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A Study on HMD-AR based Industrial Training System for Live Machinery Operation

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Abstract

As technological development is progressing recently, various technologies are actively being studied in the course of the 4th industrial revolution. So, even in the educational field, virtual reality and augmented reality technology are used in educational environments, but specialized additional equipment is required and the price is very expensive. Also, since a plurality of equipment are required for a large number of people, it is urgent to study the technology that can be effectively applied to the industrial education field. So in this paper, we propose an industrial training system for HMD-AR, MPEG-DASH and SOAP based HTTP based Live Machinery Operation using Smartphone to solve the problems of existing system.

Keywords: *HMD-AR, Industrial Training, Live Machinery Operation, Augmented Reality*

1. Introduction

Due to recent developments in technology, various technologies are actively researched in the course of the 4th Industrial Revolution. IoT(Internet of Things) is leading of 4th Industrial Revolution, and virtual reality and augmented reality in movies that are also researching. Virtual reality is an advanced technology compared to the existing simulation technology. It creates a virtual environment by using a computer and enables users to interact with virtual reality and create user experiences that realistic spatial and temporal experiences[1]. unlike virtual reality, Augmented reality is a technology that increases the effect of reality by utilizing computer graphic technology based on existing reality and changes the nature of physical space by combining artificial data in physical space. Currently, virtual reality and augmented reality technologies are used in education and training, but additional specialized equipment is needed to build the system and it is

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used only in limited fields because it is expensive[2]. Furthermore, it is difficult to use a large number of people at the same time, and it is difficult to provide additional information while practicing[3].

So, we propose HMD-AR based Industrial Training System for Live Machinery Operation. It constructs an HMD using a smartphone, shoot educational materials or exercise equipment through a camera embedded in a smart phone. It can provide more effective education environment by linking with the lecture environment by providing the streaming function.

The contents of this paper is as follows. The first section starts as an introduction. The second section describe the limitations of the existing technology and the necessity of the proposed technology. The third section consists of explanation of HMD-AR based Industrial Training System for Live Machinery Operation. Finally, the fourth section concludes the paper.

2. RELATED WORKS

In order to deviating from existing limitations that had to be provided with theoretical and practical lectures depending on the naked eye, Modern educational audiovisual systems are being offered by utilizing various visual and audiovisual materials such as beam projector, TV, etc. Through the rapid development of LED and LCD display technology in the 2000s, super-large displays of 100-inch or larger have become widespread, and It is possible to recognize and identify the object of the demonstration normally using the ultra-large display in large-scale classrooms or large-scale exhibitions that can accommodate more than 100 people[4]. In addition, CCTV or webcam can be applied to the training environment to provide a camera-based video transmission system by using a real-time video transmission system instead of an existing training or education system consisting of a single large-sized display. Technological advances have been made to provide a better audiovisual environment to the target audience, such as providing the subject with a picture of the performer in real time[5]. However, the tester cannot directly control the camera's FOV (Field of View, etc.) and therefore can only continue to transmit on to a fixed angle camera team, or video camera cameras can be controlled from a fixed angle[6].

In order to overcome these limitations, we proposed a new method using HMD-AR because the training method used in the existing industry has a limited content offering and one-by-one inefficiency over time.

3. HMD-AR based Industrial Training System for Live Machinery Operation

This section describes HMD-AR based Industrial Training System for Live Machinery Operation technology which a next generation application technology that provides new training method based on HMD-AR with smart device. With Object Tracking technology applied to HMD-AR, users wearing HMD-AR can recognize objects more precisely and precisely Moreover, it provides real-time streaming between HMD-AR and display technology implementation is possible.

This section consists of the concept of proposed technology, System architecture, and System Flow chart.

3.1 The Main Concept

'HMD-AR based Industrial Training System for Live Machinery Operation' aims to provide users with HMD-AR based industrial training for live machinery operation in industrial environment. In order to provide the user with information about the object (Machinery Operation) in real time, it is essential to establish a communication environment with the media streaming server. Through the data transmission / reception of wired / wireless environment between the smartphone based HMD-AR and the media streaming server, it is possible to recognize information about the object and provide the training service for the object.

In practice, in order to recognize an object using HMD-AR equipment, object tracking in HMD-AR should be applied. By extracting the features of the object through object tracking, the user can experience the visual effect on the training program stored in the object. Also, it is linked through the communication network connection between the HMD-AR and the display in the wired/wireless environment, and the same image information as the HMD-AR view is displayed on the display through the real-time streaming.

