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Virtual Reality in a shipbuilding environment

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ABSTRACT

A natural consequence of the extended use of *CAD* systems for the design and production of any kind of vessel is its use in *Virtual Reality* environments, mainly because now it has become an accessible technology. *Virtual Reality* is extended in every industry, in every sector, at any level. Important improvements both in software and hardware have had an important impact in its use in the shipbuilding industry, where it is necessary to handle complex ship *3D* models with huge amount of data. So, efficiency is the base condition in the *Virtual Reality* navigation around a vessel. To enhance it, there are three important factors that play a fundamental role. The first one is having an appropriate *CAD* system with all the information of the ship in a single data base. The second important issue is to have a viewer, which is a tool that allows the management of the *3D* model to be used in *Virtual Reality* environments. No need to say that a good integration between the viewer and the *CAD* system will be translated into more functionality and better performance. Finally, the third important player is hardware, which makes possibility the *Virtual Reality* navigation in many different environments.

This paper describes first of all different efficient uses of *Virtual Reality* in the shipbuilding industry, taking in consideration all the agents involved and describing in particular the advantages for any of them. Regarding the software requirements, it will be described in particular the new *FVIEWER*, developed by *SENER* for the *Virtual Reality* navigation and design review and based on the *FORAN* system. From the hardware side, it will be described some of the most relevant and feasible applications of the *Virtual Reality*, taking in consideration potential uses and accessible technology in the market. The future of the *Virtual Reality* in shipbuilding will be explained after that.

1. Introduction

Virtual Reality is defined, in any encyclopaedia, as a computer-simulated environment that can simulate physical presence in places in the real world or imagined worlds. *Virtual reality* can recreate sensory experiences. Most current *virtual reality* environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones.

FVIEWER VR is the new *Virtual Reality* and design review module developed by *SENER* that contains all the functionality of the module *FVIEWER* and add the possibility of tracking. It is fully integrated in the *FORAN* environment. *FVIEWER* gives the user the possibility to review the ship *3D* model, walk through it in real time, interrogate it about properties and attributes, detect collisions, and make annotations and measure clearances and distances. Being developed in native *64 bits* thus allowing the use of more than *4 GB RAM*, and taking advantage of the latest graphic cards capabilities, *FVIEWER* can handle in an efficient way huge amount of data.

FVIEWER, with an intuitive and modern user interface, incorporates new scene navigations tools and other features to enhance the user navigation. The viewing control in *FVIEWER* is performed by direct mouse or joystick manipulation. Other capabilities are:

- The design tree information is displayed in the main window for object selection and to see information about the model and annotations. Selection of components is done by different criteria.
- Operation with groups of selected items.
- Possibility to check the ergonomic of the design by importing in the scene human models.
- Information about references available, such as frame system, and significant points.
- Query of object attributes.
- Measurement by selection in the scene, surface on objects or significant points for exact positions.
- Addition of notes.

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- Clipping planes.
- Advanced searching tools.
- Advanced algorithms are included, allowing detection of collisions indicated by color highlighting and sound notification.
- A path editor is available, making possible to assign paths to objects and also for the camera, thus allowing of checking removal routes, escape routes and design inconsistencies.
- An overview map following the actual position of the camera allows the user to know the relative position inside the model, and to easily and quickly change it by selecting a new position in the map.
- *Stereoscopic vision*: The stereoscopic vision requires a quad-buffer enabled graphic card such as the *NVIDIA® Quadro®* series. Stereo may be used with *NVIDIA 3D* Vision compatible screens and projectors.
- *Object texturing*: An object or part of an object may be assigned a texture image (*PNG* image file).
- *Full screen mode*: All the short-cut keys, selection, popup menus and navigation modes are available when navigating in full-screen.
- *Tracking*: Tracking of head coordinates for immersive *Virtual Reality* with use of wand for navigation and model interaction.
- *FVIEWER* incorporates a new file format *v3D* generated by merging information from *p3D* files, which makes easier to handle big scenes.

In addition, the module uses some techniques for improving the performance, such as occlusion culling to speed up the rendering of large scenes by omitting hidden objects from the graphics pipeline that geometry hidden behind other geometry is not sent to the graphics pipeline, and incorporates better visualization capabilities without performance penalty.

