Final Measurement and Verification Report for I&T Trial Project

CAVE Training Simulators about BIM-AM for Tin Shui Wai Hospital

I&T Project No. : P-0025
I&T Wish No. : W-0045
I&T Solution No. : S-0077

E&M InnoPortal

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Purpose of the Project and Target Deliverables

CAVE (Cave Automatic Virtual Environment) is a virtual reality environment consisting of large, fixed screens to display 3D models to provide users immersive experience. On the other hand, EMSD had been developing Building Information Modelling-Asset Management (BIM-AM) as a unify platform for up-to-date static and dynamic information of Electrical & Mechanical (E&M) installations such that EMSD frontline O&M staff could respond faster to incidents and emergencies, especially at mission critical venues such as hospitals. In light of the advantages to Electrical & Mechanical (E&M) O&M by CAVE and BIM-AM, this project integrated both technologies into a Training Simulator for EMSD Technician Trainees (TTs) and in-service staff.

Project Description

In this project, an immersive CAVE system was implemented for providing Electrical & Mechanical (E&M) training. The simulator would provide an emergency training for EMSD trainees and in-service staff. The training would integrate the simulated environment of Tin Shui Wai Hospital and the use of BIM-AM to locate, to investigate and to resolve the emergency situation.

Trial Site

The trial site is at E&M Inno zone, 4/F of EMSD Headquarters.

Type of Equipment/ Installation/ Technology Adopted

The Immersive CAVE, which is a room-sized VR theatre that immerses a group of users into the same virtual environment with spatial sense and human 1-to-1 scale. By integrating high-resolution, multi-sided projections, 3D reality simulation and dynamic timeline, the Immersive CAVE makes team-based immersive training sessions, engineering design and information-rich analysis possible.

To provide the most realistic training application, 3D photorealistic model of the Hospital with enhanced BIM and aerial photography was created. With the use of the seamless CAVE environment, multiple users can access to different areas of the hospital without the need of wearing any head devices like VR goggles or 3D glasses. The CAVE helps to replicate scenarios that are dangerous and non-accessible, helping users to prioritize in emergency situations, learn and control the BIM-AM and fully understand the whole procedure.

The inner and outer dimension of the 4-side projector CAVE are approximately 3400mm (W) x 2550mm (D) x 2550mm (H) and 6900mm (W) x 4350mm (D) x 3150mm (H) respectively. The hardware and software deployed in the trial is listed in table below.

Equipment list	Quantity
1 CAVE Display Structure - 1 pc of immersive CAVE frame	1-set
2 CAVE Display Screen - Curved projection screens at two vertical sides - Projection screen on floor	1-set
3 Projector - Epson EB-G7500UNL WUXGA 3LCD Projector with 4K Enhancement - Resolution: 19020 x 1080 with 4K enhancement - Brightness: 6500 lumens - Lens Lock	4-set
4 Server - 2 sets of Ultra Performance Processing Unit Intel Xeon W-2145 Processor	2-set
5 Mouse and Keyboard - Logitech MK545 Wireless Combo KB and mouse	2-set

Equipment list	Quantity
6 Monitor - Samsung 23.5" wide, PLS panel, WLED, VGA, HDMI (Black) Monitor	2-set
7 IR Touch System - Infra-red touch for the front wall	1-set
8 Joystick - Wireless joystick controllers	3-set
9 Mobile Phone	2-set
10 Sound System - Logitech Z506 (5.1 surround sound system)	1-set

Trial Timeframe

The trial timeframe was 1 Sep 2018 to 31 Mar 2020.

Name and Background of I&T Solution Provider

Chain Technology Development Co. Limited

Founded in 2016 at the Hong Kong Science Park, CHAIN Technology Development Co. Ltd is an innovator that specializes in developing Digital Twin solutions for the Architecture, Engineering, Construction & Operation industry. It developed the Hybrid Reality Platform (HRP) which integrates cloud computing, Internet of Things (IoT), Big Data Management, Artificial Intelligence, Building Information Modelling (BIM) and 3D Mapping, etc to provide intuitive visualization on massive data and insights for better decision making throughout the whole lifecycle from design, construction, operation to facility management. CHAIN also developed the Immersive CAVE solutions and advanced 3D content creation technology.

Details of Implemented Trials

I. Methodology and Applicable Standards

- Immersive Cave Design & Implementation

The Immersive CAVE can be custom made, from the hardware to the outlook design according to the client's request and the specific requirement given in the location. The design of the CAVE in this trial was tailor-made specifically for the daily training and project showcase in EMSD.

- Multiple User Collaboration & Naked Eye Experience

The capacity of the CAVE can hold multiple users and no goggles are needed to support presentations and promotional events as multiple users can collaboratively discuss on the 3D contents from a different angle, giving users a totally unique experience to reach realisation of conceptual ideas.

CAVE Interaction: With the use of motion sensing, Multi-touch Wall and mobile app, the interactive user experience was enhanced because users can remain control of the content they see by using natural gestures.

