Unreal Engine / NVIDIA for Automotive Design and Simulation

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Abstract: This paper has investigated the approaches of the past, present and the possible future design techniques that can be used to model, simulate and test automobiles before they can be approved for production in the manufacturing industries. The present 3D modelling techniques using AutoCAD, Solid works and 3Ds Max with the option of 3D printing is analyzed and a better solution for modelling using an upcoming game development engine which has the flexibility of importing data from CAD and 3Ds max into its development environment and also the ability to work as a standalone design software. The Unreal Engine was primarily developed for the production of video games of various genres, but now, with its collaboration with NVIDEA, they have crossed all boundaries by combining virtual reality with a real-time work environment for designing.

Keywords: Virtual Reality, Real-time Simulation, Design Visualization.

1. Introduction

With the development of computer aided design, Researchers have found a flexible way of designing and developing a variety of products without the need for Automated Test Equipment's (ATE). This has provided design engineers endless possibilities to create stunning visuals for Architecture, product design, manufacturing and more. In the past, design engineers did not have the facility to visualize the end product before they were even created. This led to the development of products which had serious flaws or variations from the product which was originally planned and hence, rectifying these flaws meant loss to the organization. To minimize this, the industries began to invest in labs and test equipment to test the product before manufacturing. This ultimately minimised the losses but could not eliminate it entirely. The development of Design and Simulation software's, enabled researchers to develop and test the product beforehand. The present day software platforms like AutoCAD, Solidworks, and 3Ds Max are the most prevalent platforms for designers. This is mainly because of their flexibility and their ability to provide a real-time work environment. Although, they are good platforms for design and development, they could not provide designers the ability to physically interact with the product unless they were actually created or made to exist using 3D printing techniques. This particular drawback can be eliminated and a wider range of flexibility can be obtained by using the Unreal Engine for product design.

2. Automotive industry design challenges

The present day automotive systems are becoming increasingly difficult and excessively complex as the market demands increasing complexity. A perfect example for this would be the rear view camera. As it may seem a simple task in which, a camera is mounted on the rear end of the car and a display is kept on the front panel of the car, it is not as simple as it sounds and it needs to satisfy a lot of requirements. This mundane process involves meeting the market requirements as well as the legislative requirements, which means creating a control system which collects input from several sensors and follows complex behavioral roles. The parking assist feature requires the identification of obstacles and also providing an indication of where the car is supposed to park without hitting any obstacles. The traditional design methodologies involve writing a text specification and also writing the necessary algorithms in C. The problem with this method is that, algorithms cannot be verified without the necessary hardware. This, not only increases the overall cost, but also increases the time period. To bypass these problems design engineers, have a need to switch to a more efficient method for designing and testing a new product or an equipment. To address this need, the industries are switching to computer aided design, which provides a real-time simulation of the product.

3. Analysis of existing tools

In the present market, a successful engineer cannot limit himself to pencils, markers and papers. A modern day car designer must be a master of both traditional mediums like paper and more advanced mediums like computer aided software's. It is necessary to understand the importance of these tools in the software industry. Sketching, designing and prototyping of a car using computer aided software tools is quick and cost effective, since they allow for multiple iterations and also pave the way for advanced automation. Since these tools make the job of a designer by providing powerful options and high-end user interface, they promote productivity by motivating designers to do better and to do more.

A. Autodesk, Inc.

Autodesk, Inc is a multinational software corporation that makes software for Architecture, Engineering, Construction,

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Manufacturing, Media and Entertainment industries. The companies first versions of software were the AutoCAD, its flagship computer aided design software. Its AutoCAD and Revit software's are primarily used by architects, engineers and structural designers to design, draft and model buildings and other structures.

