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VIRTUAL REALITY VISUALIZATION FOR COMPUTATIONAL STUDIES

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Abstract
Background Virtual Reality leverages the user's intuitive skills for 3D navigation which can be used in gaining new insights and ideas from simulation data. Uncovering an otherwise overlooked Visualization is easily accomplished by VR and AR (Augmented Reality). The objective is to create an environment to post- process the Computational results in an in-house Virtual Reality Device and to create an algorithm like approach to integrate with currently available post-processing tools seamlessly with VR device or AR device. In the context that the data for visualization being provided.

Index Terms--Augmented Reality, Computational results, Post-processing, Virtual Reality, Visualization.

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INTRODUCTION

Computation is a methodology of calculation of a type of result respect to any subject that is inclusive of a combination of arithmetical and non-arithmetical series of steps and thereby follows a model that is well-defined, an algorithm can be taken as an example.

The study of computation is highly prevalent to the discipline of computer science. Computation is mostly attributed to a physical anomaly or phenomenon which occurs inside a system particularly a closed physical system referred to as a computer. Some of the physical systems (computers) that can be considered are digital, analog, mechanical, DNA type, molecular, quantum type, microfluidics-based, or wetware computers.

A branch of theoretical physics, along with the natural computing field has embraced this computational physics. The digital physics hypothesis is a pan-computation that discusses that the evolution of the universe can itself be termed a computation (which is a radical point of view).

Computational fluid dynamics (CFD) makes use of data structure and numerical analysis in analyzing and solving fluid flow related problems being a subsidiary of fluid mechanics.

Execution of the calculations which are for simulating the fluid synergy and the free-stream fluid flow with surfaces specified by boundary conditions (for liquids and gases) are performed using computers. Provided the help of supercomputers operated at high speeds, achieving enhanced results can be possible.

The application of CFD can extend in researches at a wide range and in solving engineering problems related to varied industries and fields of study.

During the acquisition of models of objects which are to be transferred from the real world to virtual reality, it becomes mandatory to process large data sets usually unstructured which organized in a specific form will be suitable for further processing. Visualization aids in the process of extraction of new information from the data. Visualization in virtual reality enables an opportunity towards interactive exploration of visualized data and also ensures to gain new knowledge in a specified field of interest. Rahman et al [1] proposed an Augmented Reality based Platform to share virtual worlds in mobile phone for enhancing education.

He states that, the transformation of teaching and learning caused by AR has certainly provided with an exciting opportunity to design learning environment that are real, authentic, engaging and fun. Following this paper, a Mobile application is put forward which uses Augmented Reality (AR) for visualizing the results from CFD in a constrained projection system.

Mixed Reality (MR) was interactive and possessed significant adaptation for post-processing with CFD and understand its results in a better manner and thereby provide information to the experts of the non-CFD background more efficiently.

The immersive technique enables the user in acquiring a rapid, intuitive understanding of the distributions of temperature, pressure, and the flow characteristics of the material properties. These simulations will greatly enhance engineers in obtaining the needed insights in designing and enhancing the industrial processes to the updated level.

DEVELOPMENT PROCEDURE

A. Review Stage

The objective of this research was to develop a system which supports Augmented Reality (AR) for the purpose creating a search engine in Computational Studies like Google. AR is that application used to annotate real world with computer generated graphics and VR (Virtual Reality) is used for generating Virtual world in user environment.

They make the surrounding environment interactive by overlaying digital 3D computable models over and around the tangible objects after getting input from the user.

The computer graphic generation is made using blender and with the engine for AR using UNITY and VUFORIA. App development is done using the Android Studio, thereby high graphical interface for the ease of the user can be designed.

