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Visualization of Heliostat Field of Solar Thermal Tower Power Plant Using Virtual Reality (VR) Technologies †

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Abstract: An important part of future global energy depends on the development of the solar industry. To date, we have noticed the shift from fossil fuels energy towards renewable energy. The past decade has shown significant progress in computer science, and CAD is increasingly used for design and development. Visualization of the data generated from the models in the CAD program plays an important role in the creation of state-of-the-art designs. An important limitation during the design phase is the visualization of three-dimensional geometry. This article attempts to illustrate the use of VR technologies in solar thermal power plant development. This article analyzes various strategies and methods for the visualization of CAD models in virtual reality. Android phone interfaces with a desktop computer, as well as head movement control strategies, are discussed. It is concluded that VR technologies can help with visualization, as well as in the development of the field of solar thermal power plants, having minimal design-related issues.

Keywords: virtual reality; solar thermal power plant; design; CAD; heliostat

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1. Introduction

VR is one of the major fields of study where we can attain every design with its maximum output by computer-generated virtual relations. The latest innovations in virtual reality content platforms, hardware, and production tools have transformed virtual reality into expertise developed primarily in the video game community [1–4]. To create models that simulate visual effects and interact with processes, three-dimensional and virtual modeling methods are used [5,6]. When modeling three-dimensional environments, content should be displayed explicitly when objects are displayed, and the details of each of these objects should correspond to the goals that the designer intends to use with each specific model. In addition, due to the possibility of interaction between all parties participating in each constructive event, the use of VR technology can increase the efficiency of the model, such as for solar thermal tower power plants [7–9]. Virtual reality allows users to recognize real situations by providing an environment for receiving information in multiple sensory modes such as vision, hearing, and exercise [10–14]. For example, if you are a person, you can walk into the lobby. Therefore, the user's perception of the virtual reality environment depends on possible actions [15]. Virtual reality allows users to enter almost-replicated scenes depicting the situation. The situation is created as a virtual machine graphical environment that can be added online to a virtual world and displayed on immersive systems such as screens or head views. This is especially useful when calculating the depth of a user's true view. In addition to signal recognition algorithms, a

tracking system can also transform normal body movements into functional interaction methods [16–20].

2. Heliostat Modeling

The modeling of different types of designs is carried out with the help of computer-aided design (CAD) software. Surface or solid modeling can be performed on software such as CATIA, SolidWorks, ANSA, etc. which will also be helpful in the field of analysis. As the assembly is made, it will help us to understand its geometry and body kinematics, which will be helpful in a detailed study. VR software accepts different types of exchange files such as Obj, VRML, STL, JT, etc. which will be converted from a design format into this format using different software.

3. Modeling to 3D Visualization

If a CAD model is to be visualized into a 3D visualization, then it is necessary to understand every step to bring its format to the 3D world. First, it must be understood which file formats are required by Unity. Unity is then used for its model development, and after that, it is pushed for 3D visualization. The headset can be used for the visualization of the CAD model of the solar thermal tower power plant's heliostat.

3.1. Steps Involved for Modeling to 3D Visualization

For 3D visualization, different software can be used, but one should be used that will help us to understand every step of the kinematics in Unity. Geometry exchange formats such as VRML, OBJ, JT, STL, etc., are supported by presently available VR software.

3.2. Domain Flexibility Adjustments

For environmental variations, 3D Cube is used for its ground visualization, and its material is changed according to user demands. Static and dynamic friction has been brought to zero, which helps the smooth movement of different objects. Ground width and length are selected according to the desired area. In the field in which the model is placed, its variables are also altered appropriately. Other factors such as light and camera position, which affect visualization, are also fine-tuned as shown in Figure 1.

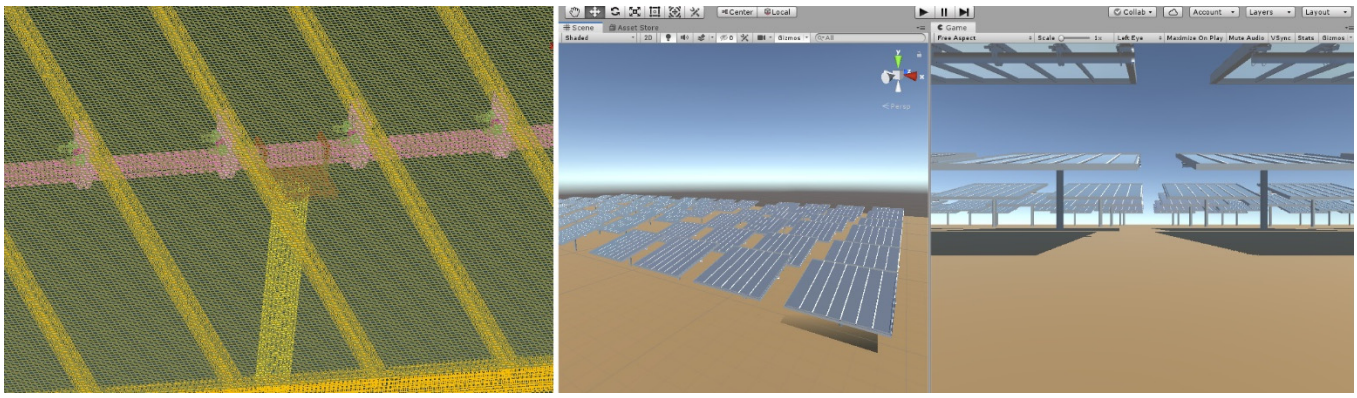


Figure 1. (**Left**) Heliostat Solar Obj. Model (**Right**) Environmental settings.

