P<2888.4>™/D<01>  
Draft <Std.> for <Architecture for Virtual Reality Disaster Response Training System with Six degrees of Freedom (6DoF)>

Developed by the

< Interfacing Cyber and Physical World Working Group>

of the

IEEE <Computer Society>

Approved <Date Approved>

IEEE SA Standards Board

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**Abstract:** <Select this text and type or paste Abstract—contents of the Scope may be used> -

1. Architecture for Virtual Reality Disaster Response Training System with Six degrees of Freedom (6DoF) is defined.
2. (Scope version) This standard defines to provide a standard architecture of a system used when creating VR content for training in preparation for disaster situations that are difficult to implement in the real world.

Keywords: <Select this text and type or paste keywords>

**Keywords:** Large space, Disaster, VR, Virtual Reality, Training, Motion Tracking, Architecture

[[1]](#footnote-2)

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Introduction

This introduction is not part of P<2888.4>/D<01>, Draft <Std> for <Architecture for Virtual Reality Disaster Response Training System with Six degrees of Freedom (6DoF) PAR>.

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Draft < Std.> for <Architecture for Virtual Reality Disaster Response Training System with Six degrees of Freedom (6DoF) PAR>

1. Overview
   1. Scope

This standard defines a standard architecture for the technology required for “building a large space-based disaster response virtual reality training system” required to simulate a response to a disaster that can occur in a large-scale physical space by applying virtual reality technology.

1) Digital twin-based 6DOF configuration (6DOF sense of space) that delivers multiple sensor data from a wide real space to the virtual world to provide a realistic spatial experience in a virtual space

2) Large space VR Disaster Response Training System Design

3) Large space VR Disaster Response Training Content Design

4) Large space VR Disaster Response Training System Construction & Operation

* 1. Purpose
  2. Word usage

***<This subclause is mandatory and shall appear after the Scope and Purpose (if included).>***

The word shall indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).[[2]](#footnote-3),[[3]](#footnote-4)

The word should indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (should equals is recommended that).

The word may is used to indicate a course of action permissible within the limits of the standard (may equals is permitted to).

The word can is used for statements of possibility and capability, whether material, physical, or causal (can equals is able to).

1. Normative references

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- Sensor gathering shall be in accordance with 2888.1. You just have to write the  
~see 2888.2.  
~see 2888.3.

1. Definitions, acronyms, and abbreviations
   1. Definitions

For the purposes of this document, the following terms and definitions apply. The IEEE Standards Dictionary Online should be consulted for terms not defined in this clause. [[4]](#footnote-5)

VR Walkthrough: A technology that allows users to experience virtual objects while walking in virtual reality space. Such technology provides superior experience of freedom, angle diversity and informational and interactive play compared to traditional methods of using controller-to-controller movement.

Disaster response training system: A system applied with technology that allows users to feel realistic in a virtual reality space with 6DoF freedom by walking freely.

Six degrees of freedom (6DoF): The freedom of movement of rigid body in three dimesional space including translational movements along each axis and rotaltional movements around each axis. 6DoF can be used to describe rotational movements (roll, pitch, yaw) and translational movements (forward/back, left/right, up/down).

S[ix degrees of freedom (6DOF)](https://ieeexplore.ieee.org/browse/standards/dictionary?queryText=six%20degrees%20of%20freedom%20(6DOF)&termId=3852236254991157585): Six operating elements of a moving object in three dimensional space. 6DOF can be used to describe rotational movements (roll, pitch, yaw) and translational movements (forward/back, left/right, up/down). ( <http://dictionary.ieee.org>. )

VR (Virtual Reality): A technology that creates a virtual world with a sense of reality on a computer.

VR (Virtual Reality): Refers to any specific environment, situation, or technology that either simulates actual reality or creates virtual spaces and objects according to the imagination of humans using computer graphics or videos. ( <http://dictionary.ieee.org>. )

AR (Augmented Reality): A technology that overlaps the real world that users see with their eyes and displays virtual objects with additional information in real time in a single image.

