Developing Skills Of Construction Engineering Students To Implement Wearable Robot Solutions In The Construction Industry Using Virtual Reality

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INTRODUCTION

Wearable robots are increasingly utilized as assistive devices in the construction industry, particularly for mitigating musculoskeletal disorders. By the end of 2025, the adoption for wearable robots is predicted to expand at an annual growth rate of 39%, creating urgent demand for skilled professionals. However, the current construction engineering and management (CEM) curriculum lacks the necessary training for students to implement these wearable robots effectively (Figure 1). One way to approach this is by leveraging interactive learning environments like virtual reality to provide hands-on experiences with wearable robot solutions. This study presents the development of a VR simulator designed to help train students on wearable robots and address the current gap in education.

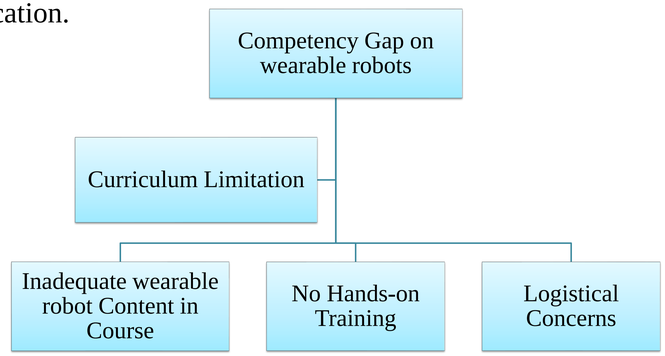

Fig 1: *Research Need and Significance*

METHODOLOGY

This study followed a three-stage methodology to design an immersive virtual learning environment (ViRLE) for training construction students on ergonomic risk identification and wearable robot implementation. Each stage builds on the previous to ensure the environment reflects real-world tasks, expert knowledge, and practical learning needs.

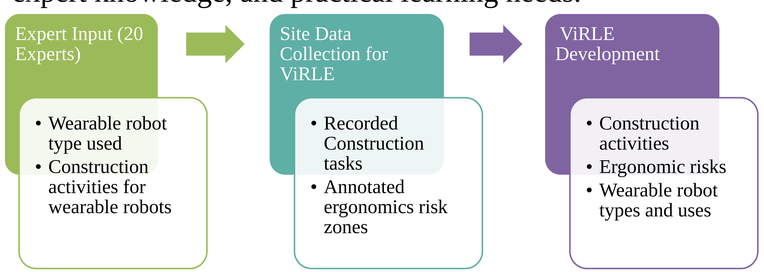

Fig 2*: Framework of Study*

FINDINGS – EXPERT INTERVIEW

Findings from 20 industry participants revealed that back and shoulder-support wearable robots are most used, especially in labor and carpentry roles (Figures 3-4). Participants emphasized the need for competencies in ergonomics, exoskeleton knowledge, construction workflows, training design, communication, ethics, and inclusion to ensure safe and informed use on site (Figure 5).

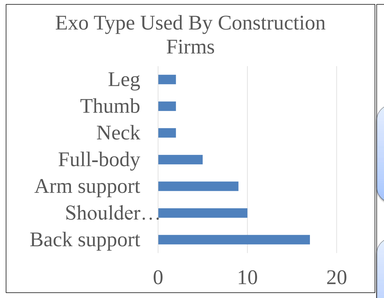

Fig 3*: Wearable robot Types*

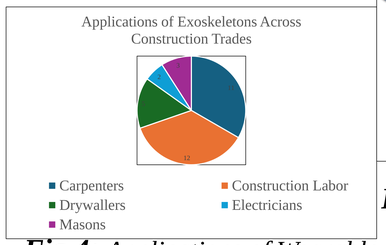

Fig 4*: Applications of Wearable Robots across Construction Trades*

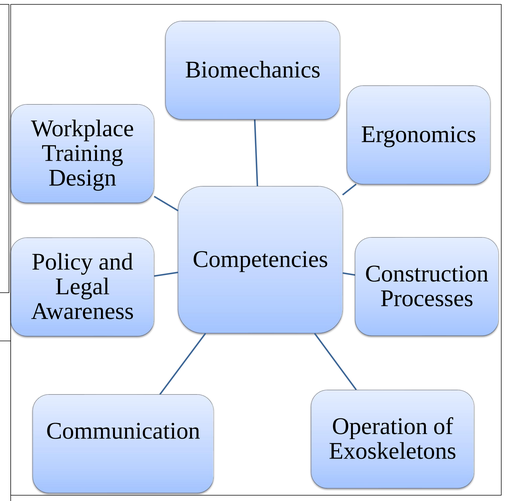

Fig 5: *Competencies Required for CEM students to advance Wearable Robot Solutions*

VIRLE DEVLOPEMENT

Based on the identified competencies, the construction trades where wearable robots are used, and the types adopted, a ViRLE was developed to support student learning and decision-making. Figure 6 illustrates the system architecture of the ViRLE.

