Self-learning/training Systems with VR/AR/MR Technologies

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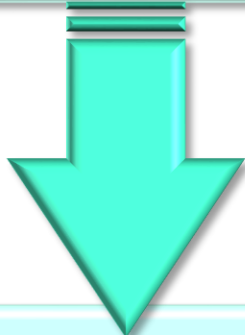
Recent VR/AR/MR trends influenced by COVID-19 pandemic

- To "Experiencing is much believing," (百見不如一験) from "Seeing is believing." (百聞不如一見)

- To "Tele-/Remote-/Online/Noncontact" from "Offline/Onsite/Contact"

  Many good/inexpensive devices such as HMDs, cameras and sensors, as well as PCs with high performance in CG rendering have recently been marketed.

  – Communication

  – Study/lerning

  – Training

  – Assistance/Support

  – Sightseeing

  Big wave has come to VR/AR/MR, which are suitable to such "noncontact" society. However, we have no enough time to prepare.
  Quality of each released contents based on such technologies should be carefully evaluated whether it satisfies users' demands, it can be alternative to the "real" one, and/or it has potential to be better than the "real" one.

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Types of VR/AR/MR contents for consumers

- 360 degree view
  - Arbitrary direction and position of view
  - Easy to product
  - No interaction with the world
  - Suitable to sightseeing/viewing
- Stereoscopic view & interactive manipulation in the virtual/real world
  - Arbitrary direction and position of view
  - Uneasy to product
  - Interaction with specific things/events in the world
  - Suitable to self-study/learning/training with interaction
- Multimodal stimulation
  - Almost the same as the real / beyond the real, where anyone can equip better ability
  - Difficult to product
  - Interaction with many things/events in the world
  - Emerging as "augmented human" from this field

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Self-learning/training Systems with VR/AR/MR Technologies (produced at my laboratory in 2020-2022)

List of researches in today's talk

[Writing/reading & manipulation in secondary education]
- A VR-based Support System of Self-learning Microscope Operation (2020)
- AR-based Self Learning System of Japanese Calligraphy Skills (2020)
- An AR-based Conversion System of Classical Chinese Text with Return Mark to Japanese AReading (2021)
- A virtual reality system for dissecting vertebrates with an observation function (2021)
- A VR-based Learning System for Operating Gas Burner in Secondary Education (2021)
- A VR-based repetitive learning system of accurate tuna dismantling for fisheries high school students (2022)

[Sports forms]
- A Real Time Feedback System of Strength Training with Motion Capture and Head Mounted Display (2021)
- An immersive self-training system of receive motion for volleyball beginners (2022)

[Manipulation]
- A Contactless Training Support System of Holding Chopsticks by Posture Estimation of Chopsticks, Hand and Fingers (2021)
- A VR-based Piano Self-training Portable System on Standalone HMD (2021)
- An AR-based Support System of Postcard Handwriting through Superimposing Drafts with Text Frames (2022)

 [Safety drill]
- A Mixed Reality-based Fire Evacuation Drill System (2021)

# A VR-based Support System of Self-learning Microscope Operation (2020)
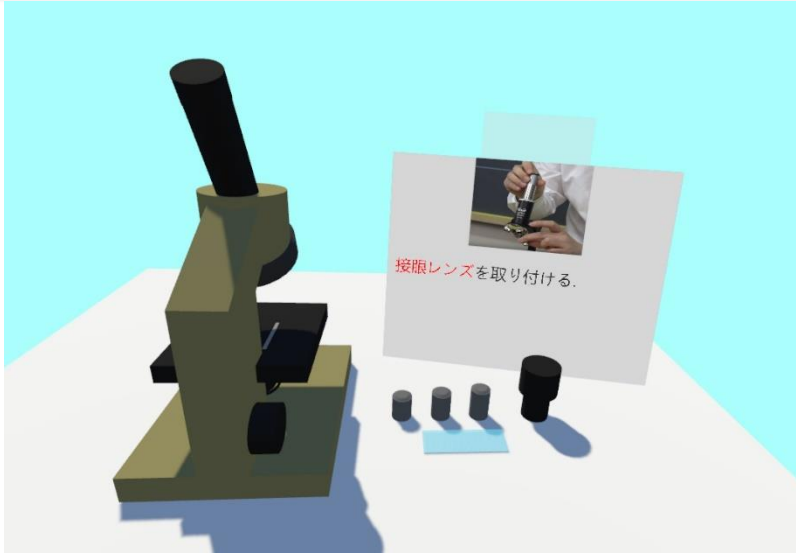
Acquiring microscope operation skills has been contained by Japanese secondary education. Although many chances of observation with the microscope operation must inspire students to study deeply science, the curriculum allows short time and small budget.