MR (Mixed Reality): A realization technology that expresses by mutually augmenting real and virtual objects.

XR (eXtended Reality): An ultra-realistic technology and service that encompasses mixed reality (MR) technology that encompasses virtual reality (VR) and augmented reality (AR).

Metaverse: World in which the cyber world and the physical world interact and resonate to create values through social, economic, and cultural activities.

Realistic Content: Digital content that can recognize and analyze human behavior such as human gestures, movements, and voices using various sensors and interact with objects in the content while feeling real.

Framework: A system that provides functions in a series of collaborative forms so that designs and implementations corresponding to a specific part of software can be reused.

Interaction: An activity in which characters and objects of content induce feedback such as movement, sound, and manipulation according to the user's action.

Motion tracking: A technique for tracking people moving in real space and applying them to characters in virtual space.

Optical cameras: A camera used to track human motion by projecting an object to the same point from at least two cameras and then inverting the three-dimensional coordinates of the object through triangulation.

IoT(Internet of things): Technique that connects to internet using sensor and communication function built into various things.

HMD (Head Mounted Display): A display device that is combined with 3D display technology and worn mainly on the head for virtual reality or augmented reality implementation. It is a display device equipped with sunglasses-type lenses made of light and thin materials such as LCD and OLED so that objects can be seen from the closest place by mounting them on the head.

Digital twin system: A system that enables the real world to connect and interact with each other by implementing machines, equipment, and objects in the real world equally in the virtual world in the computer.

Haptics: A technology used to verify product design and process design, allowing users to feel reactions or loads to movement using devices that can feel the touch in virtual space.

Tracking server: A server that provides information on the location and direction of objects and people collected from various tracking sensors.

Tracking marker: A marker for recognizing by attaching it to an object or human body to be tracked in a motion capture system. The 'passive marker' is covered with a material that reflects infrared rays generated by the IR camera, and the 'active marker' uses the flashing of the LED itself.

VR Backpack PC: A backpack-shaped PC equipped with high-performance CPUs and GPUs and powered by batteries so that users can freely move around virtual spaces and run VR content with stable frames.

Calibration: A technology that provides more accurate motion tracking by calculating the position and direction of each IR camera used for motion tracking and the degree of distortion of the captured image. These calculations should be performed periodically due to ambient factors such as temperature fluctuations or other environmental conditions that may naturally degrade calibration accuracy over time.

Rigidbody: A collection of three or more markers on objects interconnected with each other, assuming that objects tracked by the IR camera are impossible to deform. Each object can be distinguished by a pattern of three or more markers.

Latency: The delayed time occurring at the runtime of content (e.g., game or simulation) that appears on the screen as a result value when a user performs a task or task.

IMU(Inertial Measurement Unit): A unit device that measure power, angle and ratio using accelerometer and tachometer.

Gloves: Devices for tracking hands

Accelerometer: A sensor for measuring linear acceleration or angular acceleration by measuring inertia-induced reaction.

Device Controller: A physical device that generates an interactive elements in a virtual space through a physical input signal.

Physical space: A space of reality where a substance or object may exist or something can happen.

Virtual space: A space created virtually by computers and the Internet and is not a real world.

Vitual Object: Objects for interaction in virtual space.

* 1. Acronyms and abbreviations

fps frame per second

HMD head-mounted display

IMU inertial measurement unit

6DoF six degrees of freedom

VR virtual reality

AR augmented Reality

MR mixed reality

XR extended reality

**4.General Architecture**   
  
**4.1.Introduction**  
  
**4.1.1.General**  
 This standard describes: In a virtual reality space composed of a three-dimensional digital space, all movements are projected as they are in the real space, and the following four factors must be met as important factors to consider in order to feel immersive that you are walking naturally like in reality. .

