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| Re: |  |
| Abstract | This document is written in the form of the context required for the proposal of evaluation method of VR/AR/MR/XR training system |
| Purpose | This document was submitted to propose evaluation of VR/AR/MR/XR training systems |
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**Evaluation method of VR/AR/MR/XR training system**

# 1. Introduction

## This document proposes standardized guidelines for the evaluation method of VR/AR/MR/XR training systems in various industrial areas, reducing high cost and high risk compared to the training systems in the real world. Scope of VR/AR/MR/XR training system

In this document, VR/AR/MR/XR training systems are intended to increase trainees’ manipulation and procedural skills or knowledge in a specific area using VR/AR/MR/XR technology. Therefore, this document focuses on the training effect from the trainee’s perspective. Also, it should provide feedback to trainees so that they can check differences before and after the training. 2. Evaluation factors

* 1. Terms and Definitions

The VR/AR/MR/XR training system can be defined by dividing it into functional training and situational training according to the type of training being developed/operated.

Functional training enhances the trainee's ability to operate/utilize equipment functions.

Situational training focuses on helping trainees achieve their goals through rational decision-making according to a given situation, as below table.

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| Training type | Manufacture | Pubilc |
| Functional Training | Welding, Electrical Equipment, Assembly, etc. | Fire extinguisher operation, Gun manipulation, Protective gear wearing, etc. |
| Situational Training | Toxic Gas leak accident, Prevention of fall/entanglement accident, etc. | Tactical Training, Building fire suppression/rescue, etc. |

# 2. Evaluation factors

## Usability

Usability refers to an attribute that assesses how easy VR/AR/MR/XR training systems are to use. We suggest measuring motion sickness/visual fatigue, visibility, controllability, or stability to evaluate the usability of VR/AR/MR/XR training systems by questionnaire or measuring physiological signals such as EEG, PPG, or eye-tracking. The followings are examples of usability metric

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| --- | --- | --- |
| Evaluation factors | | Questions |
| Controllability | Flexibility and efficiency | 1. How simple is the head movement to manipulate the UI while wearing the HMD? 2. How simple is the operation and controller operation for the input? 3. How many different ways are there to do a single task? |
| Controllable Range | 1. To what extent is it possible to start or end content while wearing the HMD? 2. How is it possible to change the settings of the HMD and contents while wearing the HMD? 3. To what level can you manipulate content while wearing an HMD |
| Consistency | 1. How consistent is the motion for input and control of the controller while wearing the HMD? 2. How consistent is the motion for input and controller operation while wearing the HMD to start using the content and operationg the content? |
| Visibility | System visibility | 1. How mych can you grasp the progress and current status of the content while wearing the HMD? 2. How easy is it to grasp the user’s locations and orientation in virtual space? 3. How much is it possible to understand the situation outside the content and outside the HMD while wearing the HMD? |
| Consistent with Reality | 1. How consistent is the language or icon of the UI with reality 2. How much is the same language or icon for UI manipulation consistent with reality? |
| Simple Design | 1. How much extra head movement is needed for UI manipulation while wearing HMD? 2. How clear is the distinction between content and UI for manipulation? |
| Stability | Mistake and accident prevention design | 1. How confusing is the operation for input and control of the controller while wearing the HMD? 2. How far can the user know the result of the input while wearing the HMD? 3. How many warnings are there for giving a hard to revert order? 4. How low is the risk of safety accidents due to external circumstances while wearing an HMD? |
| Error countermeasure | 1. In the event of an error, how far is the recovery powwible whitle wearing the HMD? 2. When an error occurs, how far can the situation be grasped while wearing the HMD? 3. If the motion inpuy assumed during development is not recognized, how mych are the means to replace it? |
| User help | 1. How much do you get help while wearing an HMD? |

<Examples of usability factors>

## Effectiveness

Effectiveness refers to factors which VR/AR/MR/XR trainee is anticipated to achieve after training system such as increase of immersion, interest, accuracy or completeness of task, time of task completion. It can be measured by a questionnaire, physiological signals such as EEG, PPG, or eye-tracking.Effectiveness would be different to various types of the training system.

For example, in equipment function operation training-based VR, the trainee repeatedly performs trained motion or action sequences to operate the equipment and checks the training result through a test.

In general, the training system presents pass/fail or performance scores for the trainees’ test results, and these requirements include training target indicators such as required time and completion rate. User evaluation can analyze how these training goals are achieved effectively due to VR/AR/MR/XR technology.As another example, situational training is more complex than equipment function operation training.

Some situational training has manuals on response procedures for each situation. This training measures the score according to the trainees’ response behavior for each situation and criticizes the correct behavior and problems. The military, police, and firefighting fields are mainly high-risk, high-cost training areas, so the training system has been developed for a long time. To accurately evaluate the training effect, such a critique system must exist. If not, there is a need to create a credible critique system. If such a critique system is not prepared, indirect factors such as engagement/concentration, interest-inducing level, and training attitude (e.g., emotional aspects) that affect training can be evaluated.

# 3. Conclusions

We suggest discussing the proposals mentioned above during the IEEE 2888.5 meeting session and standardizing them in the IEEE 2888.5 project.