



6 | VIRTUAL REALITY PUZZLE GAME FOR MUSCULOSKELETAL DISORDERS PREVENTION

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INTRODUCTION

Musculoskeletal Disorders (MSDs) are common occupational diseases in Western countries. In recent years, the MSDs cost represented more than 1 million euros [1], and MSDs were more than 80% of all diagnosed occupational diseases in France [2]. Physical risk factors such as repetitive tasks and awkward postures have been reported as the leading causes of MSDs in various jobs and industries, specifically at assembly workstations [3]. Previous studies have shown a dose-response relationship between awkward posture, prolonged arm elevation, and neck/shoulder disorders [4–6].

Multidimensional ergonomic interventions intend to reduce exposure to physical risk factors, particularly awkward postures. Previous studies proposed interventions on individuals such as participatory ergonomics and training, and the practical approach to prevent MSDs [7–9]. However, the debate issue is the effect of ergonomic training sessions on reducing exposure to physical risk factors and MSDs prevalence [10].

PROPOSED SOLUTION

The use of modern technologies such as Virtual Reality (VR) and Serious Game (SG) needs to be explored to increase the operators' awareness of their gestures and postures in the industrial settings and helps them develop the coping strategy to regulate a task in a way that preserves their health. The aim of this study is, therefore, to produce such a device by combining VR in a SG. This tool would allow the operators to practice similar tasks to the ones they perform at work in a playful setting and have feedback on to their postures.

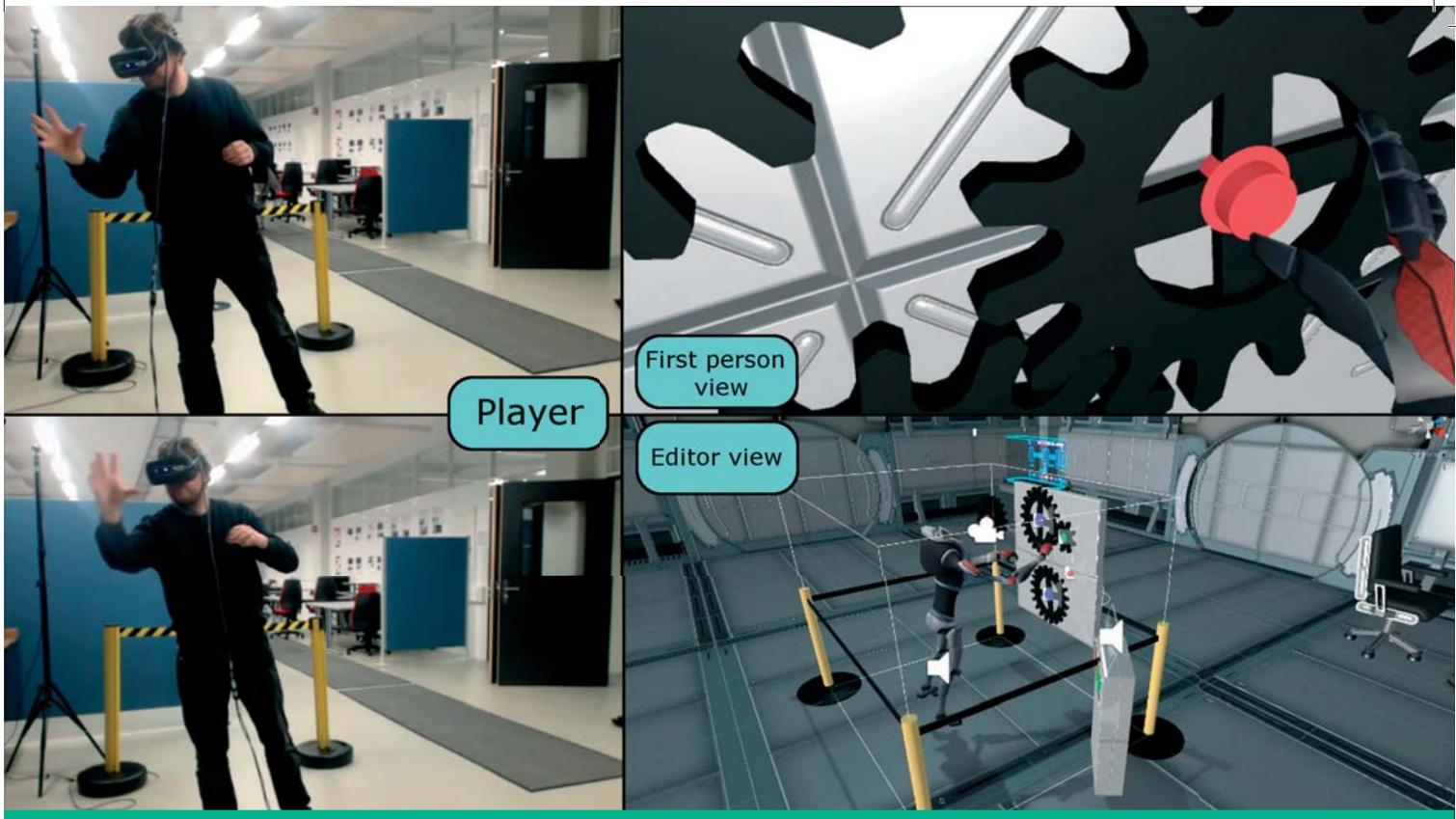
To achieve this objective and for the development of the game scenarios, we created a database

of postures and movements of industrial tasks. The experimental settings were the automobile and watchmaking industries. Twenty automobile assembly operators (8 women and 12 men) and twelve women watchmakers consented to participate in this experiment. We used nine T-motion sensors to measure continuously the upper limb joint angles at a 64 Hz frequency (TEA, Nancy, France). Once participants got accustomed to the devices placed on their body segments and the camera installed near them (5 minutes), we registered ten cycle times.

The proposed solution combines VR and motion capture (MoCap) into a SG. The MoCap technology allows tracking the user and provides real-time posture analysis. The VR combined with SG offers a decontextualization that increases learning and motivation. The imagined game is a gear puzzle game the user has to solve. The different game elements are placed to mimic real problematic work situations. The gear puzzle game has been chosen for its flexibility in size and orientation and for the variety of game mechanics which allows adapting to the different works situations in the automotive and watchmaking industry.

*Different game elements
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CONCLUSION

This project proposes a new approach to MSD prevention in an industrial context. A SG, based on real-life industrial measurements, has been developed combining Virtual Reality and Motion Capture and provides a decontextualized and motivating environment to raise MSD awareness and training.

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