1) Digital twin-based 6DOF configuration (6DOF sense of space) that delivers multiple sensor data from a wide real space to the virtual world to provide a realistic spatial experience in a virtual space

2) Large space VR Disaster Response Training System Design

3) Large space VR Disaster Response Training Content Design

4) Large-space VR Disaster Response Training System Construction & Operation Guideline

This standard enables the realization of digital twin technology in which the information of physical behavior in the real space that makes the above four possible can be delivered to the virtual world as it is, and it is a technology developed to move on foot using a wide space “large space virtual reality walk” It is based on a “through system”.

In general, it is difficult to use content while moving in VR without the constraints of space like reality. A space plan is needed to allow the use of a large virtual reality space in a somewhat limited real space. As such, the 6DOF sense of space like in reality, interaction technology in the virtual world and walking movement, and digital twin technology that connects reality and virtual reality will be of great help in realizing virtual reality contents in response to disasters that can occur in large-scale physical spaces. is. The following subsections provide an overview of these areas.

테이블이(가) 표시된 사진

자동 생성된 설명

<Reference architecture of a digital twin 6DOF disaster response system>  
  
**4.1.2.6DOF   
  
4.1.3.Large space VR Disaster Response Training System Design  
  
4.1.4.Large space VR Disaster Response Training Content Design  
  
4.1.5.Large space VR Disaster Response Training System Construction & Operation Guideline**

**4.2.General design principles**

**4.2.1.6DOF**

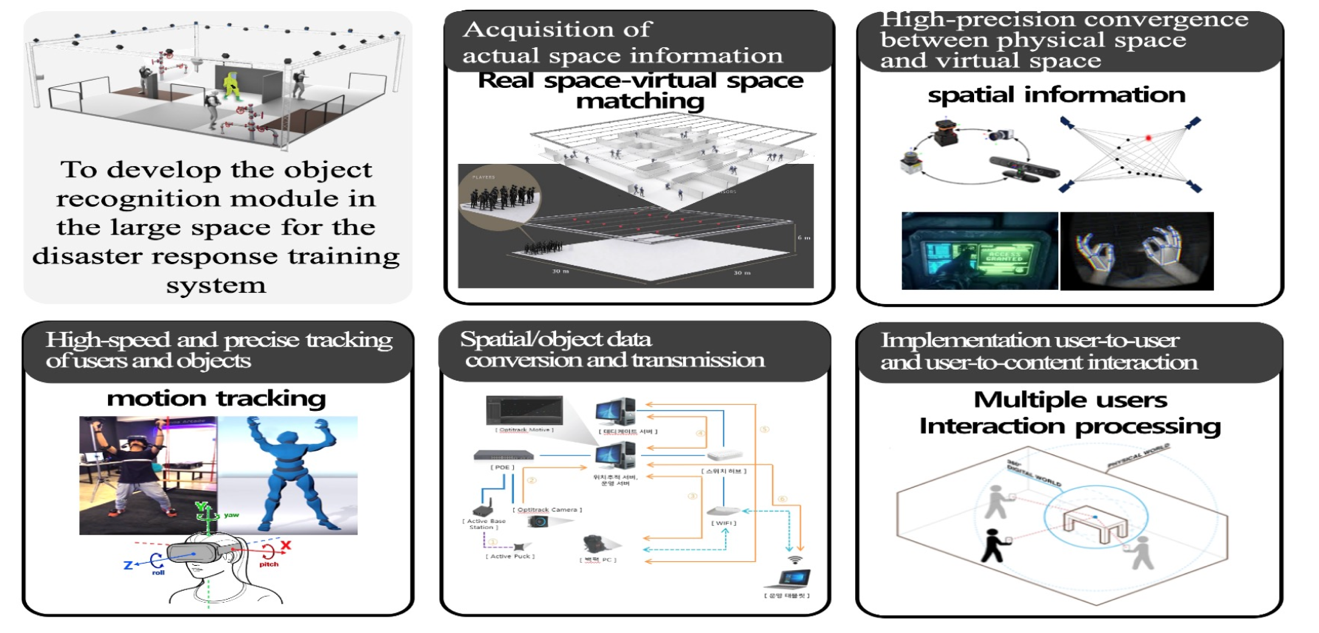
**4.2.2.Large space VR Disaster Response Training System Design  
  