In this paper, a virtual reality (VR) system of self-learning for the microscope operation is proposed, which makes inexperienced students equip fundamental skill of the operation. The system, composed by a computer, a head-mounted-display (HMD) and a dial type input device, display the student a virtual microscope in the center of the virtual world. In the virtual world, the student can manipulate the virtual microscope with controllers and a dial type input device, as well as he/she can see the procedures of the operation. The operation to focus with focus knob is especially important in the procedure, so the system adopts a dial type input device to experience under the condition more similar to the reality by the sense of touch. The system displays how to operate a microscope by visual information in texts and figures and judges if user's operation is correct by comparing result of user's operation and the correct one stored in the system such as the position and inclination of virtual objects. If the user operates the virtual microscope incorrectly, the system represents an alert with audiovisual stimulation. The system is expected to help users to learn microscope operation skills practically at relatively low cost.

AR-based Self Learning System of Japanese Calligraphy Skills (2020)
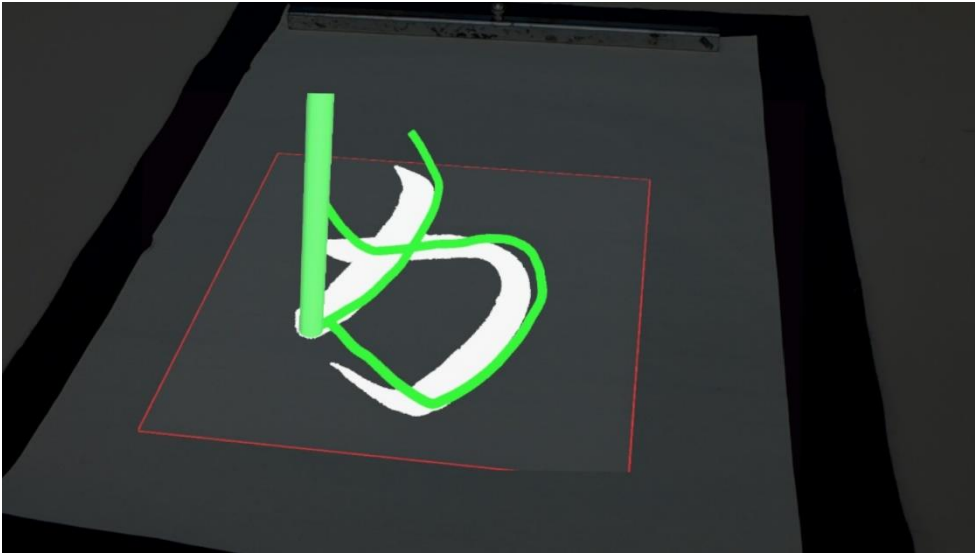
While Japanese calligraphy has been contained by Japanese elementary and secondary education curriculum, teachers in charge of the calligraphy education are not always proficient, since skill of the calligraphy is unnecessary for teachers' license. To overcome the problematic situation, not only training of teachers but also an ICT-based support system for the students to learn the skill by themselves.

Therefore, this paper proposes a system that combines a self-study support system for inexperienced people to learn Japanese calligraphy skills, and a virtual writing system for practicing calligraphy without using ink in a virtual environment. The proposed system is a kind of the augmented reality (AR) system, which consists of a computer, a head-mounted-display (HMD) and a non-contact motion sensor. Firstly, the system introduces AR technology into visualization of expert's motion data, which is previously recorded from an expert's action. Secondly, on the system users practice calligraphy by imitating expert's brush motion on virtual paper. To obtain user's motion, the motion sensor obtains the position and tilt of the brush at each frame. Simultaneously, the system simulates the handwriting from these data and superimposes it on the tip of the brush using AR technology. After user's practice, the system calculates the differences in brush position, tilt and speed between expert's brush motion and user's brush motion by using DP matching and encourages user to improve his/her motion, finally. This system is expected to overcome problematic situations in calligraphy practice.

An AR-based Conversion System of Classical Chinese Text with Return Mark to Japanese Reading (2021)
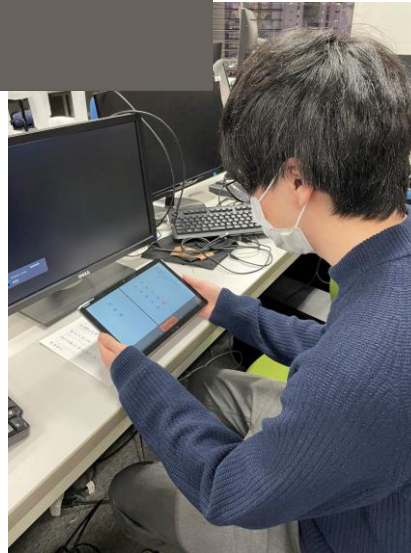
The so-called "Kanbun," the Japanese reading of the classical Chinese text, has been studied as a type of the classical Japanese in secondary education in Japan. In Kanbun the word order is changed based on symbols called "return mark," which is converted into a Japanese reading. This change is often so complicated that it may cause phobias in learning for junior and senior high school students in Japan.

Therefore in this paper, a visualization system of step-by-step change of word order is proposed, which recognizes the return marks on the classical Chinese text and visually superimposes the converted text beside the original one, in the use of the augmented reality (AR) technology. The proposed system is applicable to any Kanbun sentences so that it is expected to contribute to improved student understanding.