B. AutoCAD

Autodesk became best known for AutoCAD. AutoCAD is a well-known commercial Computer Aided Design and Drafting software application. Before AutoCAD was introduced most commercial CAD programs ran on mainframe computers, with each user working on a separate graphics terminal. There are three variants of AutoCAD,

- AutoCAD Architecture- AutoCAD Architecture or ADA is a version of AutoCAD with tools and functions especially suited to architectural work.
- AutoCAD LT-AutoCAD LT is a lower cost version of the original AutoCAD, with reduced capabilities. While there are a lot of small minor differences between the AutoCAD LT and the original version of AutoCAD, there a few recognized major differences. For example, AutoCAD LT lacks the ability to create, render and visualize 3D models as well as 3D printing. AutoCAD LT has a limitation that, it cannot be used on multiple machines over a network. It does not support customization with LISP, ARX, .NET and VBA.
- AutoCAD 360-The AutoCAD 360 is an account based mobile and web application enabling the registered users to view, edit and share AutoCAD files via mobile devices and web using a limited AutoCAD feature set. This program is an evolution and combination of previous products and uses cloud stored drawing files. AutoCAD 360 includes new features such as the smart pen mode and linking with a third party cloud storage such as the Dropbox.

C. Sketch Book Pro

Sketch Book Pro is also a design tool by Autodesk. This tool perfectly combines the traditional designing with modern computer aided design by allowing the engineers to sketch like a pro as the name suggests. This software is known for its user friendly interface, powerful illustration tools and features like flipbook animation, dynamic gradient fill and perspective guides. Sketch Book Pro is made available on all platforms that is, Windows, Mac OS, Android and IOS operating systems.

D. ALIAS

ALIAS is another car design software tool by Autodesk that comes loaded with intuitive sketching, modelling, surfacing and visualization tools. The sketching is not given the primary importance here as in SketchBook Pro. The software's primary focus here is on the Surface modelling and creating Class A surfaces for Virtual Prototyping of cars.
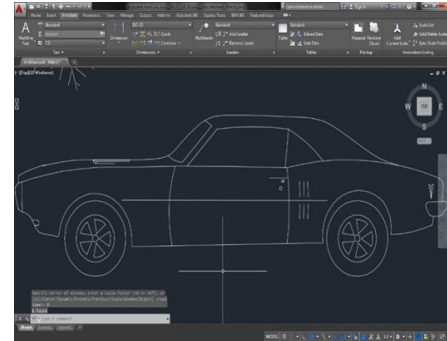

Fig. 1. Computer aided design using AutoCAD

Fig. 2. Sketching a car using Sketch Book Pro

Fig. 3. Design and Digital Prototype of a Light Commercial Vehicle using ALIAS
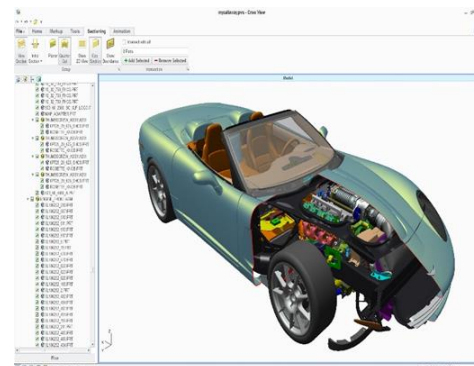

Fig. 4. Modelling of a car using PTC Creo

E. PTC Creo

Creo is a scalable and interoperable CAD design software by Parametric Technology Corporation. It enables the user to perform 2D design, illustrate, view, visualize and perform 3D parametric and direct modeling.

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4. Unreal engine – the ground breaker

Unreal Engine was originally created for games development, by Epic Games, one of the world's largest and most successful games publishers. They noticed that the platform was being used for a growing range of complex B2B and B2C applications with a high proportion in the auto industry, including systems developed for BMW, Jaguar Land Rover, McLaren and Toyota. Even NASA is using it, they have the International Space Station modeled in VR to train astronauts, that led to the decision to create Unreal Engine Enterprise, which we believe is the first major VR and real-time engine supplier anywhere in the world that is structured specifically to support the companies that develop business applications. Their model is not just technology transfer: they also bring a collaborative approach that will accelerate development. For example, they have a partner technology manager who is dedicated to find new ways to do things using technology transferred from other industries and other specialist suppliers. In just over six months they've seen amazing work in the automotive arena, featuring Ford, GM, McLaren, Toyota, Tesla, BMW, Daimler, Audi, Jaguar Land Rover, VW, Peugeot and many more. The vehicle manufacturers that are taking VR seriously are already reporting improvements in their development processes, reductions in late-stage design changes, increased vehicle sales and more sales of high-value options. The technology already exists to make these benefits highly accessible. As one developer said, 'it's just a question of having the vision to see what's possible'.