4.2.3.Large space VR Disaster Response Training Content Design**  
 **4.2.4.Large space VR Disaster Response Training System Construction & Operation Guideline**

**5. Large space VR Disaster Response Training System Design**

**5.1.General**

**5.2.General scope**

To develop the object recognition module in the large space for the disaster response training system, the following detailed development goals are derived

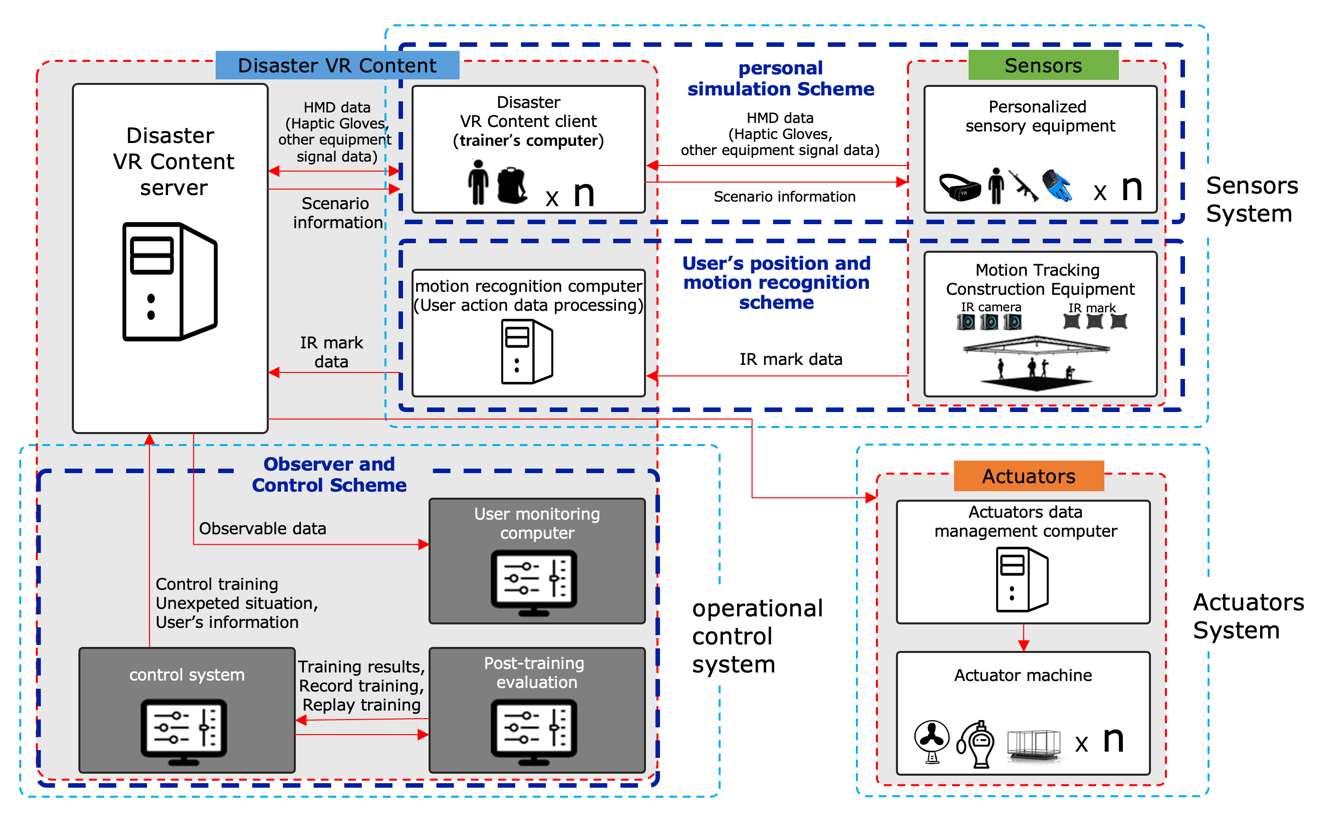


<2 Large space VR Walk through System>

1. Acquisition of actual space information  
2. Spatial/object data conversion and transmission  
3. High-speed and precise tracking of users and objects  
4. High-precision convergence between physical space and virtual space   
5. Implementation user-to-user and user-to-content interaction

**5.3.Use cases**

**5.3.1.Use cases of Large space VR Walk through System**



<Use cases of Large space VR Walk through System>

* In the Sensors part, the data obtained from the position and motion recognition sensors are delivered to Disaster VR Content clients through the sensor data converter.
* In the Disaster VR Content part, the data received from the Sensor part is reflected to the content client, and the Disaster Anlayzer sends it to the Actuators part through the Command Data Converter.
* (Also the observer is a client too, it does not receive sensor data and reflects the user's position and motion to the observer in real time.)
* In the Actuators part, the data received from the Disaster VR Content part is operated through the Command Data converter.

**5.3.2.Large space VR Disaster Response Training System of User Tracking Use case**

텍스트, 하늘이(가) 표시된 사진

자동 생성된 설명

* It is possible to check the sensory equipment data that is converted according to the user's interaction by enhancing the matching precision between the real space and the VR space.
* Based on 3D spatial location information matching technology, direct interaction is possible by matching the location of objects in the real space with the 3D virtual image in the virtual space using sensory equipment.
* It proceeds to enable precise tracking by attaching a marker that can recognize the location and motion to the user.
* Motion sensors are attached to the location of the user's head, upper body, arms, and HMD is worn to enable walking like in real life, providing a maximized sense of reality like a real situation.