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A virtual reality system for dissecting vertebrates with an observation function (2021)
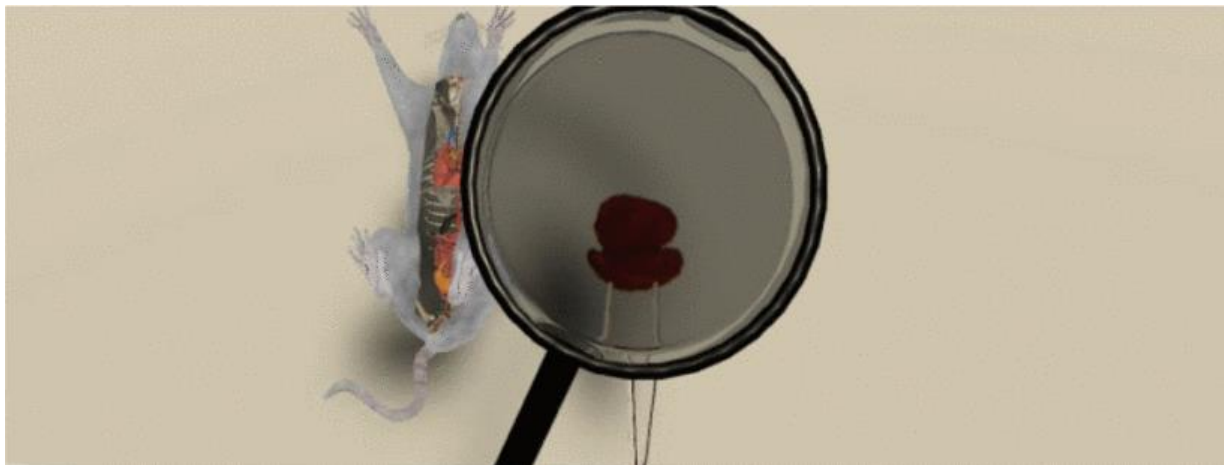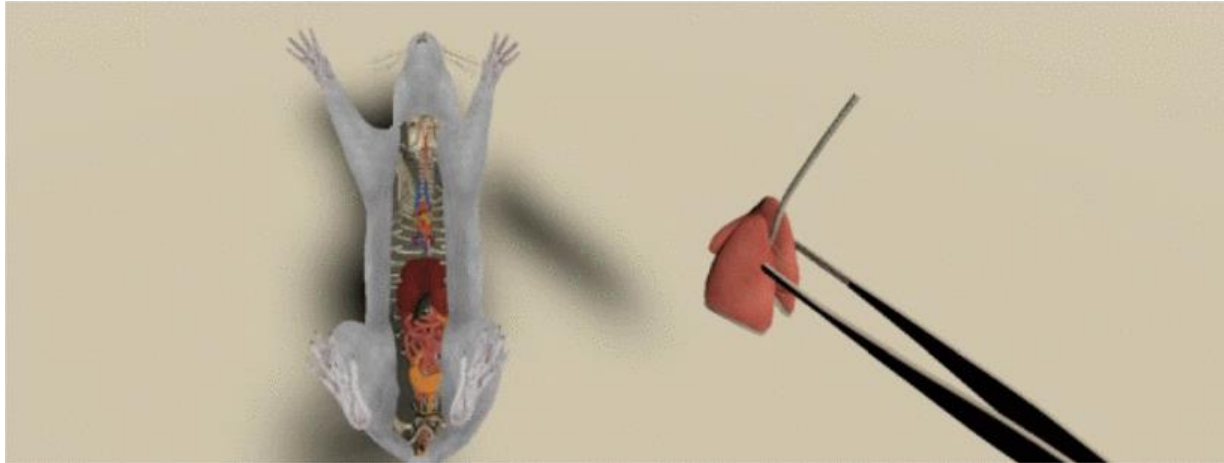
Giving chances of hands-on experience is important for K-12 education, in order to make students obtain deep understanding. However, there is less opportunities of such experience in science education in Japan, due to some reasons. Therefore, in this paper, a virtual reality system is proposed with which the students can interactively experiment the dissection of vertebrate animals. Through a series of four stages in VR space, the proposed system provides a learner to learn the inner structure of the animal and the procedure of the dissection. Also giving the haptic sense in use of the vibration on the hand controllers, the system represents difference between alive and dead, so that the learner has a chance to think of the animal ethics.

