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VR as a Service: Use of Virtual Reality in a Nuclear Accelerator Facility

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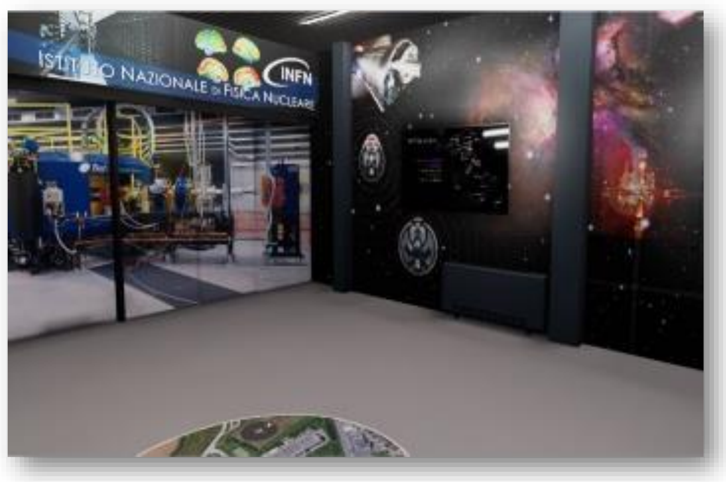
A nuclear accelerator laboratory can be described as a complex system composed by several functional sub-systems which have to be coordinated properly in order to provide the service to the end user. Every single system has to work correctly and requires a big effort in continuous maintenance in order to guarantee a stable beam for experiments. Because of the nature of the experiments and the kind of facility, different problems and limitations related to area accessibility occurred during and after operations, causing delays and uncertainty in planning process at every level (management, logistics and operations). Virtual Reality technology can be seen as a methodology and a tool to overcome these constraints through dedicated software experiences, allowing regular operations in the facility.

Cases of Interest

This technology can be adopted as a tool to help users (managers, developers, operators) in different critical tasks and it can be integrated in the common design process. Different types of experiences can be designed and implemented, depending on the goal the application wants to achieve. For the proof of concept designed and implemented, we focused in the following cases of interest:

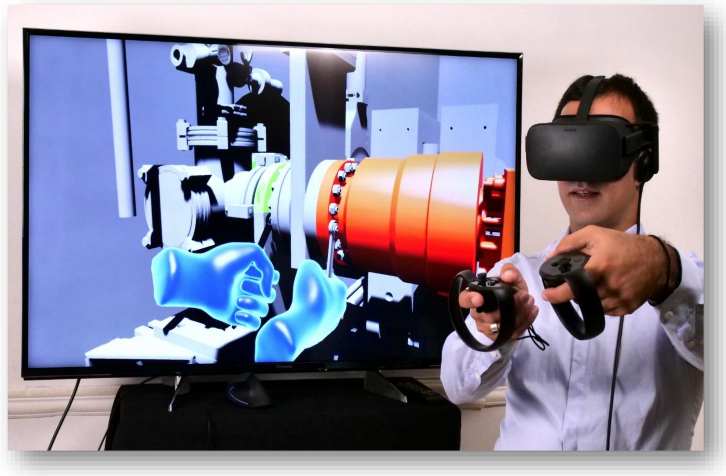
Data Collection and Design

The virtual model is defined starting from 3D CAD models. As different groups manage the different sub-systems constituting the facility, the tool can be very useful to test and verify data integrity and co-herence. This aspect results in reducing design errors and optimizing communication and data exchange among the groups.