**5.4.Requirement**

**6. Large space VR Disaster Response Training Content Design**

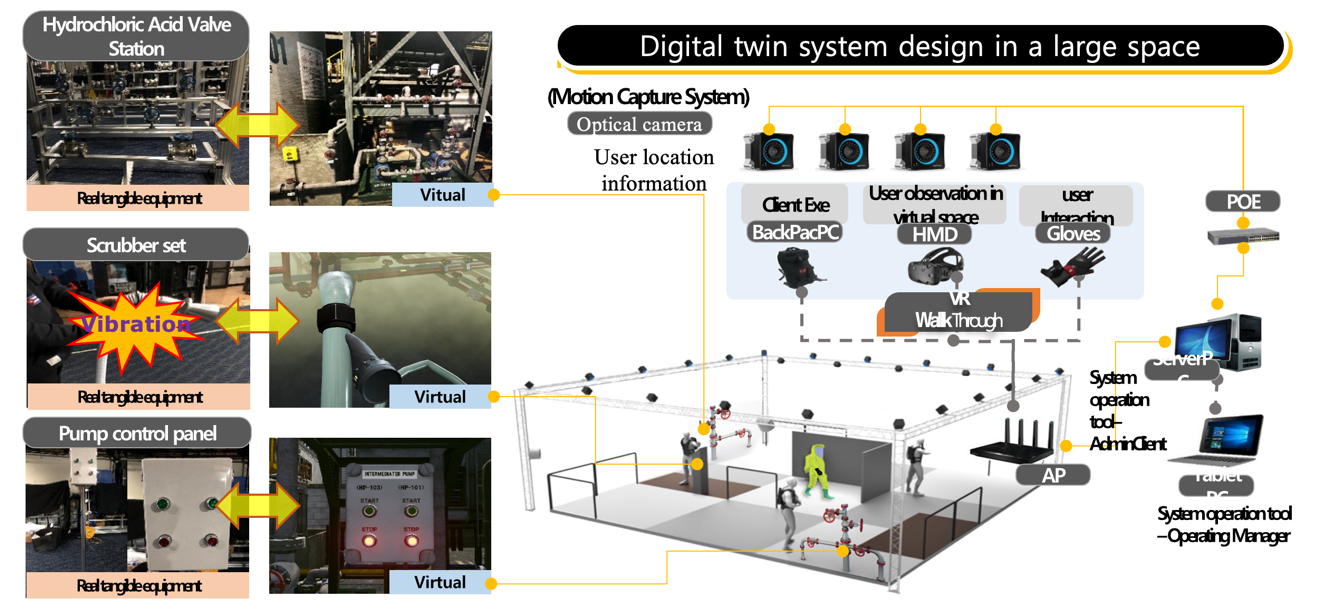
**6.1.General**

**6.2.General scope**

**6.3.Use cases**

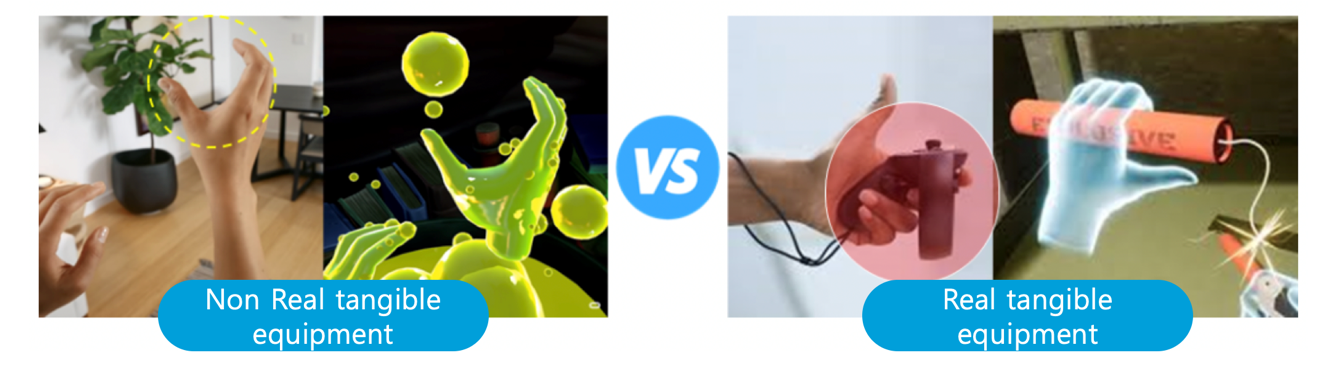
**6.3.1.Chemical Accident Disaster Prevention Training System**

* Example of development of a virtual reality training program capable of chemical accident disaster prevention training



<Large-space chemical accident response training system>

* Establishment of a large space virtual environment based on actual chemical facilities
* Applied haptic VR technology based on real-time user location/motion tracking
* Development of training scenarios for collaboration with 4-5 people and design of multi-user flow
* Accurate interaction between real tangible equipment and virtual equipment is applied
* Establish a training evaluation system using data of users in a large space acquired during training
* **Matching real objects and objects in virtual space**
* It is a technology that allows users to feel the sense of touch by matching real objects with virtual objects. It provides objects that can be touched in real space, and it provides excellent immersion to users by matching the objects in various forms in the virtual space. .

