A Study on a Method of Integrating AR Markers into a Foreign Language Learning System for Task-based Activities

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Abstract
In this paper, we investigate a method to integrate Augmented Reality (AR) into a foreign language learning environment for task-based activities. We accomplish that task by focusing mainly on two objectives. First, AR markers can be applied to integrate some objects into the language learning environment as learning materials. Second, movement of an AR-tagged object used in the activities can be recognized and tracked, based on the AR marker's positional information. AR technology is the integration of digital information with the user's environment in real time. AR uses the existing environment and overlays digital information on it. We developed a prototype tool with the AR markers, and conducted an experiment to investigate the objectives mentioned above. In the experiment, 22 university students participated in the activities with the prototype tool. Concerning the first objective, the results of the experiment suggest that the prototype tool is easy to use as learning materials. The tool with the AR markers shows the possibility of achieving task-based style activity objectives. Concerning the second objective, an AR-tagged object moved by the learner was successfully recognized and tracked by the system in the activities. The results suggest that the AR marker's positional information could help track the learner's movement in the learning activities. It should be noted that the ability to track an AR marker sometimes suffers from the problems caused by the amount of light in the classroom. Evenly distributed light is preferable when trying to identifying and detecting AR markers.

Keywords: augmented reality, tasked-based activities, foreign language learning system

Introduction

With the rapid advance of globalization, the development of proficiency in English as a common international language is crucial for Japanese students. In 2020 the Tokyo Olympic and Paralympic Games will be held. With an eye to those events, the Ministry of Education, Culture, Sports, Science and Technology-Japan (MEXT) (2014a, 2014b) will proceed with studies on new reforms of English language education.

In order to promote foreign language communication skills, providing students with more opportunities to use English should be considered. The TPR (Total Physical Response) approach and task-based foreign language activities are expected to be among the methods employed to improve oral proficiency in English.

Constructing a foreign language learning environment could be one of the measures to support task-based activities based on the approach mentioned above. In particular, if we apply Augmented Reality (AR) technology, it is possible to embed real-world objects into the language learning system as learning materials.

AR technology is the integration of digital information with the user's environment in real time. AR uses the existing environment and overlays digital information on it. There are two main approaches to generate events from AR: marker-based and placed-based. Placed-based AR uses GPS-supplied locations, similar to Pokémon GO. Marker-based AR relies on optical sensors and uses a camera with some type of visual marker to produce a result only when the marker is sensed by a reader (Kato, 2002). Distinct, but simple, black and white square printed patterns are used as the markers. These patterns are used because they can be easily recognized and do not require a great deal of processing power to read. The position and orientation are also calculated, using a process in which some type of content or information is then laid over the marker.

Research projects with AR applications have been conducted to help teach vocabulary in situated, task-based language learning (Li et al., 2014; Valle, 2014; Godwin-Jones, 2016; Santos et al., 2016). In these projects various types of multimedia information, such as text, audio, images, and animations are associated with physical objects attached to the AR markers in order to enhance language learning.

In our study, we consider applying the positional information of AR markers to the learner's activity logs. Based on our previous research (Kashiwagi et al., 2013), in this paper we investigate a method of implementing a task-based foreign language learning system by using AR markers. In doing so we focus on the following two objectives:

(1) The AR markers can be applied to integrate some objects into the language learning system as learning materials;
(2) Movement of an AR-tagged object used in the activities can be recognized and tracked by the system, based on the positional information of the AR marker.

With regard to objective (1), we use some objects as learning materials by attaching AR markers to them. That way, learners can interact with the system using these

objects. Learners are required to respond to the instruction from an instructor. An instruction might be the following: "First, go to the department of internal medicine, then go to the department of otolaryngology." The learner would then move an AR-tagged object to the appropriate places on the map. Interaction between a learner and the system's AR-tagged object implements task-based activities that differ entirely from repetitive model conversation practice. We anticipate that learners will gradually acquire words and expressions using such activities in a simulative manner.