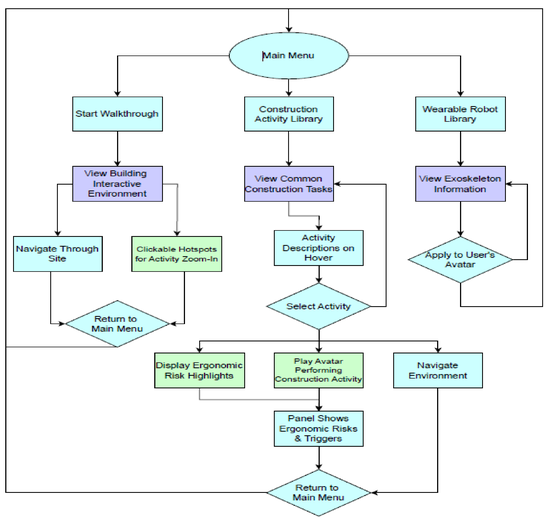

Fig 6*: System Architecture*

FEATURES OF VIRLE

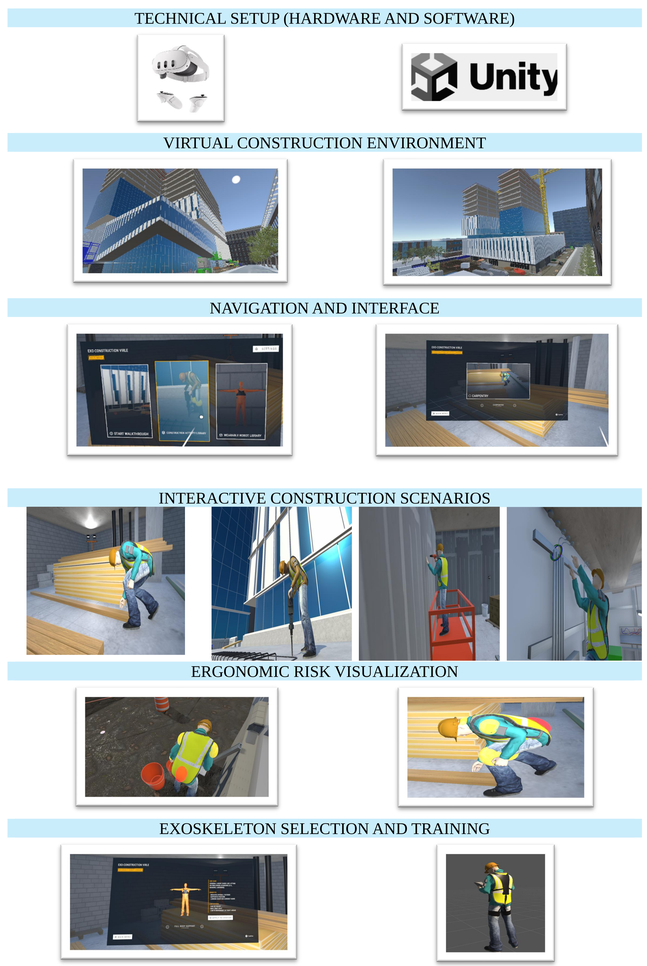

Fig 7*: Features of ViRLE*

RESULTS, IMPLICATIONS AND FUTURE WORK

- ViRLE enhances hands-on learning with wearable robots by simulating real jobsite tasks and ergonomic risks in a safe, virtual environment.
- ViRLE equips CEM students for emerging technologies like wearable robots used in modern construction.
- The current phase successfully develops core ViRLE components (task scenarios, risk overlays, wearable modules).
- This study bridges the gap between instructional offerings and industry's expectations, enhancing student readiness for industry roles.
- Future versions of ViRLE will include performance tracking and more construction scenarios for enhanced learning.

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