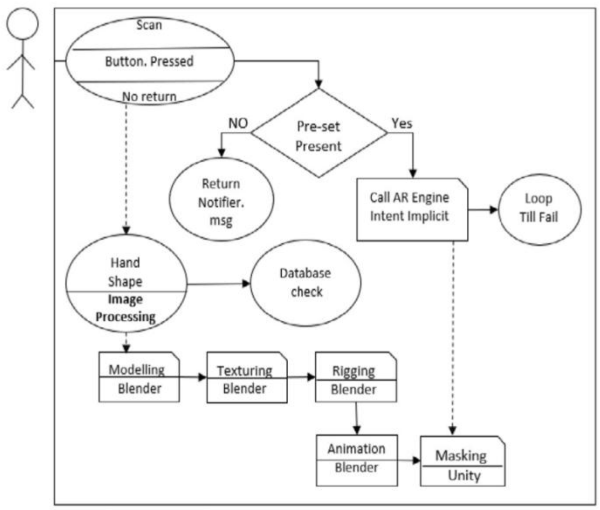

Figure 1. Initial Use-case Diagram

B. Approach towards Modifications

High variety of 3D .obj files were created, and stored in cloud database. The Cycles rendered in BLENDER provides much Realistic Graphics for better understanding and extra sequence for enhanced learning were devised using UNITY Game programming features. This idea was supported by the creation of AR models for springs and dashpot which lead to the start of building computational models.

Later a solution was devised with hands-on in UNITY. Particles were bombarded over an object using Particle Emitter in BLENDER (as an initial step) and the flow was observed. The results obtained were not that accurate as to the expectations. So this narrowed the path towards a case study on CFD software. The allied software was also studied and worked on which includes detailed study on ANSYS and Openfoam.

The outputs from ANSYS and Openfoam were tried to be fed to UNITY but in vain. Then screen casting was a mere failure, so the idea of creating a server/database plunged. The object was sliced as Cut plane and fed all the images into the database for usage. The particular coordinate on the object returns the appropriate image which is a 2D view of the object at that point of view. The computational model was constructed using the blender software from which the computational results are uploaded to the server.

A model was designed for reference. Then using BLENDER software, the baking process is initiated. The pre-computation of the object is noted in detail. Now, BLENDER gives an approximate result. This result is fed to UNITY to produce 3D visualization. Then further guidance was provided

- To cut the computational model at a particular point
- To visualize the model in 3D view with the parameters' action on the model

C. Final Stage

The computational results obtained from ANSYS are exported to PARAVIEW where the mode is changed. This result is further sent to the BLENDER for texturing process and then to UNITY to get the end result which can be visualized in the Virtual Reality. This includes:

- 3D visualization of the computational model with the analysis of parameters
- Locate the pressure points at particular positions of the model
- The end units can be manufactured in an efficient manner since they can be simulated and verified beforehand
- Locate the defect or fault of the device without the need of dismantling it in a virtual environment

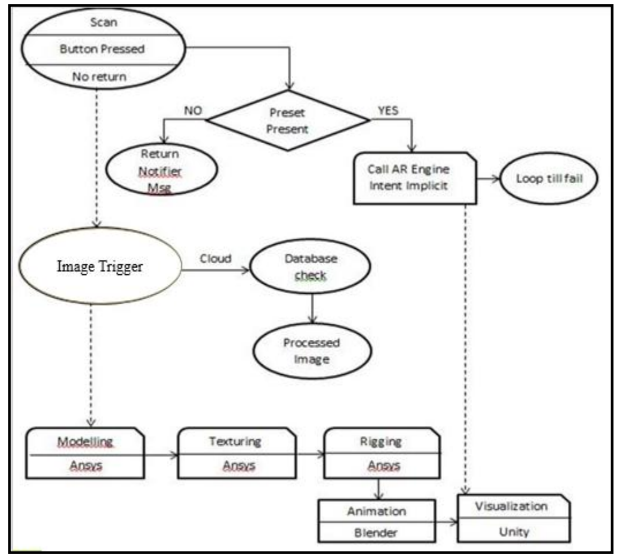

Figure 2. Final Use-case Diagram

RETRIEVAL OF COMPUTED RESULTS

The current situation can be fitted right into an example which is depicted as follows: let us consider a room for instance. The conditions of the same room are given as inputs to the computing software provided the dimensions of the room are supplied to it.

Here the computing inputs include, temperature, pressure, velocity, and much more can be fed into it. The computed result would comprise of the room being exposed to the specified parameters in a 3D model fashion as shown in fig.10 and fig.11.

The results are computed in ANSYS and obtained in the file format of .csv (Comma-Separated Values). The computed results are retrieved from ANSYS in various formats to portray the specified parameters uniquely.