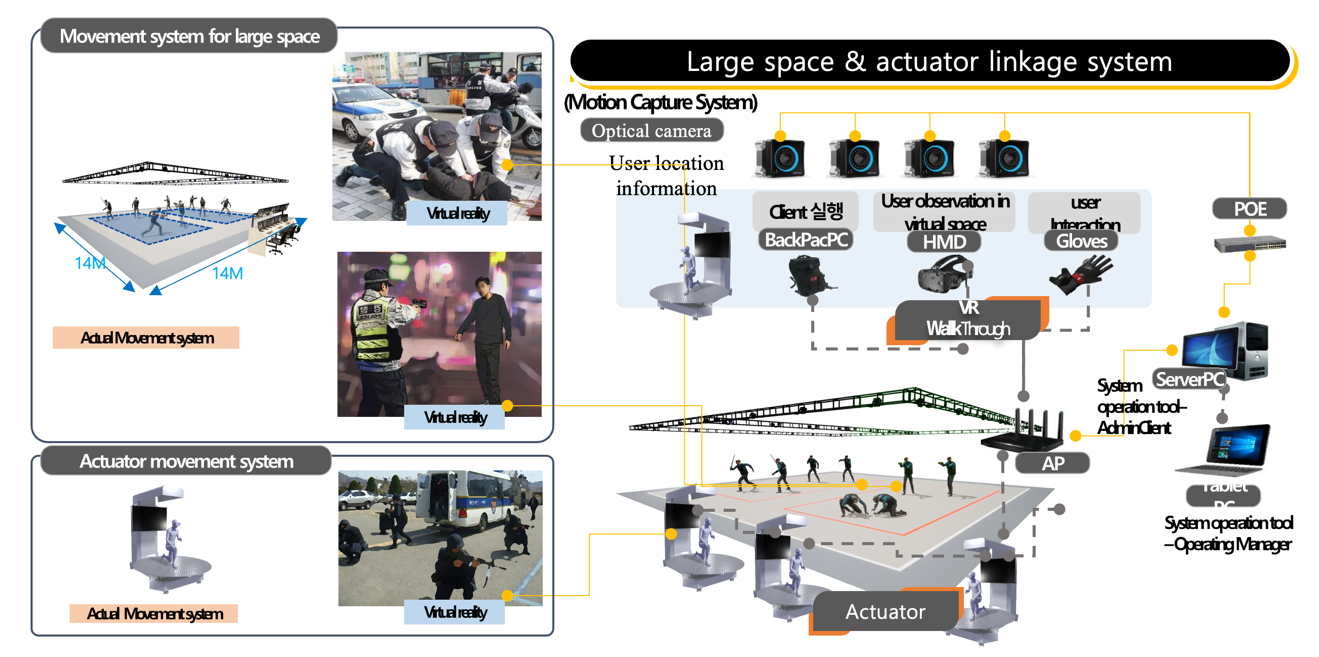


<Matching real and virtual objects>

* By adding a vibration function or button to an actual object, you can provide feedback on the interaction to the user in the form of vibration.
* As shown in the picture above, real objects can be expressed in various forms in virtual space, so you can freely express them according to the purpose and purpose of the content.
* **Benefit**
* By giving various shapes and functions to one object in the real space to be matched, there is no need to produce objects according to functions, so development cost is reduced.
* In reality, objects with problems such as cost and size can be implemented in virtual space, so it is possible to provide various experiences to users.

**6.3.2.Public security response training system linked with large space & actuator**

* **Example of system development**



<Public security response training system linked with large space & actuator>

* Building a virtual environment at the actual measurement level of practical security incidents of natural walking movement based on large space
* Long-distance travel is built with actuator movement system
* Application of tangible VR technology based on real-time user location/motion tracking
* Developing collaborative training scenarios and designing multi-user movement lines by interlocking large spaces and actuators

**6.4.Scenarios**

**7. Large space VR Disaster Response Training System Construction & Operation Guideline**

**7.1.General**

**7.2.General scope**

**7.3. Large space VR Disaster Response Training System Construction Guideline**

**7.4. Large space VR Disaster Response Training System Operation Guideline**

**(informative)Bibliography**

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2. The use of the word must is deprecated and cannot be used when stating mandatory requirements, must is used only to describe unavoidable situations. [↑](#footnote-ref-3)
3. The use of will is deprecated and cannot be used when stating mandatory requirements, will is only used in statements of fact. [↑](#footnote-ref-4)
4. IEEE Standards Dictionary Online is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page. [↑](#footnote-ref-5)