2. State of the art: the current software research

A quick examination of shipbuilding magazines over the last five years will reveal that there has been much talk about the application of *3D* models and applications of *Virtual Reality*. This all presupposes the existence of a digital prototype, in other words, a digital or virtual mock-up of a ship. The concept behind using digital prototypes is to do as much work, analysis, and communication as possible within a *3D* digital environment, rather than in the physical world. This involves using computer simulations more than physical models and viewing videos and fly-through, rather than interpreting paper drawings. The concept of digital prototyping goes beyond simply creating product designs in *3D*. Having digital prototypes on a screen of the engineers in their office is one thing but getting the *3D* model down onto the shop floor, extends the concept even further. This goes beyond than simply having production workers viewing the design. It involves production department utilizing the *CAD* model on a day to day basis.

Most of *CAD* suppliers are developing the *Virtual Reality* concept in order to achieve future success. For example, some of them are promoting the use of the shop floor *3D* concept as a logical extension of its digital prototyping tools used in their programs. There are still limitations on the number of parts that the software can handle. Only limited strides have been taken in the direction of shop floor *3D* at even the most progressive shipbuilding companies.

Another way where the *CAD* companies want to improve the *Virtual Reality* tools is using tablets. Showing complete build sequences, via *3D* animations in tablets, would dramatically aid in communication compared to simply viewing static models. The use of tablets would also allow mobile shipyard workers to bring the digital prototyping experience with them, further enhancing productivity. It is true that due to the size and complexity of *3D CAD* models used in shipbuilding, there are current limitations imposed by the software and hardware that affect the viability of this approach.

PLM tools are used for configuration management of the digital mock-up. The *Virtual Reality* applied to *PLM* will bring together the product, tooling and production line around a single database. The totality of processes and data necessary for the different functions will be included. As well as integrating the different skill areas, this *Virtual Reality* applied to *PLM* could be used to apply the design-to-build concept and enable complete product lifecycle management. Industrialization process must be optimized. The *Virtual Reality* applied to *PLM* could also be used to simulate production processes and maintenance operations. Finally, *Virtual Reality* applied to *PLM* will achieve ever greater degrees of optimization: automatically produce instructions and documentation and follow project progress, reviewing the mock-up in *Virtual Reality*.

3. *Virtual Reality* in a shipbuilding environment

Shipbuilding industry is affected by a global and extremely competitive environment. All processes and systems have to be adapted to this challenging scenario, making special efforts in innovation and applying the most advanced technology available in the market. The *Virtual Reality* application to shipbuilding is not new, but it is more extended now thanks to the important improvements in software and hardware. From a user point of view, it is possible now to find a wide range of solutions to meet the most demanding requirements, to achieve measurable results, in terms of efficiency and costs.

The ship *3D* model is the core to all tasks related to ship design and manufacturing.

It is the starting point of a series of thousands of tasks that are absolutely based on the coherence of the model. As an added value, *CAD* suppliers develop smart tools to use this model in realistic navigations in *Virtual Reality* environments with multiple purposes. Some of the most important uses of *Virtual Reality* in shipbuilding are described in the following paragraphs.

3.1. Virtual Reality during the ship design stages

Maybe the engineering department of a shipyard is where is more extended the use of this kind of solutions. And production department is maybe where it should be extended because is where there are the most costly errors. They are not usually working with a *Virtual Reality* solution but now it is starting to be clear that it is very useful to check the model, to avoid errors and inconsistencies but also to improve the tasks of production.

So, the first and most important use of *Virtual Reality* is for avoiding errors. The possibility of viewing the ship *3D* model as much realistic as possible is really effective to find out errors, in all stages of the design. From early design stages, to manufacturing and production phases, it is possible to use it to check all the elements, to see inconsistencies, to prevent interferences and collisions, to query about properties and attributes and to study different design alternatives and changes dynamically. In addition, the user and model interaction has become much more realistic with the implementation of tracking devices which give the sense of being inside the model, walking and moving on it, touching it.

Viewers allow an easy navigation and a fast-movement. Different modes of visualization, search and query options, inclusion of annotations and measurement of distances are important and useful capabilities. Ergonomic aspects in the design can be studied and checked better having a *Virtual Reality* solution, with the possibility