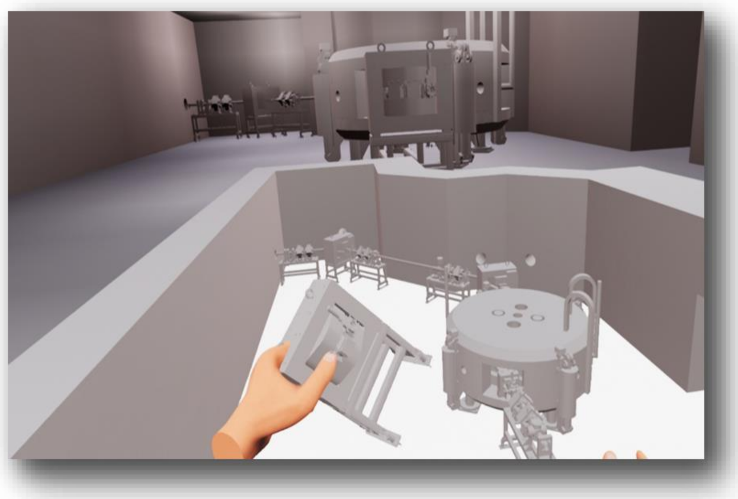
Training

Through VR technology, operator training can be done in a secure simulated environment, independent of the physical machine. In this scenario, the trainer can also simulate emergencies and evaluate behavior feedback, estimating the response time in a hazardous environment.



Machine Operation and Maintenance

Using the same virtual environment provided for the training, it is possible to evaluate and prepare maintenance planning (ordinary and extraordinary) and machine upgrades. As the entire environment is rebuilt starting from CAD models, the final 3D virtual model guarantees sub-millimeter resolution where VR users can operate in the virtual simulation to evaluate, for example, device positioning for ma-chine upgrades.



Long Term Studies (Further Development)

Data Integration: particular interests are related to the idea of integrating and merging heterogeneous data and information into the VR environment, such as data results coming from Beam Dynamics studies or control data provided by EPICS.

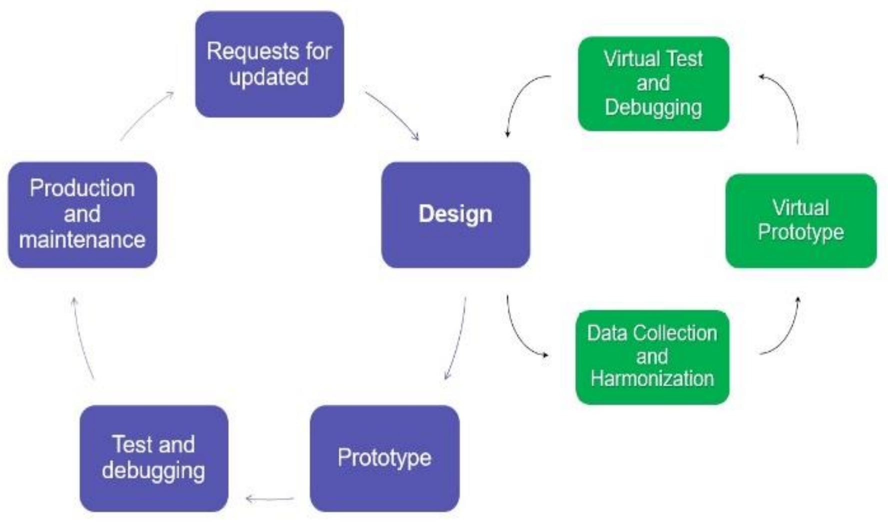
Multi-users experiences: thanks to the improvement of the actual hardware and software, we are now able to achieve multi-users experiences based on different and heterogenic fields and applications; actually, we are focusing and testing proof of concepts for **virtual control room** (training and control operations), **remote training and assistance with customers, live meeting between different divisions, real-time cooperative design.**

Augmented Reality (AR) and Mixed Reality (MR): These two technologies introduce an additional degree of interactivity between real and virtual worlds. In this scenario the user can use particular information data to be aware of dangers (i.e. data produced by Radioprotection Service).

Control Process and Integration

An important aspect kept in mind during the preliminary study and design for the test-bench application was how to integrate a VR solution into the normal common design and organization process. It was mandatory to proper define the set of tools (hardware and software) and the process required to integrate a VR experience into the regular control process.