- - Training Storyline Creation

The training storyline was specifically designed and created to help staff to be fully capable of monitoring and controlling the BIM-AM of the hospital in emergency situations. The training starts with explaining the whole E&M system of the hospital and visually showing the whole pipeline of the system structure, different emergency situations will then appear and the user will then be guided through for the whole situation from how to locate the emergency area to priorities which problem to be dealt with.

- 3D Model Creation

To enhance the whole CAVE experience, realistic content creation were created by drone, laser scanning and 3D modeling. BIM/CAD models were also used for BIM adaptation and enhancement. For the particular training in this trial, the outdoor reality modelling of the surroundings was combined with BIM of the Tin Shui Wai hospital to enhance realistic experience of users.

Figure 1. Immersive CAVE & Photorealistic Modeling for Training & Digital Twin Visualization

Figure 2. 3D Photorealistic Content with First Person Perspective

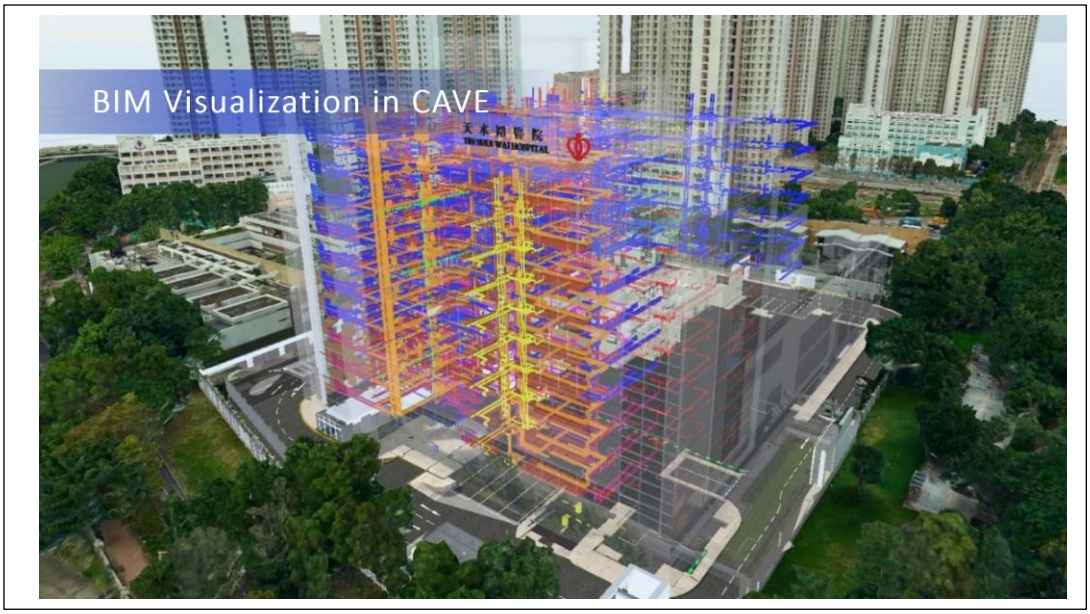

Figure 3. Training Content Integrated with BIM

II. Measurement and Verification Activity Details

The solution had been demonstrated to guests visiting to 4/F inno zone and operated for training during the trial period. Through the application trial, the solution deployed turned the structural BIM to a photorealistic 3D model which leads to huge possibilities of many other applications. With the photorealistic quality and accurate spatial and non-spatial information in the BIM, users can utilize the model in training, operation, design and advanced construction visualization as well as Digital Twin model visualization.

Apart from BIM, this solution also demonstrated the integration between the reality model formed by aerial photography and BIM. This has further enhanced the combined use of such modeling technologies in the industry.

Photo 1. Enhanced BIM

Photo 2. Reality Model by Drone

Summary Results and Analysis

I. Pre and Post-installation Comparison

The CAVE system makes use of large, fixed screens more distant from the viewer to allow a small group of users to collaboratively examine and manipulate complex 3D models with natural interaction and human 1-to-1 scale. Different from Head-mount-device (HMD), a small group of users could communicate naturally (e.g. see each other's body language) and use other devices (e.g. tablet, paper and pen) concurrently.

II. Analysis of M&V Results to Address the Target Deliverables

The CAVE allows multiple users to become fully immersed in the same virtual environment at the same time. The solution integrates both CAVE and BIM-AM technologies into a Training Simulator for EMSD Technician Trainees (TTs) and in-service staff. The solution could simulate the realistic environment for EMSD TTs and in-service staff for emergency training on the application of BIM-AM.

Conclusion and Way Forward

The Immersive CAVE and its applications have been proven in the trial in EMSD and widely adopted in various government departments, public organizations and private sectors. It is suggested the Immersive CAVE solution to be further enhanced with flexibility to cope with different user requirements and integrate their Digital Twin solutions for more instant data availability and human centric visualization.

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Digitalisation & Technology Division

Electrical and Mechanical Services Department

17 April 2020