This includes the .csv file format for Streamlines framework view of the computed result, .stlfile format (Standard Triangle Language or Standard Tessellation Language) for Pressure ISO framework view of the result, .case (SlipCover's utilization of file, case cover images made using a program for digital media files; disc case cover designs can be stored; can be used for game titles, iTunes music, DVD and Blu-ray graphics, and custom cases) file format for the Wall Pressure framework view of the result and also as Cutplanes for visualization.

Any of the parameter to be visualized must be extracted from the ANSYS software in the required format and has to be processed using PARAVIEW and BLENDER to be finally sent to the UNITY platform. Here, the final stage of the processing occurs at the UNITY platform from which the computed model is visualized in AR or VR.

D. Pressure ISO Framework

The framework of Pressure ISO is obtained from ANSYS and sent to PARAVIEW as .stl format. This file format is made into a texturing model through change of mode and exported as .x3d (declarative representation of 3D computer graphics can be done using royalty-free ISO/IEC) file format to the BLENDER. This file is exported as blender file to UNITY to be visualized. The flow process is shown in Fig.3.

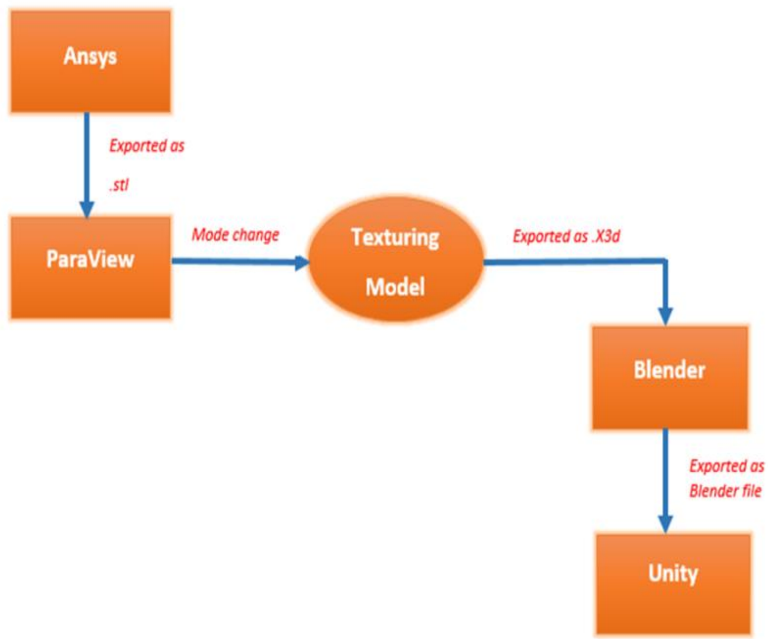

Figure 3. Framework – Pressure ISO

E. Wall Pressure Framework

The framework of Wall Pressure of the computational result is also extracted from ANSYS in .case file format to the PARAVIEW and further exported as .X3d file to the BLENDER software from where the objects and textures of the computed result are exported to UNITY as blender files for the final processing stage. This process is depicted as in fig.4.