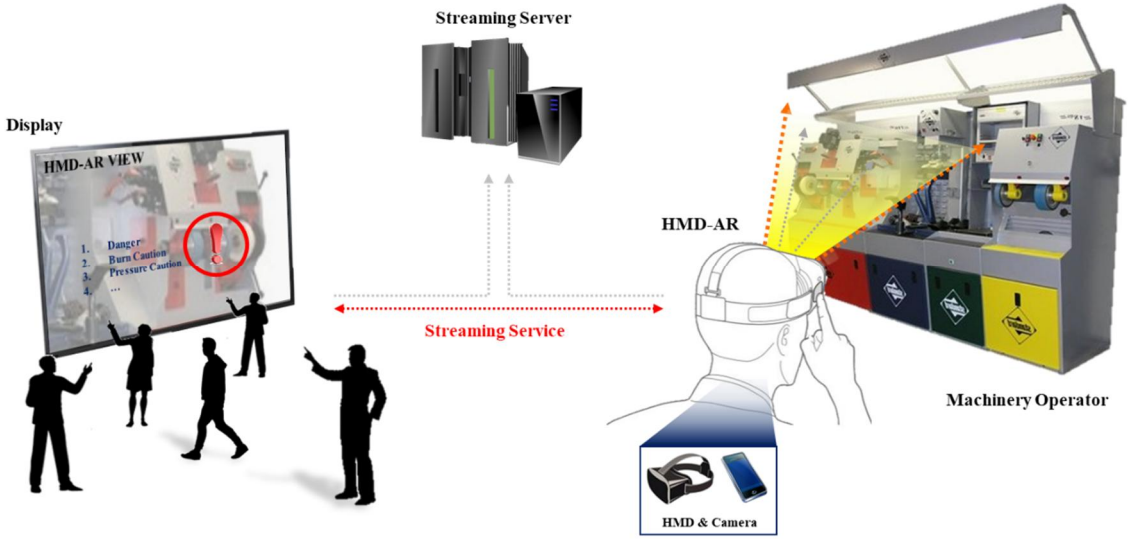

Figure 1. The Main Concept of HMD-AR based Industrial Training System for Live Machinery Operation

3.2 System Architecture

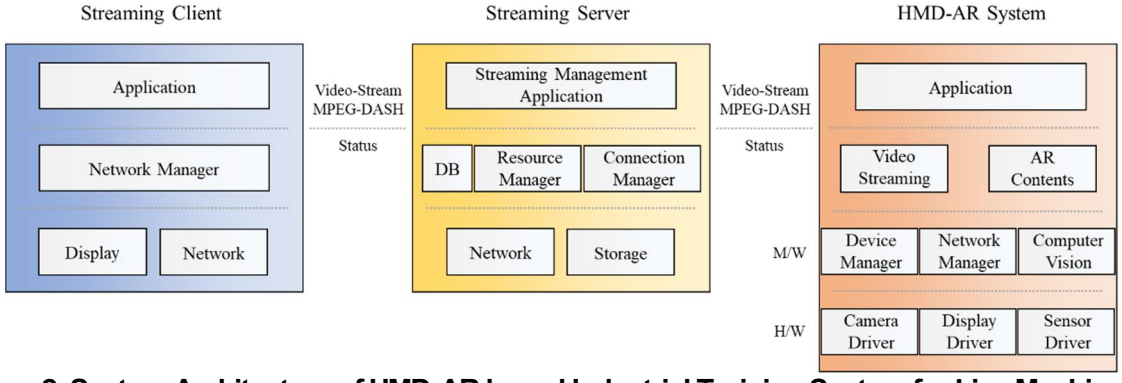

Figure 2. System Architecture of HMD-AR based Industrial Training System for Live Machinery Operation

The system architecture largely consists of an image source providing part using HMD-AR, a server part for managing video streaming, and a part for displaying streaming.

In the case of the part that provides the image source using HMD-AR, it is possible to provide immediate additional information about the equipment for the effective industrial training for the live machinery operation to many person, and it is possible to provide experience in the eyes of trainee through streaming without having to have a plurality of equipment for the practice. The HMD-AR part utilizes smart phones to build HMD-AR environment and provides most of the functions from smartphones and utilizes built-in sensors for smartphone's built-in camera and HMD environment, use smartphone built-in sensor for image generation.

The HMD-AR part is composed of a function for changing the generated image into MPEG-DASH-based video streaming in real time and a function for transmitting the current state of the HMD-AR.

The streaming server part manages / mediates the streaming between the HMD-AR and the display client, and supports a large number of people through the streaming server to enable industrial training in the eyes

of the practitioner. The components include video streaming storage, resource management for training, device connection management, and a management program for managing them integrally.

The Streaming Client part is a part for receiving and displaying the streaming video transmitted from the HMD-AR. It serves to display the training image created using the HMD-AR using the display, and at the same time, it can be applied flexibly according to the educational environment, such as expressing or supporting the practice to each user by utilizing a small / medium display. And The Streaming Client part consists of applications that receive video streaming according to the network management and selected contents, and display the video and deliver the current status to the server.

Data transmission / reception between each part utilizes HTTP based on SOAP, and MPEG-DASH standard is used for video streaming. MPEG-DASH is an adaptive video streaming standard that is adaptive to HTTP and used for adaptive video streaming support for optimal streaming according to network conditions for real-time education.

