DOI: https://doi.org/10.56198/ZH3JOMUZ4

Work-in-Progress−Immersive Reality Simulator, a Proposal to Support Siderurgy Processes

Ahmed Musle Alfaro[1], Adriana Navarrete Bibiano [2], Leticia Amalia Neira Tovar[3] and Ivan Isaias Reyes Gamez[4]

[1]Universidad Autónoma de Nuevo León, San Nicolas de los Garza, Nuevo León
ahmed.muslelf@uanl.edu.mx

Abstract. This work-in-progress highlights the significance of interactive elements in virtual reality applications for foundry processes, with a specific focus on the casting stage. The research employs both 2D and 3D techniques to create immersive scenarios, resulting in two virtual reality scenes where users can engage with objects and gain a comprehensive understanding of the casting process through accompanying videos. The study's findings stress the considerable influence of virtual reality interaction, as it permits users to acquire knowledge of the process without having to be present in a factory, effectively lowering the risk of accidents and minimizing potential material wear costs. In summary, this research establishes the crucial role of interactive virtual reality tools in enhancing the learning experience and safety measures associated with foundry processes, further emphasizing the need for continued advancements in the field of virtual reality technologies.

Keywords. Foundry, Virtual Reality, Casting Stage, 3D, Immersive Reality.

1 Introduction

The popularity of contemporary entrepreneurship has led to an increased interest in creating innovative products and services that cater to market demands. However, starting a new business venture is an unstable and unpredictable process that requires a developed mental model to navigate through sense-making and decision-making processes. Traditional education methods often fall short in teaching the necessary skills, but virtual reality technology can offer a complementary tool that immerses users in a virtual environment, allowing them to learn and develop their skills effectively [1, 5].

Immersive technologies, such as virtual reality, have been used to enhance training and learning in various industries, including the chemical and mining industries. These technologies aim to improve safety and process training by increasing motivation, engagement, and skill development. Recent studies have shown that immersive virtual reality can be an effective tool for training operators, such as electric overhead crane (EOT) operators, in comprehending operations' sequence and managing potential hazards [4, 6].

Virtual reality-based training tools provide exposure to real-world working conditions without the associated risks, making them an effective solution for addressing safety concerns in the mining industry. Additionally, the use of immersive technologies can offer a cost-effective and repeatable solution for industrial training, allowing individuals to gain practical knowledge without generating material waste or process rework [2-3, 9].

Exploring virtual reality as a functional teaching approach can create more effective learning tools for aspiring entrepreneurs and enhance training and learning in various industries. Immersive technologies have the potential to improve safety and process training, increase motivation and engagement, and offer a cost-effective and repeatable solution for industrial training [7-8, 10].

2 Methodology

For the development of this project, the following method was implemented based on the new project creation stages which are: Research, design and development, and testing.

2.1 Research

At this stage, the smelting process was analyzed and in turn a visit was made to a steel company to see the process of this where the following processes were understood.

- Molding:
  - Check the model for emptying before creating it. A manager handles reviewing it digitally in search of errors or weak points of it, virtual simulations are also carried out to test it and obtain a more thorough analysis.

- Melting and casting:
  - At this stage you can see the load placed on the smelting furnace, which is scrap copper, bronze, and other metals.

- Emptying area:
  - In this process is where the lava is placed in the mold, for them the oven is transported to the place where the molds are found, to empty the product into the mold it must be done carefully to avoid accidents and waste of material.

- Demolding and cleaning:
  - Once the molded parts are cooled, they begin to be extracted with light blows to the sides, it is usually waiting 4 to 5 hours for them to cool completely.

2.2 Design and Development

For this project, different software was used to model the 3D objects and give textures to them. The software that integrated the project was Unity which is a video game development tool. The first thing that was done was the 3D objects with the help of SolidWorks software where they were later textured in Blender. Once the design of the objects to be needed was finished, they were exported to Unity to create the scenes.

Afterwards, two scenes were generated where the user can interact, which will be described later. Before the user investigates the scenes, it is necessary to know the operation of the equipment that is being used, in this case virtual reality viewers. For this, a main menu was generated where you can see the instructions of the project and the beginning and end of its execution. As shown in Figure 1.

Fig. 1. Scene of interaction to the immersive world.

Once a first interaction interface was made, the first scene's assembly was followed, where the user interacts with the personal protective safety equipment necessary to enter the casting process. For the user to interact with the objects present in this scene, it was necessary to relate these objects to rules and/or actions programmed in the C# language. In addition to this, sound and a series of visual and auditory instructions were added to the scene so that the user gets a more realistic experience (see Figure 2).

Fig. 2. Personal protective equipment.

Once the user correctly selects the necessary safety equipment, he can enter the casting scene, for this he had to relate by code that the program finds when the selected PPE is correct so that it can be linked to the second scene. In this scene, like the earlier one, each element was arranged according to the casting process flow. Videos from each process were added to generate a more complete experience. What stands out from this scene is the simulation of the emptying process that goes from the oven to the molds, as shown in Figure 3.