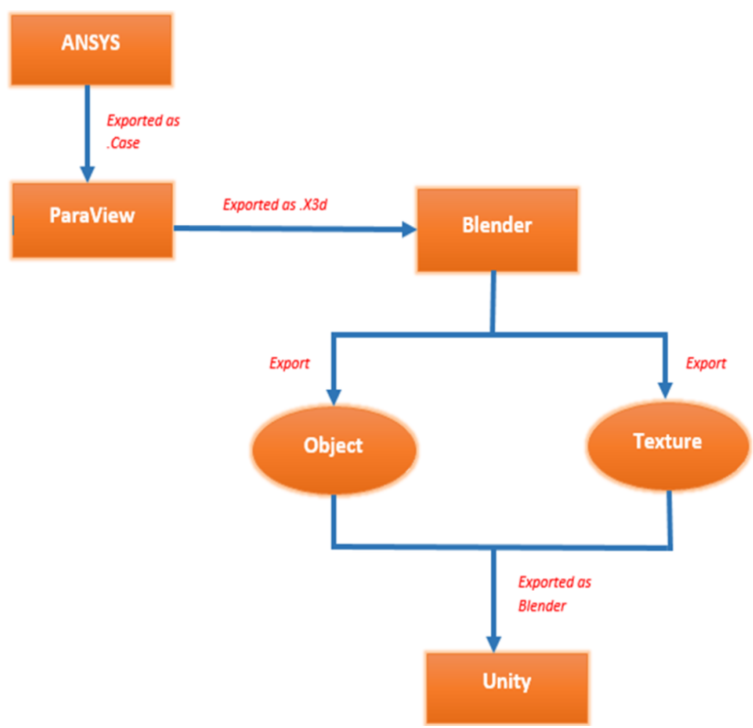

Figure 4. Framework – Wall Pressure

F. Cut Plane Framework

The Cutplanes are required to be created and visualized in order to get hold of the results view at specific points on the axis. So the computed result from ANSYS is extracted as snapshots. These snapshots are taken at the required plane to get the needed view and are stored in a database. These snapshots are stored as image files (that is, .jpeg file in the database) and are exported to UNITY in the same .jpeg format for visualization in VR. This process is described as in fig.5.

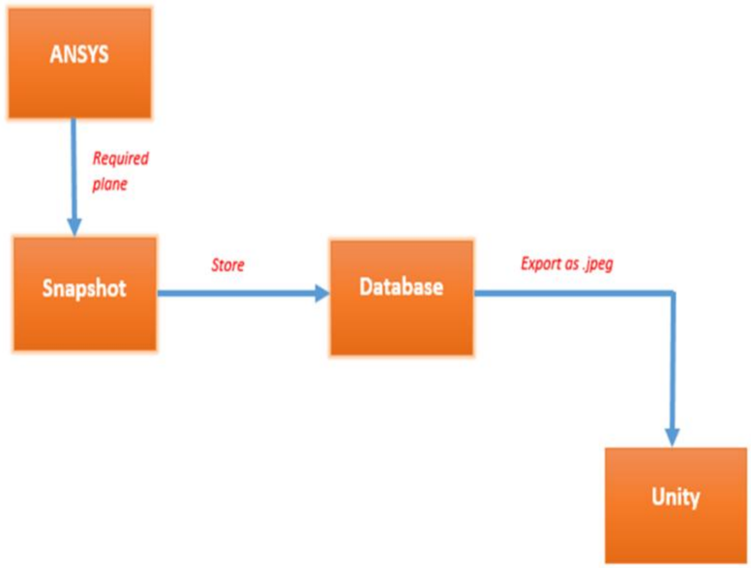

Figure 5. Framework – Cut Plane

G. Streamlines Framework

Streamlines are used to denote the flow of air, water or any other parameter in a specified area of space. They help us to know the pattern of flow which may be required to understand the nature of the particles in motion and this enables us to design an adaptable environment to the flow pattern. The flow process for Streamlines extraction is shown in fig.6. The computed result is fetched from ANSYS in the file format of .CSV and if fed to the BLENDER for texturing of the model. The streamlines are then sent to UNITY as blender file to be visualized in a later stage.

Figure 6. Framework – Streamline

H. Visualization of Computed Results

The ready-to-be results available at UNITY software should be extracted and visualized as a final step of the process. This result is extracted to a mobile app exclusively created to deliver the computed results. This app recognizes the model to be visualized using a trigger image (In our example, Fig.7 shows the trigger image). The model to be visualized is accessed and controlled using virtual buttons which also have their source from the trigger image. The VR box that is to be used as a visualization tool is affixed with the circuit that ensures the wireless reception of the computed result. The control over the model view is enabled through the use of virtual buttons and also through the motion control (using hand gestures). The various views can be selected using a drop-down check box which appears on the screen. Thus the visualization is brought out in VR and the screenshots are available in Fig.8 and Fig.9.