The "Double Wheel" Flowchart



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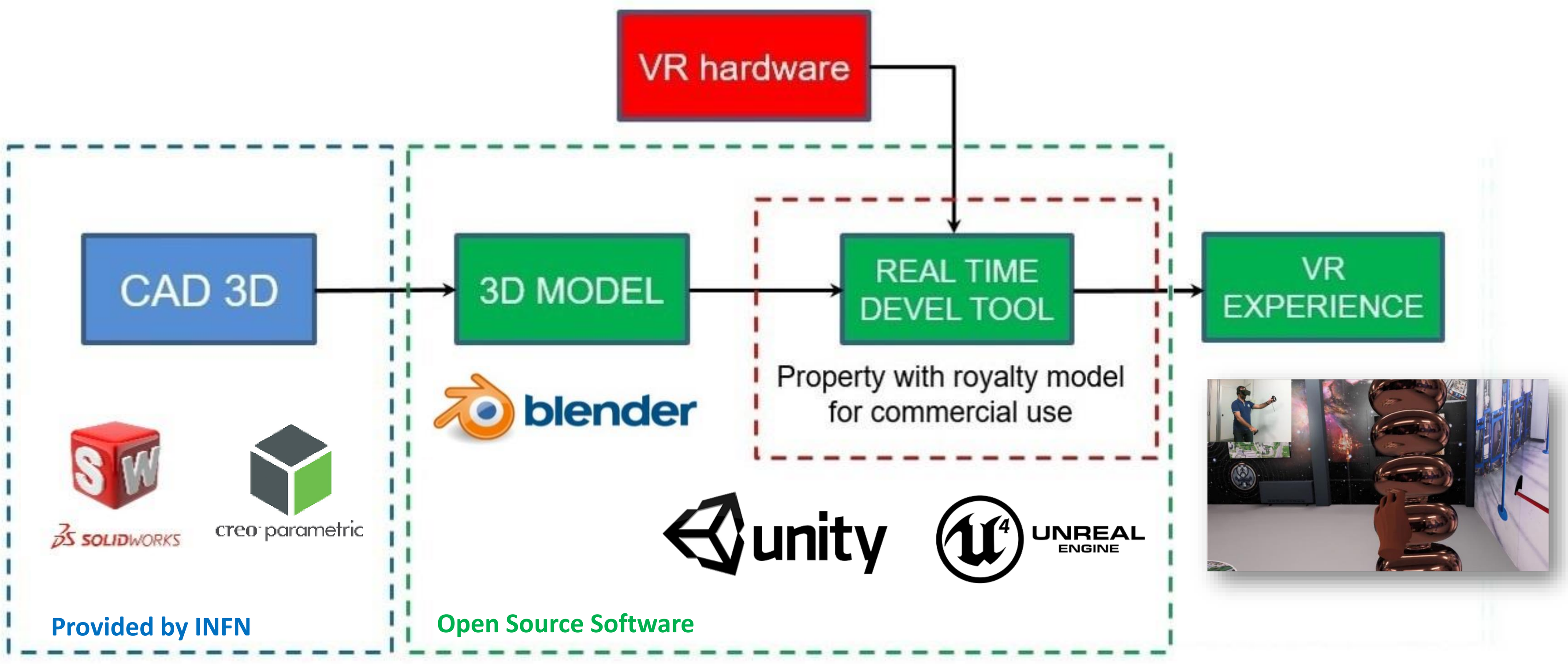
Secondary control process cycle:

- *Data Collection and Harmonization*: collect data provided by every involved and verify its coherence before designing the virtual experience.
- *Virtual Prototype*: design for the virtual experience is made in this phase. The complexity and the effort required de-pends on the kind of experience desired.
- *Virtual Test and Debugging*: use the virtual experience to verify the application it-self (logic, design, etc.) as internal debug and to receive the first feedback from the end user using the VR simulation.

The Development Flowchart



The goal: the best set of software which permits **to minimize costs impact** related to licenses and to have, at the same time, **the best resolution in terms of photorealism and real-time execution**.

- **Licensed Software**: different 3D CAD suites are used in the Laboratory by the different groups and costs related to them are already in charge of the Institute
- **Open Source Software:** Computer Graphic Framework (Blender) is required to simplify 3D models and Real Time Development Engine (Unreal Engine) is the *core suite* for VR programming.

Hardware: several solutions are available on the market. We decided to focus the development using the Oculus Platform because the device is fully integrated into the Unreal Engine framework, it has a large community support and it provides a good photorealistic immersion at high frame rate.

First Results and Conclusion

The studies executed and the proof of concept designed and implemented verified the maturity and the versatility of this technology: the application developed gave us preliminary good feedbacks for the main areas of interest where we focused the work (training and maintenance planning). The tests results were very promising and pushed us to extend studies and application functionalities of the prototype, embracing different hardware solutions and integrating heterogeneous data and information, but more effort is required to extend and optimize the user experience.

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