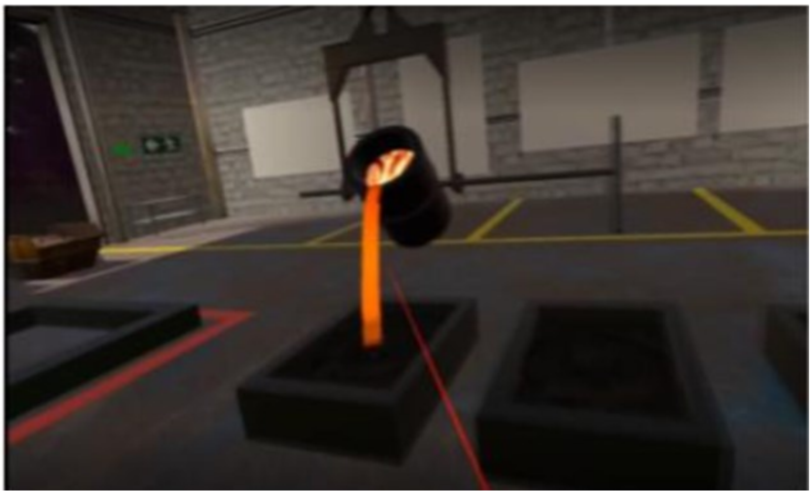

Fig. 3. Casting process flow scene.

2.3 Test

Since the virtual reality product was completed, tests were done with students and teachers with the help of viewers, where they gave us their feedback and thus, we made the necessary corrections to improve the project. According to the usability test, in which 11 questions were generated to know the ease of use of the project, it is obtained that 90% of the users perceived a friendly interface of the project.

3 Results

Once the people tested the virtual reality product, the result was obtained the fulfillment of the interaction aim, since the user can have an interaction of the casting process in a virtual way obtaining the required learning to be able to carry it out in real life.

Like the earlier case, based on the usability of the users, it was obtained that 90% of them thought that the product was friendly in addition to considering the programming of the times during the use of the simulator was perceived acceptable.

4 Conclusion

Finally, based on the results obtained, it can be concluded that the project leaves a great contribution to the user due to the knowledge and learning obtained when interacting with the virtual reality environment. This means that the user can arrive with prior knowledge to the foundry industry and avoid accidents and / or waste of material. On the other hand, it gives way for the construction of a second level of simulator, where the interaction is to generate exchange between two users, giving entry to the theme of virtual multiplayer.

Acknowledgements

Thanks are given to the Facultad de Ingenieria Mecanica y Eñectrica the virtual reality laboratory and the researchers of the doctorate of materials Dr. Roberto Benavides and Dr. Manuel Diabb, who took part in this project, for the support provided during its development.

References

1. Babich, A., & Senk, D.: Simulation of complex metallurgical processes and phase systems for educational training and research. In The International Conference on E-Learning in the Workplace, New York, pp. 1-8 (2009).
2. Baker, D.: Interview with Safety, Health and Environment Manager, Anglo Platinum Bafokeng-Rasimone, (notes in possession of researcher) (2005).
3. Bise, C. J.: Virtual Reality: Emerging Technology for Training of Miners, Mining Engineering, 49 (1997).
4. Dhalmahapatra, K., Maiti, J., & Krishna, O. B.: Assessment of virtual reality-based safety training simulator for electric overhead crane operations. Safety science, 139, 105241 (2021).
5. Garcia Fracaro, S. Glassey, J, Bernaerts, K. Wilk, M.: Immersive technologies for the training of operators in the process industry: A Systematic Literature Review.Computers & Chemical Engineering, 160, 107691 (2022). https://doi.org/10.1016/j.compchemeng.2022.107691.
6. Huang, C. Y., Lou, S. J., Cheng, Y. M., & Chung, C. C.: Research on teaching a welding implementation course assisted by sustainable virtual reality technology. Sustainability, 12(23), 10044 (2020).
7. Krueger, G., & Linz, S. J.: Virtual reality: Barter and restructuring in Russian industry. Problems of Post-Communism, 49(5), 31-44 (2002).
8. Manzhong, L.: The Application of Virtual Reality Technology in the Preservation of Mining and Metallurgy Culture in Huangshi Region. In 2017 International Conference on Information, Communication and Engineering (ICICE), pp. 529-530, IEEE (2017).
9. Pilataxi Tuapanta, D. I., & Quillupangui Morales, C. E.: Estudio y optimization del proceso de fundición de poleas en aluminio para la empresa EcuaPoleas S.A (Specific Activity). 102 hojas. Quito: EPN, (2018).
10. Xu, T., Song, G., Yang, Y., Ge, P. X., & Tang, L. X.: Visualization and simulation of steel metallurgy processes. International Journal of Minerals, Metallurgy and Materials, 28(8), 1387-1396 (2021).