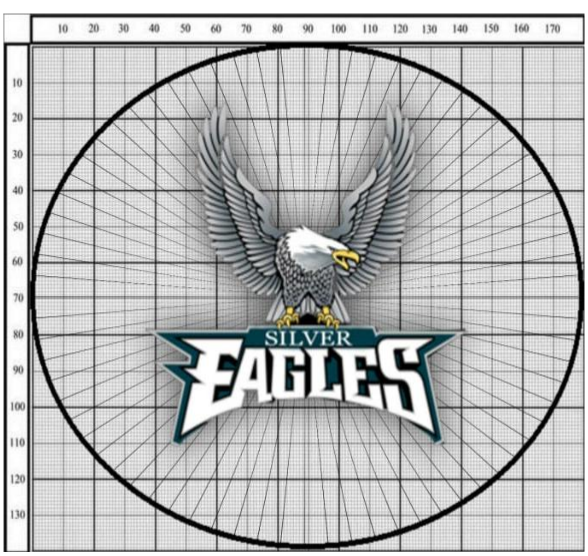

Figure 7. Trigger Image

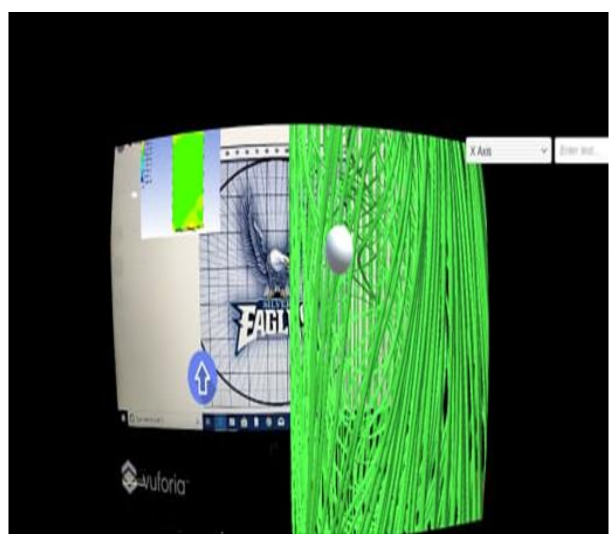

Figure 8. Streamlines View

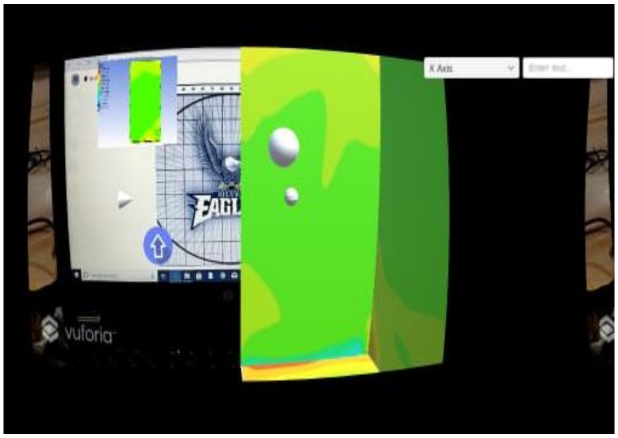

Figure 9. Wall Pressure View

The computed results from ANSYS make their way to UNITY by undergoing number of processes finally providing the users with the VR experience of the points of view. The various views that are to be visualized are provided with the computational results as in Fig. 10.