A VR-based Learning System for Operating Gas Burner in Secondary Education (2021)
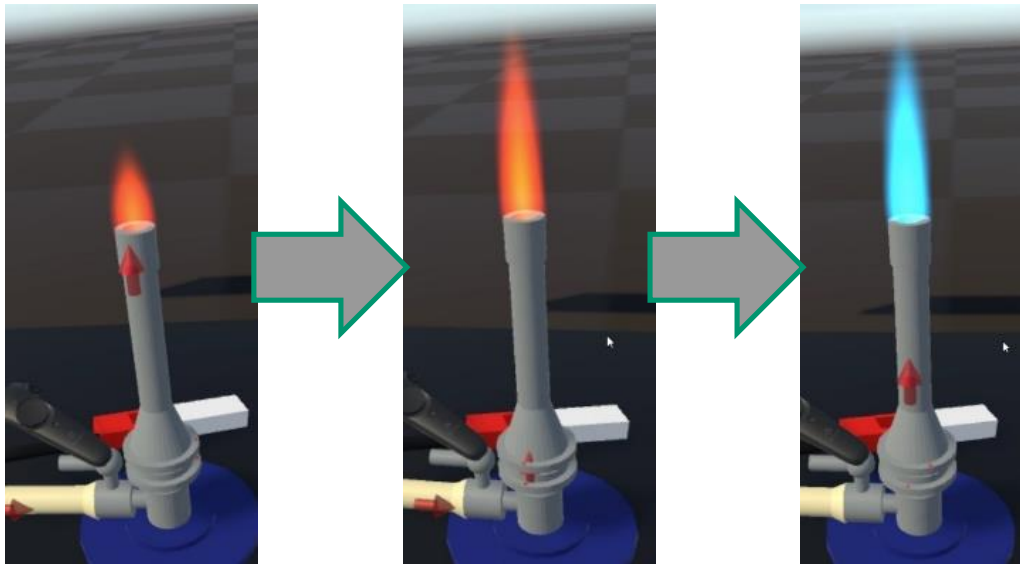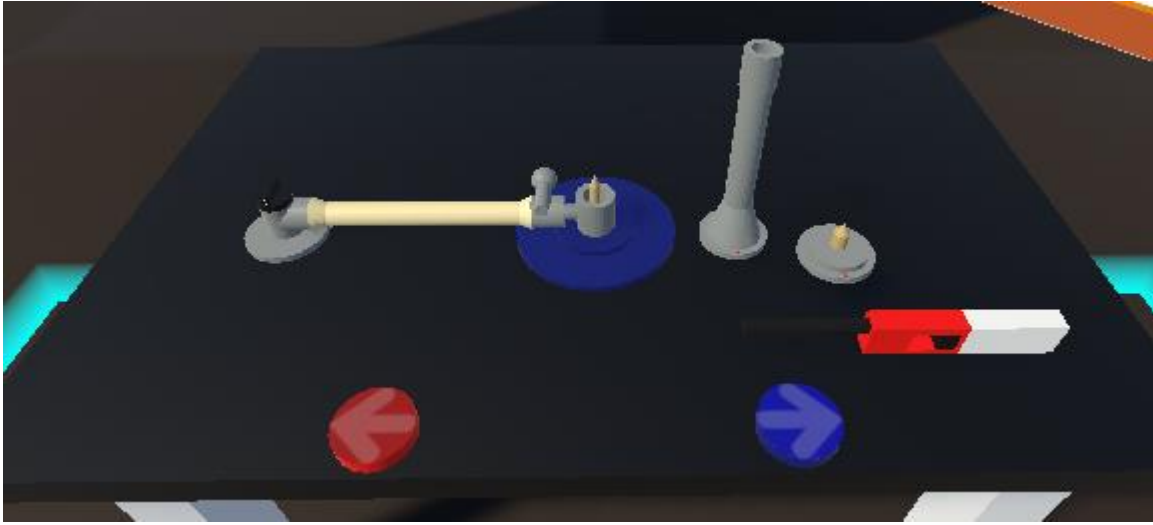
A gas burner is often used in science experiments in Japanese lower secondary school education, and its correct operating procedures are included in the study content. However, students are given only inadequate learning opportunities for the operating procedures with the actual gas burner, due to time and instrumentation constraints. Therefore, this article proposes an operation learning system of a gas burner using virtual reality technology with high realistic sense to supplement the learning with the real one. The proposed system provides interactivity through a dial controller and a pair of hand controllers as an input device, and a stereoscopic HMD as an output device. The dial controller imitates an adjusting screw, so that a learner can easily get a realistic sense of turning screws for air and gas. Also judging whether the user's operation is correct or not, the system displays necessary information on the virtual scene of the gas burner for learning to promote the learner's understanding.

A VR-based repetitive learning system of accurate tuna dismantling for fisheries high school students (2022)

Among characteristic club activities in Japanese fisheries high schools, demonstration of dismantling tunas and other fishes dismantling is attractive to consumers as well as to students. To improve the situation where it is difficult to provide sufficient practice opportunities due to high cost, the previous research proposed a virtual reality support system of self-study for tuna dismantling. The system provides visual sense through Head-Mounted-Display (HMD) with interactive manipulation of some kinds of knives by both hands. Implementing additional functions into the previously proposed system, this article proposes a system that enables effective repetitive practice and allows students to learn exactly dismantling procedure and operation, through the experience of the virtual world.

