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Science Education for Society 5.0

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Abstract. Teaching aids for middle school science classes using virtual reality, augmented reality, and a face-to-face learning management system are reviewed. These aids have possibilities for the Internet of Things, big data, and artificial intelligence, all of which are necessary for the social realization of Society 5.0.

1. Introduction

Thanks to the advancement of autonomous technology, robots are capable of doing tasks by evaluating situations themselves. A shift from automatic to autonomous technology is known as Society 5.0 [1]. Society 5.0 brings an industrial transformation due to technological advancements in the Internet of Things (IoT), a sensor technology; big data (BD) obtained through sensor measurements; and artificial intelligence (AI), which finds and analyzes correlations in BD. The resulting industrial autonomy will mean that about half of the tasks traditionally fulfilled by humans are expected to be replaced by robots [2].

In the future, therefore, people will work in new jobs using IoT/AI/BD that do not exist today. Because people specializing in system engineering will be needed, new training programs, including programming education, must be introduced starting in Japanese elementary schools as soon as 2020 [3]. Such training programs should include not only a shift in educational curriculum, but also the development of teaching aids. In this paper, we review some teaching aids effective in compulsory learning in IoT/BD/AI technologies and propose directions for developing additional aids in the future.

2. Internet of Things (IoT)

Tablets are capable of making various sensor measurements, making such measurements increasingly accessible to students [4–5]. Using tablet devices, it is possible to display measurement results not only as graphs but also through other display methods that help students understand the data in other ways, including through virtual reality (VR) and augmented reality (AR), both of which make it possible to visually describe the world in a way we cannot normally experience. In science class, for example, students are able to visualize phenomena they are unable to see otherwise, thereby facilitating an intuitive understanding of scientific phenomena.

VR allows not only for a high-level visual sense of reality, but also for changes in spatial and temporal scale. Therefore, VR is suitable when learning about celestial objects that require students to think at a macroscopic scale of space and time, such as diurnal motion (Fig. 1a) [6]. AR allows us to analyze videos shot with tablets' internal cameras in real time and add VR components to the videos. Marker-based AR uses markers as coordinates to display objects we cannot see in real life. We used marker-based AR to display the propagation of sound waves in the atmosphere to teaching students about the nature of sound (Fig. 1b) [7, 8].

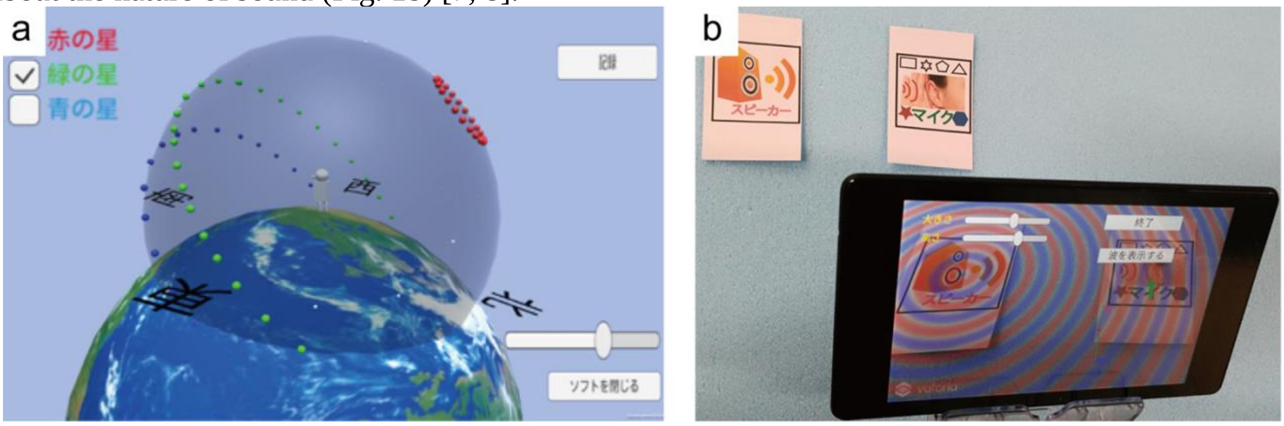

Fig. 1. Developed aids for learning about celestial bodies using VR (a), and about the sound propagation using AR (b).

3. Big Data (BD) and Artificial Intelligence (AI)

The use of tablets in education has many advantages. Students can communicate information over the internet. Learners can proceed at their own pace using a remote site and by watching online lectures. Video distribution provides one-way communication to learners, while learning management systems (LMS) enable e-learning through bidirectional communication. These tools can help provide a uniform education to schools in remote areas where there are few teachers available. In addition, LMS can also be used in face-to-face classes instead of connecting various remote sites [9, 10].

4. Discussion

While Section 2 shows that displaying scientific phenomena using VR and AR facilitates students' understanding, Section 3 suggests that such an understanding can be furthered by online communication and incorporating sensor measurements into IoT. In other words, online education using VR and AR is a method of IoT utilization, a research topic that should be furthered addressed in the future. Although a large volume of data must be communicated, we believe that a new way of e-learning can be achieved through the use of high-speed 5G mobile networks.

Section 3 shows that sharing of opinions in a text format through the use of a face-to-face LMS is effective at the middle school level. A function for categorizing and aggregating opinions is necessary after they are shared. Future research should address the possibility of BD and AI in this role. Equipping the face-to-face LMS with a machine learning function for automatic categorization makes it possible to not only share opinions but also to aggregate them. This should make it easier to handle class opinions and aid in the dissemination of the face-to-face LMS. Moreover, utilization of LMS for managing of the students' homework is expected to reduce the teacher's time and effort.

5. Conclusion

In this paper, we introduced VR/AR teaching aids using sensor measurements and a face-to-face LMS and explored their implications for science learning. We hope that these tools, as well as their integration with IoT, BD, and AI, can facilitate active learning and experiment observation and connect remote sites. We also hope that equipping the face-to-face LMS with a database function to handle BD and enabling it to categorize data through machine learning would allow the LMS to instantly aggregate learners' opinions, which has been considered difficult in the past.

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