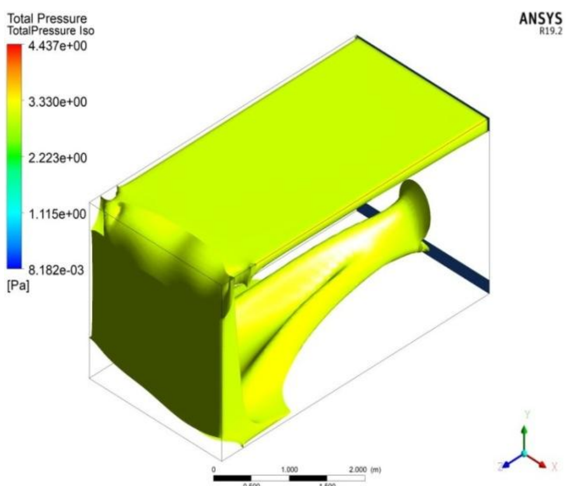

Figure 10a. ISO Surface

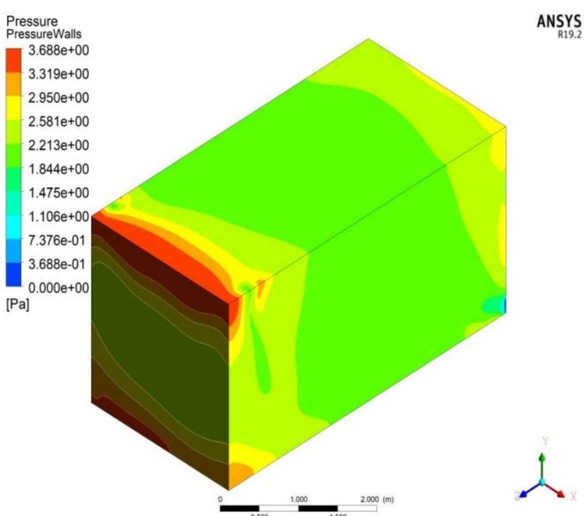

Figure 10b. Wall Pressure

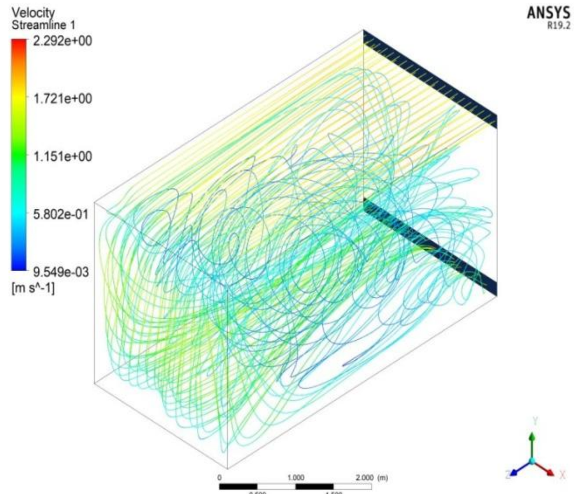

Figure 10c. Streamlines

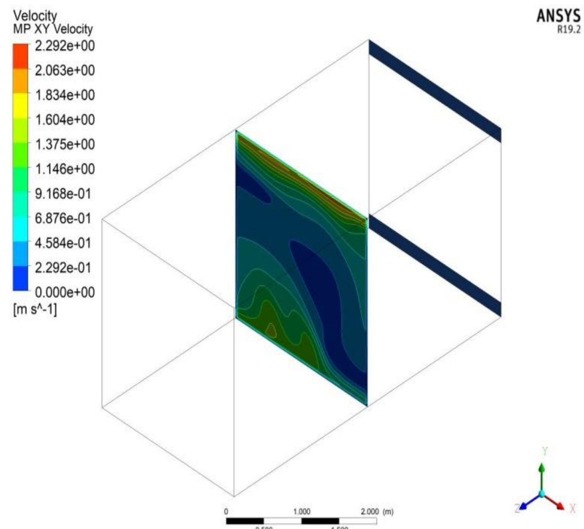

Figure 11a. XY plane

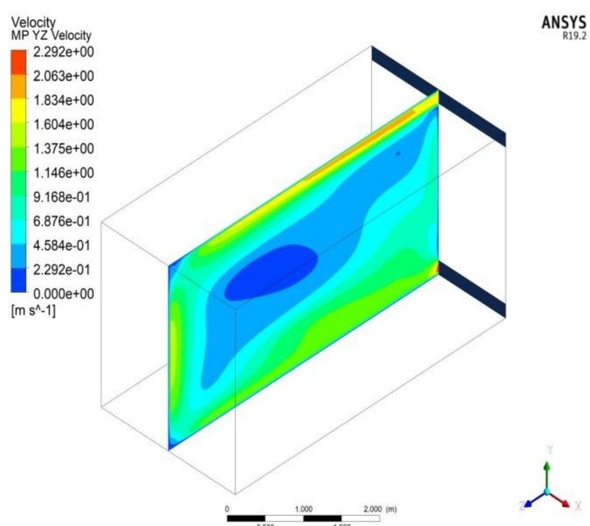

Figure 11b. YZ plane

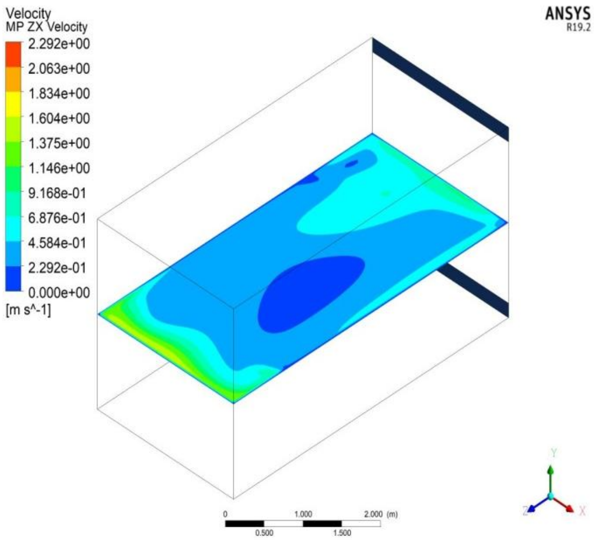

Figure 11c. ZX plane

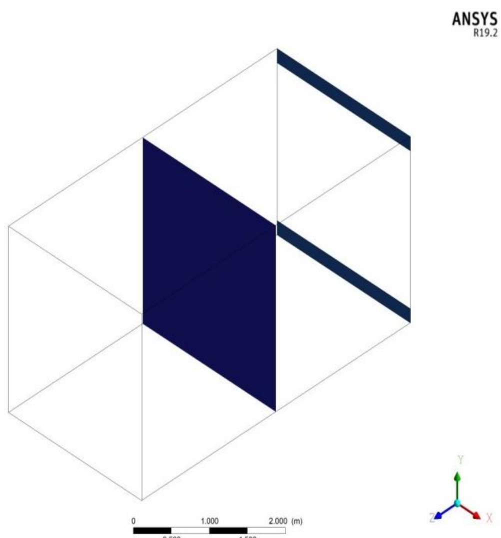

Figure 11d. XY plane

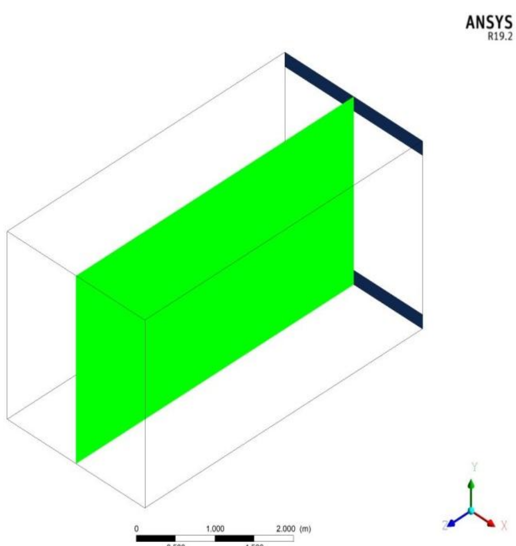

Figure 11e. YZ plane

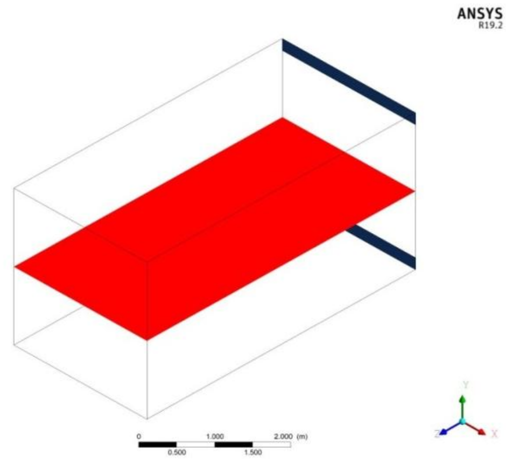

Figure 11f. XZ plane

CONCLUSION

The Virtual reality visualization for computational studies is an application for virtual reality in augmented environment, which is used to provide a better insight for engineers, industrial persons, to promote manufacturing and technology. This application can be extended in future when mobile phones can be replaced by AR glasses and with high speed computing facilities, this solution can be stretched to its next level of reality for computational studies.

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