Immersive Virtual Reality Training for the Operation of Chemical Reactors

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Abstract: This paper discusses virtual reality (VR) training for chemical operators on hazardous or costly operations of chemical plants. To this end, a prototypical training scenario is developed which will be deployed to industrial partners and evaluated regarding efficiency and effectiveness. In this paper, the current version of the prototype is presented, that allows life-sized trainings in a virtual simulation of a chemical reactor. Building up on this prototype scenario, means for measuring performance, providing feedback, and guiding users through VR-based trainings are explored and evaluated, targeting at an optimized transfer of knowledge from virtual to real world. This work is embedded in the Marie-Skłodowska-Curie Innovative Training Network CHARMING[3], in which 15 PhD candidates from six European countries are cooperating.

Keywords: Virtual Reality; Training; Chemical Reactor; Safety

1 Introduction

In chemical plants, mistakes during training can cause safety, time, and cost issues [Na12]. Besides, there is also a hesitation from a trainee to explore the scenarios to their worst and best outputs. Thus, virtual reality is chosen as an immersive solution because it can provide safe training options for hazardous scenarios [NKS14]. Our research is under CHARMING[3], which is focusing on training of children, students and employees in chemistry, chemical engineering and chemical industry. Our focus is to develop a VR training prototype and evaluate it with the employees of industrial partners of the project. In the section below, the current state of prototype and training plan is discussed.

2 Virtual Reality-based Training

A VR-based prototype is developed which allow users to perform a chemical procedure of Butyllithium. From requirements analysis, this reaction is very dangerous and relevant to the products formed in chemical plants. Besides, a 3D model of a full chemical reactor is embedded which is required for this reaction and for multiple chemical reactions in industry making it a valid model for training. According to the current prototype, users

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can perform the procedure by controlling the virtual reactor both manually and via a simulated computer screen inside the VR environment. This is to copy the original procedure by learning both automated and manual controls of today's chemical plants.

Fig. 1: The VR Prototype would span three levels (left) of a large building in real life, which would be costly to realize as a pure training environment. The main area (middle) hosts the reactor and the control panel (right, enlarged for visibility reasons)

The next step is to induce multiple training modes accompanied by feedback and reporting strategies. For employees, it can be a first VR attempt. Thus, rather than confronting them with all knowledge of VR and chemical operations at once, a step by step knowledge acquisition will be provided in the form of training modes (as in figure below). This will enable exploration, practicing with guidance, continuous feedback and then performance evaluation for both trainee and the trainer. The prototype will be assessed to industrial partners and it will be tested against their limitations of classroom lectures and pilot plants. The target is to achieve a VR training design that fills up the real weaknesses of traditional training and complements the whole training system.

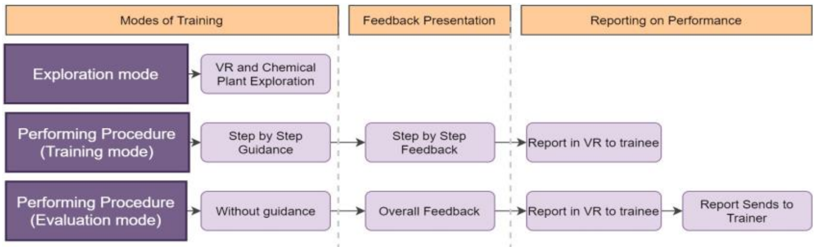

Fig. 2: Training Layout in Virtual Reality

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