# A Real Time Feedback System of Strength Training with Motion Capture and Head Mounted Display (2021)
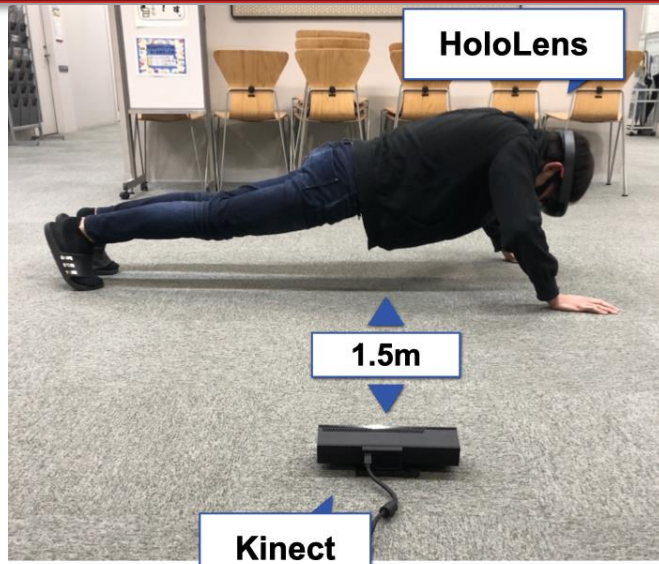
The correct posture and procedure are essential for effective and injury-free strength training. Although it is necessary to know the differences between the postures and procedures of the trainer and the trainee, it is difficult for the trainee to know them during training without the presence of the trainer. Therefore in this article, we propose a mixed reality (MR) system which uses motion capture to recognize a trainee's posture on a HMD. Through the system, the trainee can train while looking his/her own postures on a HMD. Also the PC with the motion sensor can be placed some distance away since the HMD is connected with the PC wirelessly.

