Mixed Reality and Digital Twin powered environment for training and education

Hong Kong Metropolitan University

Introduction

- Gaming improves as the 3D rendering powered by Graphics Processing Units (GPUs) improves [1]
- VAR in 3D environment and simulations is immersive [2] and can be used in manners that can solve problems

Problem

- Building management industry is facing a labour shortage
- Traditional training method is slow in training new comers
- Turmoil of the pandemic that causes early retirement

Solution

- Utilising Digital Twin (DT) and Virtual/Augmented Reality (VAR)
- Provide immersive and interactive training programme

Objective

- Explore the potential of DT and VAR in game-like educational experience
- Use the game to train new people, and evaluate performance

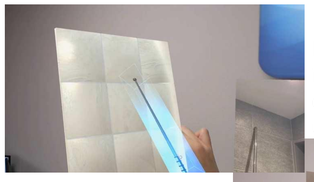
Method

Capability
- Explore capability of current hardware

Development
- Develop a gamified training program using DT and VAR with industry input

Deploy
- Apply the program for a few tasks for testing

Evaluate
- Conduct a case study to evaluate the effectiveness and satisfaction on both the user/trainee and the industry's ends



▲User hitting on virtual tiles for testing for tile drumming phenomenon

▼Details on bathroom sink inspections being displayed to the user

▲User is doing a trivial to learn the right tools for inspecting furniture

Results

- Questionnaire shows new routine have better user experience and learning rate
- Programme allows training at anytime to fit the schedules at no quality loss
- Labor shortage of tasks covered by the system are relieved to some extent
- More tasks are to be adopted in industry

Compare	Traditional	MR powered method
Learning	Apprentice uses physical booklet	MR tutorial allows the apprentice to learn from the master at any time anywhere
Internship	The master teaches the apprentice to practice and test on the spot	
Inspection	Apprentice follows a physical booklet to inspect	Apprentice can revise a MR tutorial during inspection
Evaluation	Veteran efficiency-average 75% complete (Comparing the report and real situation)	Veteran efficiency-average 90% complete (Comparing the report and real situation)
Persistency	The master will retire and intricate details may be lost	MR tutorial will always able to provide comprehensive teachings

Discussion

- DT and VAR technologies can be applied on serious training and tasks
- Immersive and interactive experiences enhance user engagement and learning
- VAR also enhances the entertainment depths when used in gaming
- Further research is needed to fully explore the potential of DT and VAR

References

[1] K. Gerling, M. V. Birk, R. L. Mandryk, and A. Doucette, "The Effects of Graphical Fidelity on Player Experience," Proceedings of International Conference on Making Sense of Converging Media, pp. 229–236, 2013, doi: 10.1145/2523429.2523473.

[2] V. O. De Jesus, "Impact of Graphical Fidelity on a Player's Emotional Response in Video Games," MS thesis, Purdue University, 2013. [Online]. Available: https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1031&context=cgttheses

Contact Dr. Jimmy Chi-Ho Li
chli@ieee.org

Acknowledgement
The work described is part of the research projects (Project Reference nos. 2020/3003 (R7016), 2021/3002 (R7026) & 2021/3005 (R7031)) and was substantially supported by a grant from the Research Matching Grant Scheme, Hong Kong Metropolitan University and Hong Yip Service Co. Ltd.

香港都會大學
科技學院
Hong Kong Metropolitan University
School of Science and Technology
建築與品質管理系
Department of Construction and Quality Management
HKMU