3.3 Flow Chart

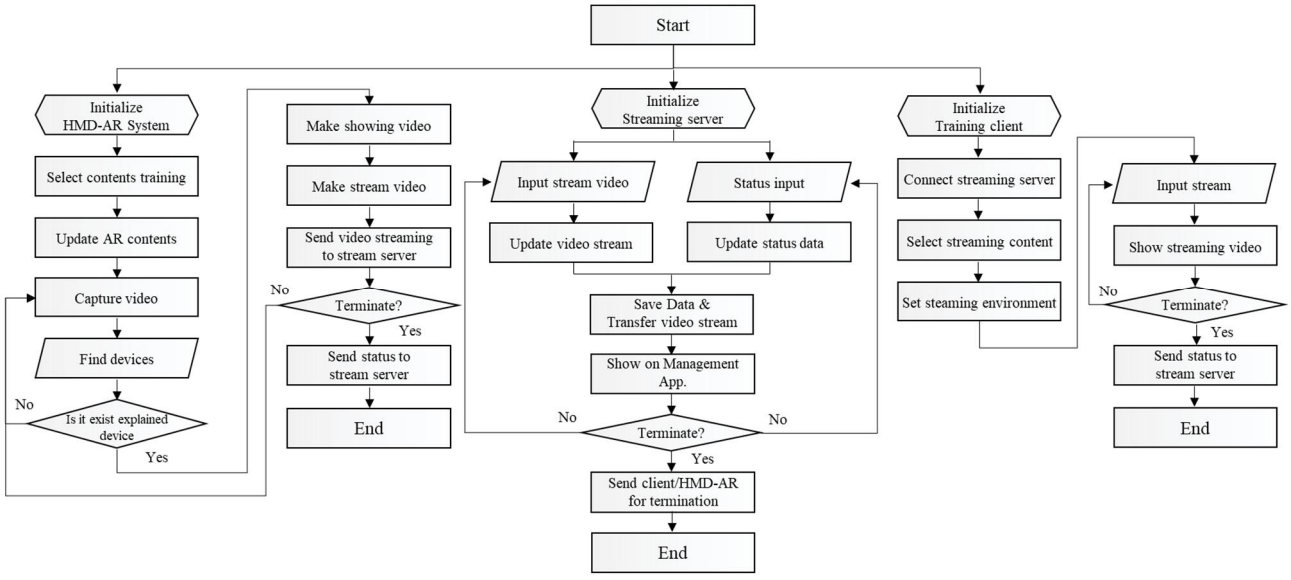

Figure 3. Flow Chart of HMD-AR based Industrial Training System for Live Machinery Operation

The HMD-AR based Industrial Training System for Live Machinery Operation consists of an HMD-AR part for generating video frame, a streaming server part for managing / transmitting images, and a streaming client part for receiving and displaying images.

When the system is started, an initialization process is performed in each part for performing a function, and then a working for system operation is performed. The HMD-AR updates the necessary information from the streaming server according to the education contents for Machinery Operation, and then capture equipment the equipment using the camera in the smartphone. If an explanation of equipment is required during shooting, a streaming image is generated for displaying updated information. In other cases, the image data acquired from the camera is transmitted on a frame-by-frame basis. Also, the state of the HMD-AR is transmitted to the streaming server whenever the state of the HMD-AR is changed, so that the state of the HMD-AR can be confirmed in the streaming server.

The streaming client connects to the streaming server after initialization, selects the video to be played, and displays it using the display. If the status is changed, the status is transmitted to the streaming server so that the streaming server can check the status in real time.

The streaming server performs initialization for streaming, and acquires the video stream received from the HMD-AR, and the status information received from the HMD-AR and the streaming client. Based on the acquired data, it exposes it to the management program and at the same time sends the video stream

according to the request of the streaming client. If the management program wants to terminate, send the termination command to HMD-AR or Streaming Client and terminate the system.

3.4 System Implementation

We conducted system implementation based on the designed system architecture and algorithms. The HMD-AR system is constructed using the HMD package that can utilize the built-in camera of the smartphone. and the display of the smartphone in HMD is displayed so that the wearer can confirm the image acquired from the camera. Figure 4 shows an HMD-AR site, that combines a smartphone with an HMD package and displays images captured from the camera on the display.

Figure 4. The Implementation of HMD-AR based Industrial Training System for Live Machinery Operation

As shown in Figure 4, the practitioner or the performer can stream the screen viewed by the practitioner or the performer through the HMD-AR device and share it with other users for industrial training. And also it is confirmed that the screen of the existing smartphone is divided into the HMD for convenient experiment.

4. Conclusion

In this paper, we suggest an HMD-AR based Industrial Training System for Live Machinery Operation with smartphone-based HMD-AR, MPEG-DASH, and SOAP. Applying this technology to industrial education can provide experience to users without supporting many equipment. Furthermore, it is expected that effective industrial training will be possible because it can be linked with existing educational infrastructure. Also it is expected that this study will be a valuable reference material for HMD-AR related research as well as industrial training system related to Live Machinery Operation through the results obtained from this paper. This positive effect is expected to have a significant ripple effect not only in industrial education but also in various education system systems. It is expected to be reflected in the field.

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