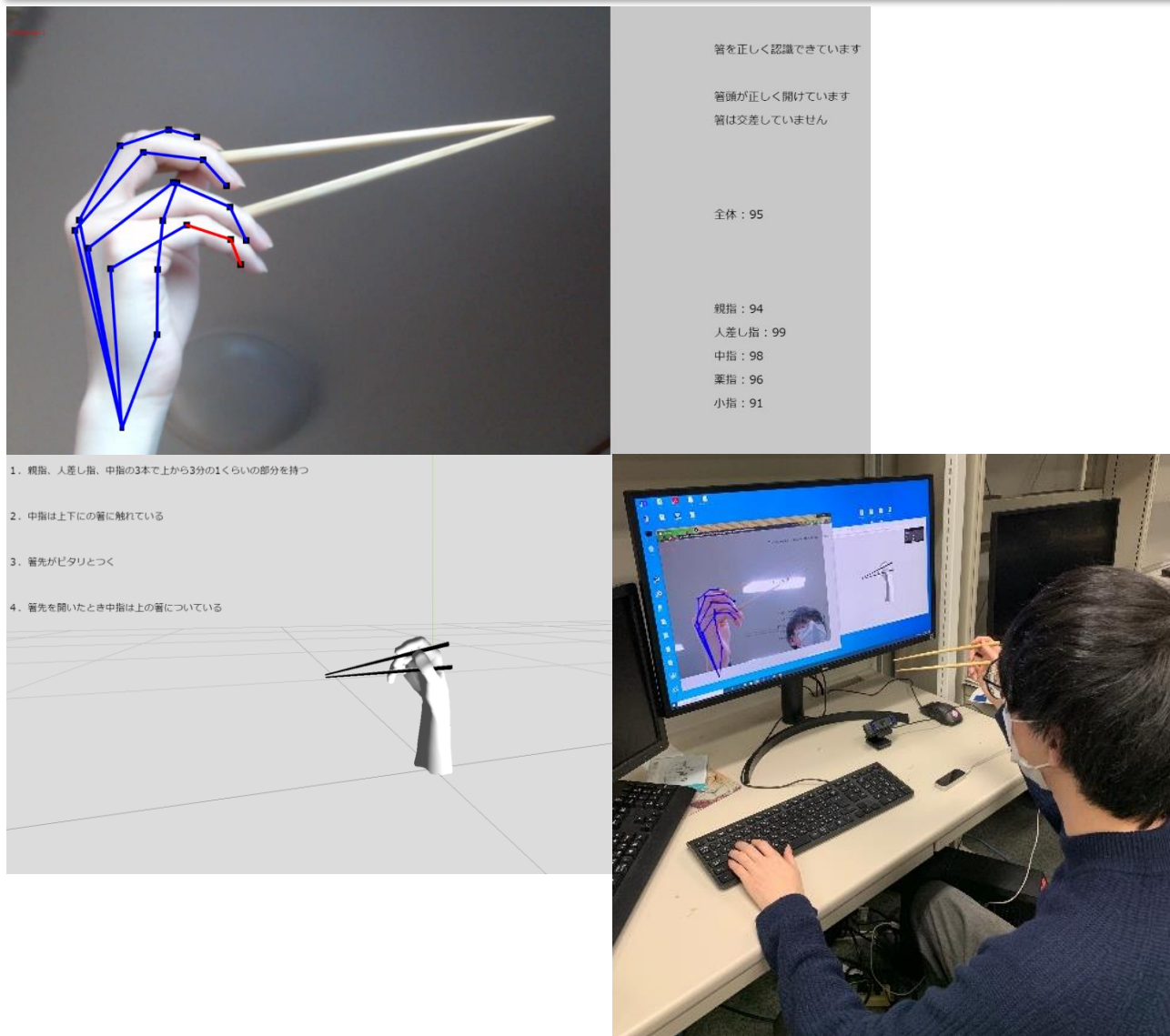# An immersive self-training system of receive motion for volleyball beginners (2022)
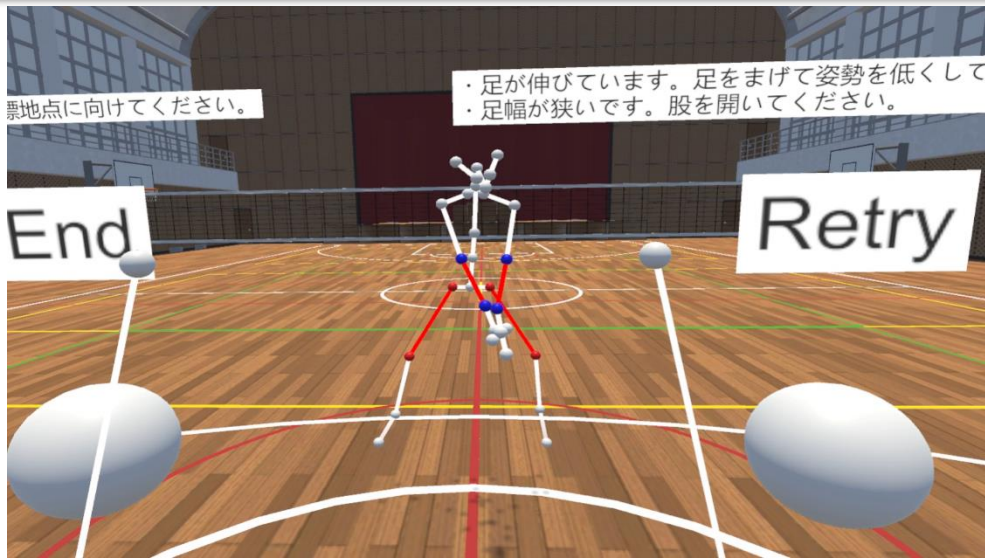
In this article, we propose a VR-based immersive self-training system for volleyball beginner's receiving, by which a virtual training environment is given to a practitioner with a head-mounted-display (HMD). Not wearing motion capture markers and haptic devices, a practitioner has free hands to receiving a virtual ball, so that the proposed system is expected him/her to be able to play receiving motion as the same as in the real world, in order to enhance skill upgrading effectively.