Unreal Engine has a high degree of efficiency, which means it reduces the demands on hardware. The high-end graphics cards needed are still very expensive in desktop terms, so being able to use one, rather than two or three, also makes a huge difference. As an example of today's state-of-the-art, BMW's Mixed Reality system is built on Unreal Engine 4 to enable stable rendering of 90 frames per second while achieving photo-realistic quality. The computations are performed using high-end gaming computers with water-cooled, overclocked components including Intel Core i7 and two NVIDIA Titan X graphic cards, that's hardware that is readily available at many specialist retailers. The BMW and MINI's mixed reality lab, which is running on Unreal Engine, is carving out a bold path for automotive design that pairs custom hardware with virtual reality to bring a whole different level of real-time experience to the production cycle. In the ever changing automotive world, staying ahead of the design curve without sacrificing visual fidelity is becoming more and more critical for efficiently crafting the cars of tomorrow. The BMW and MINI which rely on faster iteration through high resolution real-time technology and the ability to collaborate in VR across global design teams is driving fresh approaches to automotive design that are determined to change the industry in exciting ways. The biggest challenge in automotive design is finding the middle ground between crafting what a new car model would look like in a perfect world and what's actually feasible from a production

and manufacturing standpoint given the time allotted. By using a mixed reality design experience with Unreal Engine, VR, and specialized cutaway elements of physical car hardware, the team is able to experiment and make key decisions beforehand, leaving more time for iteration and refinement before locking in its designs. The Unreal Engine evolved from Epic's experience in rendering for games. Epic, is a gaming studio, which is known for titles such as Fort nite and the Gears of War franchise, began working with Porsche about two years ago and was allowed advance access to NVIDIA's latest hardware and core ray-tracing code. The system is already being used to help develop the next generation Porsche 911.They used the SIGGRAPH IT conference in Vancouver to unveil Speed of Light, a video presentation of a Porsche 911 Speedster concept rendered using real-time ray-tracing software. Epic's Unreal Engine, teamed with a new-generation NVIDIA graphic processing unit (GPU), allows designers to see more accurately how light plays off different surfaces at various angles without having to send the image back for reprocessing. The digital model can be rotated on horizontal and vertical axis and the position and intensity of light sources changed to create realistic shadows and focal points.

Fig. 5. Design and Modelling of a car using Unreal Engine 4

5. NVIDIA Holodeck

NVIDIA unveiled its Holo deck VR design suite, which is a true design lab for the future that comprehensively integrates AR and VR-assisted technology. It is an exciting visualization platform suite, which includes haptics, multi-user collaboration, photorealistic graphics and even real-world physics. There are many benefits for the manufacturers, engineers and design teams can be trained differently. Thus the efficiency will improve and collaboration will be enhanced in the automotive industry. Holo deck is a truly hybrid platform, based on a version of Epic Games Unreal Engine 4 and the VR Works, Design Works and Game Works packages. Additional software, perhaps a Quadro P600, NVIDIA 1080 Ti or Titan XP GPU, could be needed, but most likely a simpler suite of software will be used. This sounds very positive, and the company is well aware of the fact that small adjustments will need to be made to an already well-performing platform. The true aim of the creation of NVIDIA-Holo deck is to provide

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creative collaboration. Design engineers will be able to model and interact with robots, people, and objects, all of this carried out in real time. The company is providing a crucial roadmap that will assist enterprises in using VR and AR technology capabilities in a way that can be more profitable. This represents a rudimentary shift towards a company-centered approach, as opposed to the consumer-centered approach that was used when the technology was still in its infancy. NVIDIA is on the vanguard of virtual reality and has made wise efforts to move the technology out of the area of gaming, entertainment, sports and travelling, and into the realm of design, innovation and engineering.

Fig. 6. NVIDIA Holodeck

6. Conclusion

Thus, both the present and the possible future design techniques and tools used to simulate and model automobiles were compared and analyzed. The drawbacks of continuing with the present design techniques as well as the advantages of moving on to the future by making the most of the available technologies such as AR and VR, which could improve the efficiency of the design as well as provide a platform for improvement are thoroughly explained. Moving on to a better design platform which provides the design engineers, the flexibility to connect with other engineers positioned at a different location, working on the same project, more efficiently must be considered. This real-time hands on experience can be provided by NVIDIA Holodeck where the visuals as well as the optimization is taken care of by Unreal Engine.

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