With regard to objective (2), the AR marker's current position is recognized. Movement of the AR-tagged object and the time logs are tracked and saved in the system. These activity logs are expected to allow teachers to better understand individual learner's learning process.

In the next section, we describe the prototype tool. The experiment, its results and a discussion are included in the following sections. Finally, we present our conclusions and recommendations for further studies.

Prototype Tool

In this section, we present a prototype tool in which AR markers and a map are integrated.

AR Markers as Learning Materials

Figures 1 and 2 illustrate the prototype tool developed in this study. As shown in Figure 1, this system consists of a PC, a USB document camera, an AR marker, a map, and a projector for displaying a computer screen. The tool was implemented using Processing (a programming language).
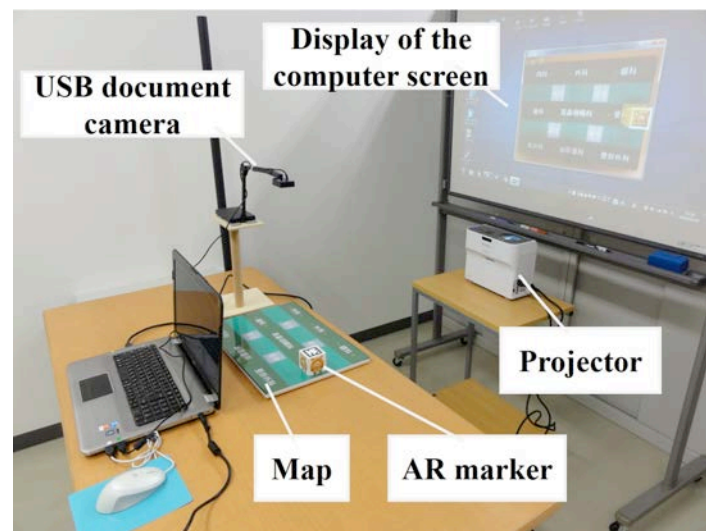

Figure 1: A prototype tool

The interaction between a learner and the tool is implemented using an AR marker on the map (Figure 2) in the process described below.

Figure 2: An AR-tagged object on the map of a hospital

(1) An instructor gives an instruction to a learner. As an example, the instructor might say, "You are at the reception desk of a hospital. First, go to the department of internal medicine, and then go to the department of otolaryngology."

(2) The learner listens to the instruction and responds to it, by moving an AR-tagged object to the appropriate places on the map as shown in Figures 3 and 4.
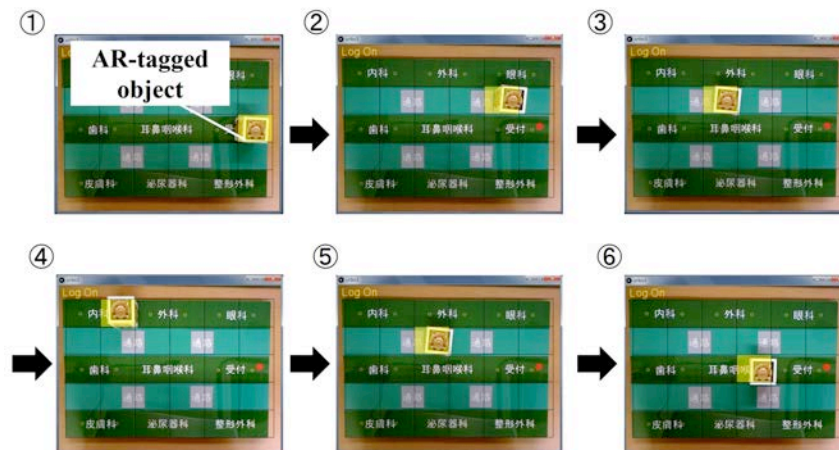

