

Virtual Visit to Research Reactor IPEN/MB-01

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1. Introduction

There's been an increase in the number of publications regarding works of science and technology [1], however, due to several different reasons, the population hardly has access to the correct information and discoveries made by the scientific community [2]. The COVID-19 pandemic also enhanced this issue, with the need to social distance, and people working and studying from home, several research facilities changed their schedule and educational visits were no longer allowed, one of those research institutes was the Instituto de Pesquisas Energéticas e Nucleares (IPEN) [3].

This created the opportunity to continue the larger project concerning virtual reality at IPEN, by developing a software of a virtual environment which allows the public to visit one of the institute reactors, the IPEN/MB-01, as previous similar work has been done on the other reactor, the IEA-R1 [4]. Other institutes who are part of the Comissão Nacional de Energia Nuclear (CNEN) also have done similar work [5].

The IEA-R1 is a pool-type research reactor in Brazil, utilizing light water for moderation and cooling, with beryllium and graphite elements serving as reflectors. Operating at a maximum power of 4.5 MW it is categorized as a Materials Testing Reactor (MTR). Achieving its first criticality on September 16, 1957, it initially operated at 2 MW. The IPEN/MB-01 is a Brazilian designed reactor, made by researchers and engineers from IPEN-CNEN/SP, it was licensed on October 19, 1988, and authorized to operate with a maximum power of 100 watts. The reactor was built with the goal of simulating a core used on naval propulsion, in 2020 it transitioned to a new core, using plate-type fuels, and the goal is to simulate the reactor physics of the new Brazilian Multipurpose Reactor (RMB) [6], core differences can be seen in Fig. 1.

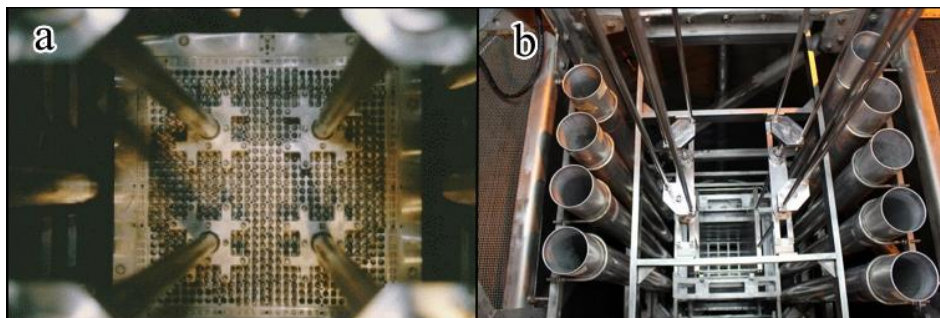


Figure 1: Comparison of the old core (a) and the new core (b).

2. Methodology

The software is currently under development, employing techniques from the video game industry and utilizing the Unreal Engine 5.11, a game engine developed by Epic Games, which is a widely used platform for game development by both independent developers and large companies [7]. Under unreal engine standard license, the software is free to use, but a 5% royalty fee applies to any game or application with a gross revenue exceeding 1 million USD. This fee is payable quarterly as long as the product remains for sale or generates over 10,000 USD in a quarter [8].

The engine supports development in both C++ and Blueprint, its proprietary scripting language. While an application can be entirely created in Blueprint, optimal results are achieved by combining both languages. To enhance the realism of the 3D environment, open-source software is employed for modelling and texturing. Online libraries with free resources contribute materials, meshes and textures during development. Audio resources play a role in conveying information, mimicking the guidance provided by a monitor during live visits to the facility.

The virtual environment development began with visits to the reactor, including guided tours to grasp how information is presented to regular visitors. Independent visits were conducted to capture images and record the internal environment. Using the 1980s original blueprints, the modelling process aimed for accurate replication of building proportions and interiors. Similar to guided visits, not all rooms are accessible in the software, mirroring instances where visitors often skip certain areas of the reactor.

After completing the modelling step, the next part is the programming and animating, as most of commands are simple, such as having a character walk and having a non-player character (NPC) accompanying the user and giving information throughout the visit, the whole programming is being made using the Unreal Engine blueprint script language.

3. Results and Discussion

The first stage is nearly finished, with the building structural part and external visual already completed, and most of the internal environments already completed, Fig. 2, there are still a few meshes to be modelled, those special meshes are the reactor operation table and some of the panels, those meshes require special attention in order to be possible to the user to simulate a criticalization process, trying to operate the nuclear reactor.



Figure 2: Comparison of real environment (left) with the virtual environment (right) in different reactor areas: (a) external area, (b) laboratories area, (c) workers area

The programming and animation is also currently underway, there is currently a character which the user can take control, and an NPC, Fig. 3, both already have walking and running animation, there's also some interaction with the environment as well, such as opening doors, however all the audio and the interaction with the reactor operating table is still under development.

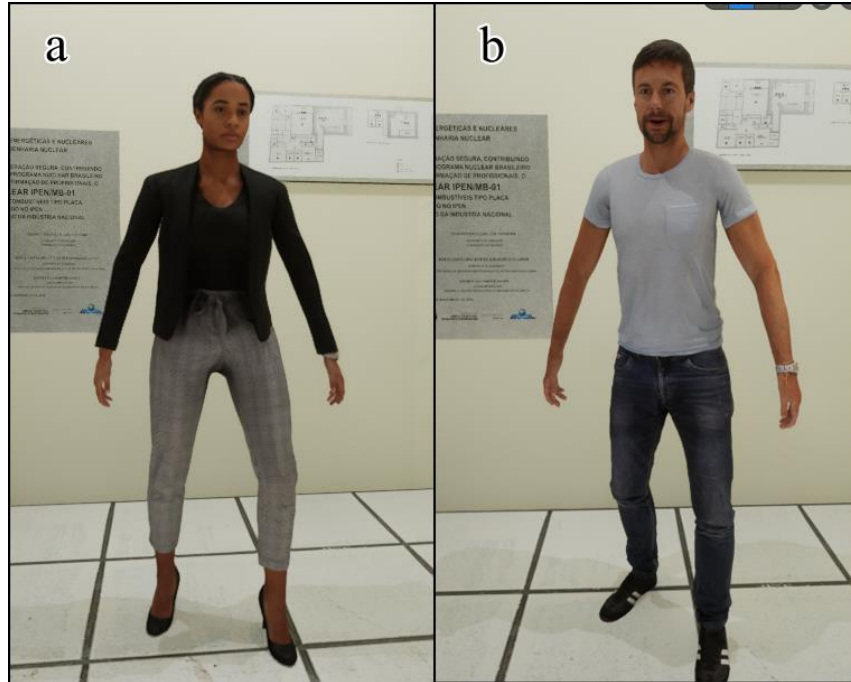


Figure 3: Player character (a) and NPC (b) models already animated.

4. Conclusions

Given the lack of information of the general population about nuclear reactors and nuclear energy as a whole, it is of high importance the existence of works that bring light into the subject, serving as a way to demystify wrong concepts and correct the misleading information known by the general public, and that can also transmit which works and innovation are being done in the nuclear area.

With the usage of digital technology and virtual environments increasing in several different areas [9], the nuclear area can also take advantage of the current global situation. It's also important that any software developed is well received by the general public, and with the majority of the public of video games is under 30 years old [10], the use of a video game engine to develop a software to make a visit of a nuclear reactor and transmit information seems to be a viable path to take, preventing misinformation in younger audiences, thinking ahead for the future.

The software development is still a work in progress, with a conclusion expected in the final quarter of 2024, which means that some changes might still occur.

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