3.3. Player Settings in Unity and Smartphone

An Android Smartphone is used to visualize; build settings are altered to Android in Unity. The smartphone is changed to developer mode to push an app to its domain. Player settings are changed by changing them to the Android nugget set, and PC settings are alternated to Android. After settings are finalized, the app is pushed to the Android Smartphone with the help of Android Studio so the model can be visualized as shown in Figure 2. The app is pushed by connecting the Smartphone to the computer with the help of Unity.

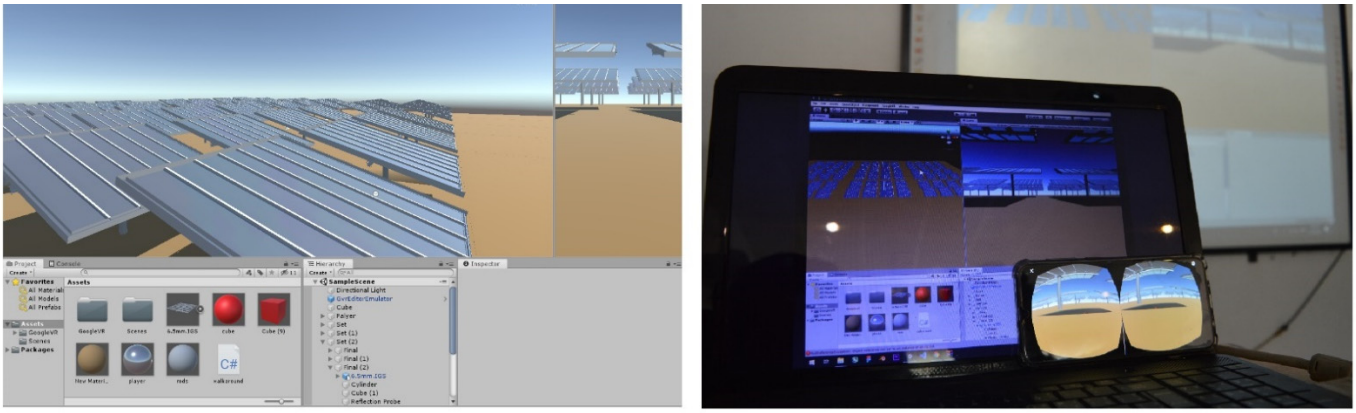


Figure 2. (**Left**) Visualization of solar field; (**Right**) Smartphone and computer control.

3.4. Visualization Methods

3.4.1. 2D Visualization

By utilizing the "build and play" feature inside Unity, the model can be visualized in the camera rendering window in a 2D setting as shown in Figure 2.

3.4.2. 3D Visualization

Two techniques can be used for three-dimensional visualization. In the first technique, a three-dimensional screen is used with polarized glasses for visualization. Examples of this include cave type or power wall. The other technique involves using a VR headset, such as Google cardboard. It is evident that visualization in 3D is much better than in 2D.

4. Movement Control

Three main properties are used to move the player or camera inside Unity. For that camera, a script is added to move it for the required motion function.

4.1. EulerAngles

Euler angles give the player or camera rotation around its axis. This code enables us to visualize the environment in all 360 degrees. Instants at the back can be seen easily.

4.2. Charachter Controller

The character controller moves the character without the use of a rigid body. It is limited when there are collisions, but it is not affected by environmental forces.

4.3. Simple Move

Mono behavior of the controller is given, which updates the speed of the controller and rotation speed. It is set accordingly so that it does not speed up or slow down.

5. Input Methods

5.1. Smartphone Control

In Smartphone control, the main focus is the combination of Smartphone and headset, in which movement is controlled by the Smartphone.

5.2. Computer Control

For controlling the view in the Smartphone through a computer, computer control is used. This helps place the objects in a required place in the correct view.

6. Conclusions and Recommendations

This article discusses VR technologies and detailed applications. This study demonstrates that VR technology can be effectively used in solar tower power plant components'

design processes. An inexpensive 3D method was developed using a VR headset. In addition, using VR for visualization can bring the scene closer to reality. VR technology improves design efficiency, minimizing errors that can occur during development and production. Other advantages of this technology in the field of CSP are: heliostat shade visualization, cleaning strategies, space optimization, and maintenance strategy. Finally, it can be concluded that future design and development processes can be redesigned using virtual reality technology. High-resolution models are recommended for perfect visibility.

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