Navigation Info – It specifies the Navigation Info helper object to use in VRML browser.
- Initial Background – It specifies the Background helper object to use in VRML browser.
- Initial Fog – It specifies the Fog helper object to use in VRML browser.
- Digits of Precision sets the number of decimal points used for calculating dimensions and the default of 4 is usually preferred.

3.3. Computing Virtual Reality Welding Platform using VRML

The VRML code is created using VRML text version 2.0 syntax which uses Universal Character Set Transformation Format 8 bit (uft8) encodes 24,000+ characters for many languages. If several shapes have the same geometry or appearance, you must use multiple duplicate nodes. All shapes are built in a coordinate system where transform node creates a new coordinate system relative to its parent. Transform node functions translation, rotation and scale syntax. Rotation syntax uses right hand thumb rule. DEF defines a name for first occurance of a node and USE syntax helps in sharing the same node in a new context. Several syntax are used such as an appearance node controls overall shape appearance, material node controls overall material properties including shading color, glow color, transparency, shininess and ambient intensity. The following coding shows a VRML scripting file for a virtual reality welding model.

```
#VRML V2.0 utf8
# File Name: Virtual welding DEF Camera02 Viewpoint {
        position            1.082e+005      9010        -3207
        orientation         0.9996          -0.02617    -0.01174    -0.8435
        fieldOfView         0.6024
        description "Camera02"
}
DEF C_Ext25 Transform {
        translation         1.13e+005       0 -5387
        rotation            -1              0           0           -3.142
        children [
        Shape {
```

```
                    appearance Appearance {
                    material Material {
                    diffuseColor    0.3451          0.5647          0.8824
                    }
            }
            geometry USE C_Ext01-FACES
            }
]
}
DEF Railing01 Transform {
            translation     1.056e+005                      -1070           -1186
            rotation        0               1               0               -1.571
            children [
            Shape {
                    appearance Appearance {
                    material Material {
            diffuseColor    0.1098          0.5843          0.6941
}
DEF Mesh390 Transform {
            Translation     0               0               0
            children [ Shape {
                    appearance Appearance {
                    material Material {
                            diffuseColor            0.7529  0.7529  0.7529
                            ambientIntensity        0
                            specularColor           0       0       0
                            shininess               0.05
                            transparency            0
                            }
                    }, , , , ……................
```

3.4. Virtual Reality Interactivity

Interactivity in virtual worlds traditionally means make use of three of five human senses namely vision, hearing and touch. Perceptions of space and interaction with objects located in virtual space is sensed by combining targeted impressions. An element of interaction for a user to feel truly is by immersing within Virtual Environment (VE). VE systems allows user to have a relatively passive experience where user can see a movie by wearing a head mounted display(HMD)[14]. Using google card board software an user can feel a sense of immersion but interactivity was limited to shifting their point of view by looking around where the path in the inbuilt software is pre defined and unchangable. Using standard predefined VRML sensors one can obtain user interaction in VRML world. Sensors can be considered as special kind of nodes designed to react when properties of the sensors operates in a predefined way.

IV. VIRTUAL REALITY GLASSES

4.1. Introduction to virtual reality glasses

AuraVR Pro VR Headset is manufactured and assembled from finest quality plastic which becomes more durable and light in weight. The design of AuraVR headset is highly appreciable by researchers, customers and industry

users as it gives successful result [15]. AuraVR is inspired from oculus rift, google cardboard because it supports varieties of android smartphones. The unique features of AuraVR headset allows the user to adjust the IPD and the distance between the lens and the screen for better focusing in which both the lens can be adjusted independently and individually also [16]. The recent technology known as one finger phone insertion mechanism is used that makes the user to feel easier while inserting the phone into the device and to experience immerse viewing capability. AuraVR glasses have air vents and also removable front lid for heat dissipation from continuous usage of smartphones [17]. Lenses are the most important part of the VR headset and it uses improved nano coated optical resin 42 mm lenses and 1000-1100 FOV (Field of View).

4.2. Structure of an AuraVR headset

The AuraVR comes with three sets of lenses. First lens is to be used by people who have excellent long sighted eyesight as the VR goggles is focused at infinity. The second and third lenses are to be used by people having problems with near sightedness, though cannot be used by all, especially people with major vision complications. The major parts of virtual reality headset are lenses, display and tracking technology. An exploded view of a rendered Aura VR glasses is as shown in figure 5.

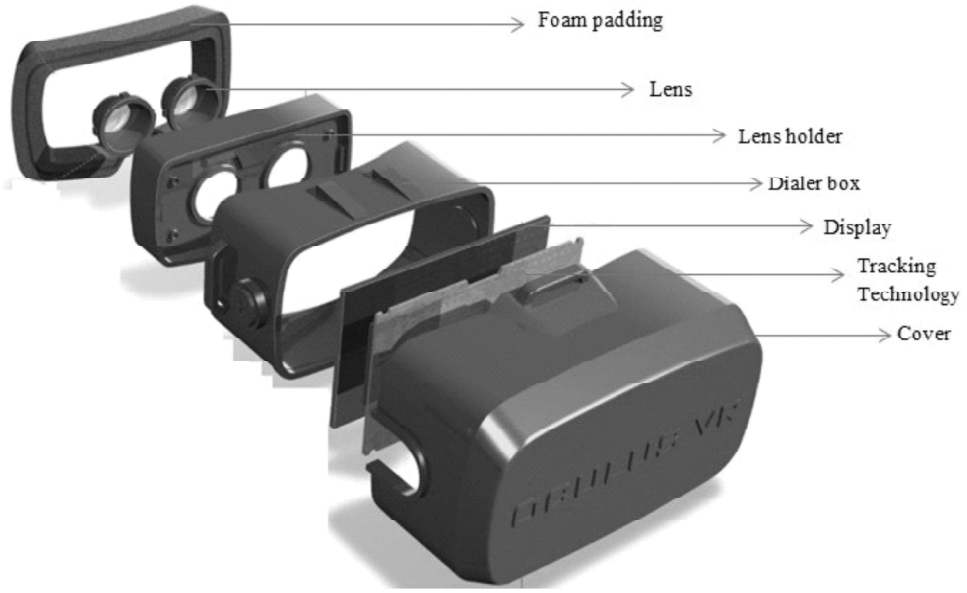


Figure 5: Exploded view of rendered AuraVR glasses

Lenses are used to establish a focal point is critical to perceiving depth. The user's eyes are staring beyond the display and into the virtual environment. Display gives high-resolution screen that sits just a few inches from a user's eyes projects a stereoscopic image or two warped images on each half of the screen. In other words, when the warped 2-D images are viewed in close proximity, users are tricked into believing they're standing in a virtual world. Tracking technology comes with the headset equipped with more than a dozen sensor inputs such as a gyroscope, accelerometer and compass that track the location of a user's head. External infrared sensors and a camera are involved by the designers to increase positional accuracy and monitoring.

V. CONCLUSION

To achieve the best in class quality of CAD modeling and converting into virtual world can be obtained with interactivity using 3ds max 9 tool. The capability of 3ds max 9 has an in-built objects and helpers for creating

essential insight of interactions and provides an excellent modelling environment for creating 3d interactive models with the competence of computing VRML script. Benefit of using VR devices such as Aura VR headset helps to accomplish real time complex animation system and an exposure to AuraVR glasses with its working helps the user to feel the virtual environment. Finally the advantage of using rapid code development by the programmers is to achieve lesser life cycle development and easy way of maintenance of developed systems from basic computer aided programming development to 3d model development and rapid prototyping.

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