A Contactless Training Support System of Holding Chopsticks by Posture Estimation of Chopsticks, Hand and Fingers (2021)

箸を正しく認識できています

箸頭が正しく開けています
箸は交差していません

全体 : 95

親指 : 94
人差し指 : 99
中指 : 98
薬指 : 96
小指 : 91

1．親指、人差し指、中指の3本で上から3分の1くらいの部分を持つ

2．中指は上下にの箸に触れている

3．箸先がピタリとつく

4．箸先を開いたとき中指は上の箸についている

This article proposes a training support system of holding chopsticks both for beginners and people with the wrong holding. Although eating with chopsticks is a part of East and Southeast Asian cultures, many people does not hold the chopsticks correctly. Since the posture of the holding is complex form in three dimensional space, two dimensional media such as textbooks and videos is insufficient for learning and training. Therefore, this article proposes a system, which acquires a trainee's holding posture from a camera and a contactless motion sensor, and evaluates and represents the correctness of the posture in comparison of the correct one. Since the augmented reality (AR) technology is introduced into the representation, the system makes the trainee understand the difference easily.

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A VR-based Piano Self-training Portable System on Standalone HMD (2021)
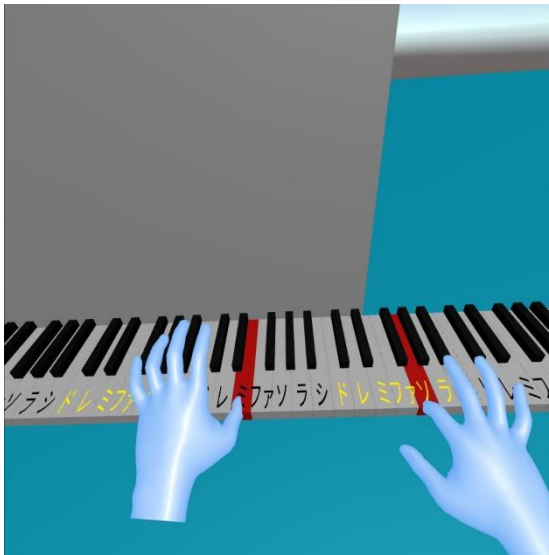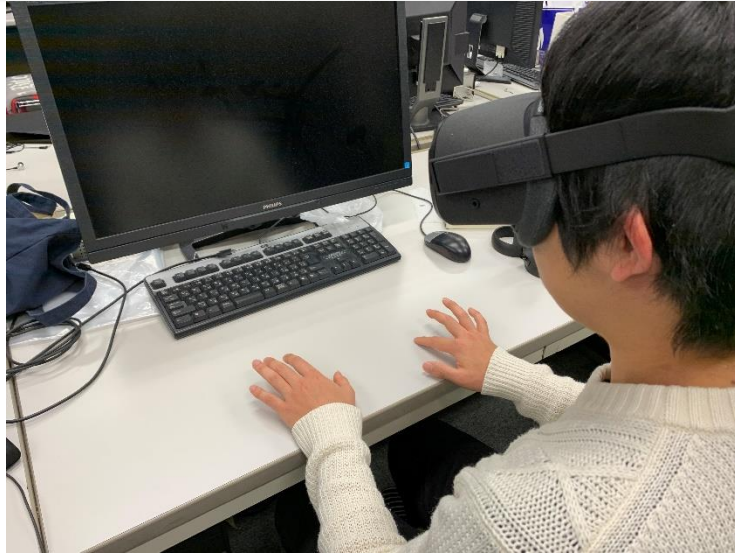
A Piano is a popular musical instrument. Development of playing piano requires frequent and suitable practice. However, the learners often have difficulty on space and time for practice due to less portable size and weight of the piano. In this article, a portable and virtual-reality (VR) based self-training system of the piano is proposed, which is installed on Quest, a standalone see-through Head-Mounted-Display (HMD). A learner wearing the HMD can see both of superimposed virtual piano keyboard and virtual his/her own fingers. According to his/her keying by the fingers, the system represents the situation acoustically. Evaluation of training outcome (number of incorrect keying) and subjective assessment shows advantages of the proposed system in comparison of a piano playing application on a tablet device.

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An AR-based Support System of Postcard Handwriting through Superimposing Drafts with Text Frames (2022)

This paper proposes a support system of postcard handwriting based on augmented reality(AR) technology.

By superimposing drafts with text frames, the system assists a user to write easily and neatly an address on front of a postcard with balanced characters. The proposed system projected adjusted text of the address and frames at the correct position on the postcard, which is determined by number of inputted text. From a user experiment in comparison with the proposed system and old-fashioned style (writing while looking a sample), it is seen that the proposed system has high effectiveness, while font style and user interface are to be improved for more usability.
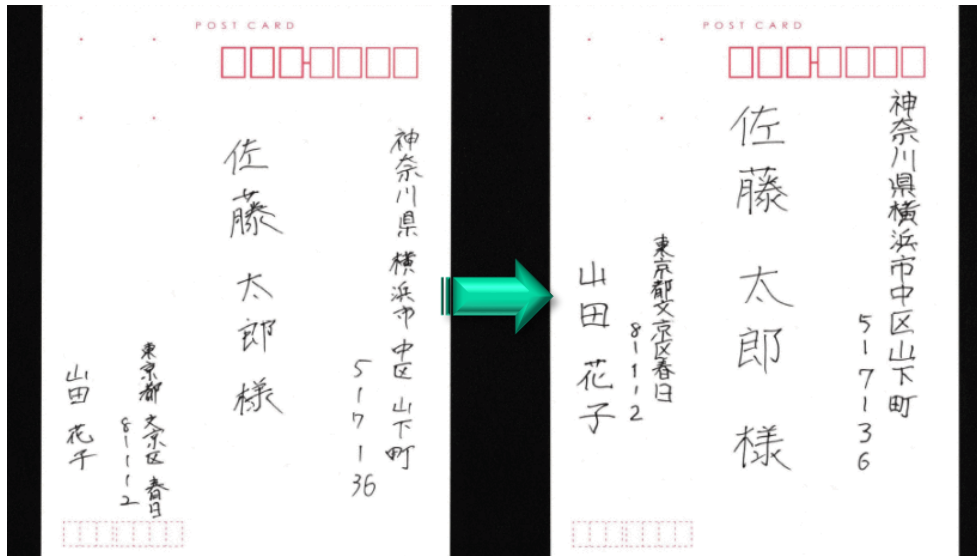
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A Mixed Reality-based Fire Evacuation Drill System (2021)

Regular evacuation drills from fire have the advantage that many people can participate at the same time. However, during training, you just walk down the corridors and passageways as usual, and it lacks a realistic feel, especially with flames and smoke. Since the number of facilities with realistic flames and smoke is limited, it is difficult to conduct drills with such realities in schools and workplaces. In this paper, we propose a system that uses mixed reality (MR) technology to simulate fire and smoke during an evacuation drill at a school or workplace. The proposed system uses a transparent head-mounted-display (HMD) to move through the real world, so that the system provides trainees with a highly realistic image of flames and smoke superimposed on the evacuation route. In addition, the appropriateness of the evacuation action is assessed by recording the route and time of the action, and the results are presented to the trainees at the end of the exercise to improve the effectiveness of the exercise.

Our new facility; 360 degree 3D scanner for human size
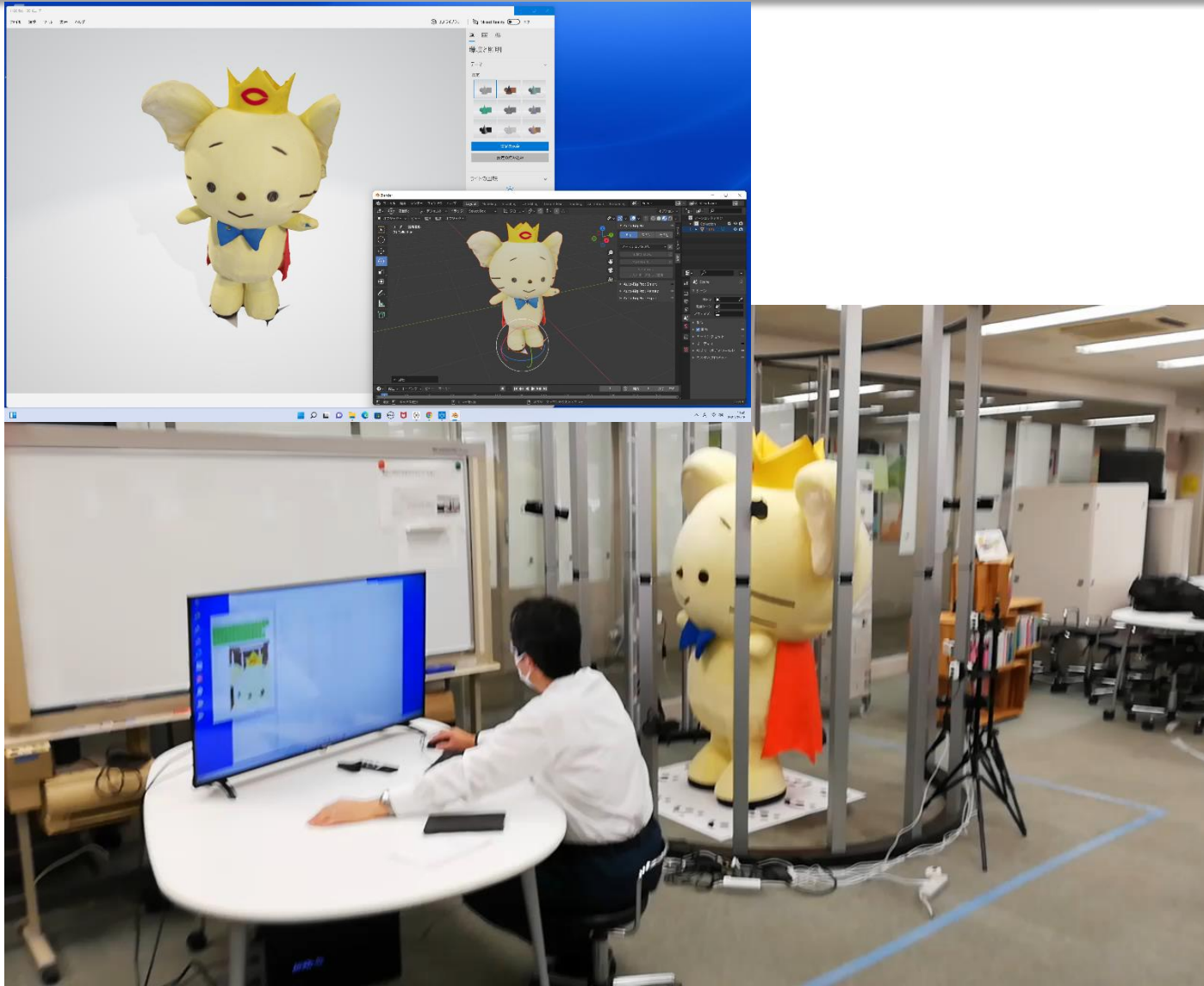
- About a second for two sets of photos shooting by 115 cameras, for shape recognition and for texture acquisition
- About 5 minutes for 3D model data generation (photogrammetry) with texture
- Avatar for the virtual world (typical case: 100,000 polygons)

Conclusion

- Nobody knows the convergence of the COVID-19 pandemic.
- Tele-/remote- systems and services will be required even with/after COVID-19 society.
- VR/AR/MR technologies and their applications must have strong potential to improve/enhance our society.
- However, such technologies/applications require users specific devices and/or locations in the real world. Thus it means not virtual in real sense. For this reason, the study must be ongoing, both in terms of core and application.
- The interest of many people will accelerate R&D in order to ease the above restriction and to achieve better things.
- The Shift is important for us to "Experiencing is much believing," (百見不如一験) from "Seeing is believing." (百聞不如一見)

Thank you for your attention!

Your interests/comments/suggestions would be appreciated for our activities!

List of researches in today's talk

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