Figure 3: Example movement of the AR-tagged object

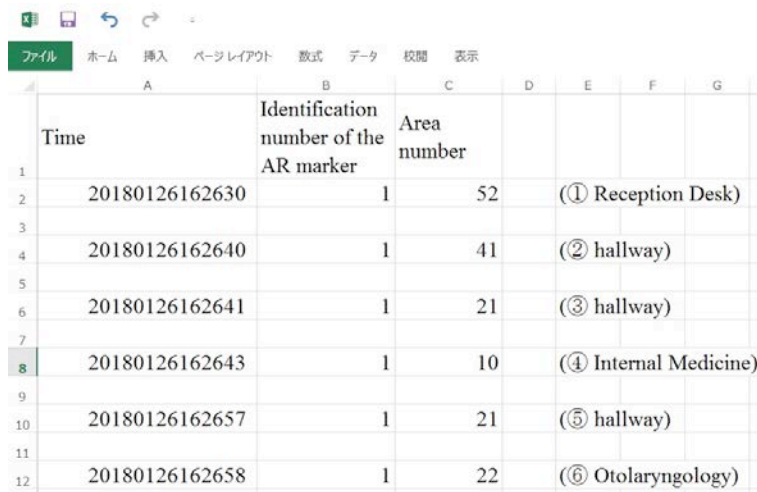Figure 4: Example recognition of the movement of the AR-tagged object

(3) The AR marker's current position is recognized by the system. The movement of the AR-tagged object and the time logs are tracked and saved as described later in this paper.

Recognition of the Movement of the AR-tagged Object

The movement of an AR-tagged object used in the activities can be recognized and tracked by the system, based on the AR marker's positional information. An area map, shown in Figure 4, is employed to recognize and track the AR-tagged object's movement. When the AR marker's specific positional information is detected, the corresponding area number on the map is acquired. For example, in Figure 4, the area number 52 is detected from the positional information of the AR marker.

Activity Logs

The AR-tagged object's movement and the time logs are tracked in the system. As shown in Figure 5, when the AR marker's movement occurs, the time, the AR marker's identification number and the area number on the map are saved as activity logs in a CSV file. With these logs, we can observe the learner's detailed behavior in the activities, such as when the learner hesitates over whether he or she should go to area A or area B.

Time	Identification number of the AR marker	Area number		
20180126162630	1	52		(① Reception Desk)
20180126162640	1	41		(② hallway)
20180126162641	1	21		(③ hallway)
20180126162643	1	10		(④ Internal Medicine)
20180126162657	1	21		(⑤ hallway)
20180126162658	1	22		(⑥ Otolaryngology)

Figure 5: Example activity log in a CSV file

Experiment

Participants

This study's participants consisted of 22 second-year students at a university in Japan. They used the prototype tool and evaluate the activities with AR markers. Their evaluations were assimilated with the help of a questionnaire.

Procedures

First, each participant used the tool and experienced the activities with an AR marker after receiving the necessary instructions on its use. Subsequently, they were asked to

complete a two-item questionnaire and to comment on the potential use of applying AR markers to various educational applications.

Results and Discussion

Here, we discuss the introduction of AR markers into task-based foreign language learning activities.

Introduction of AR Markers into the Language Learning System as Learning Materials

Twenty-two participants were asked to select the statements that best described what they had observed. Q1 in Figure 6 concerns their experiences in using AR markers. In the bar graph, blue represents "This is my first time using them," and red represents "I have heard about them, but this is my first time using them." Green represents "I have used them before." According to the results of Q1, 41% of the participants agreed with the statement, "This is my first time using them," while 36% agreed with the statement, "I have heard about them, but this is my first time using them." Finally, 23% agreed with the statement, "I have used them before." A total of 77% tried the AR markers for the first time.

Q2, shown in Figure 6, concerns using the tool with AR markers. According to the responses to that question, a total of 81% (36% strongly agreed and 45% agreed) agreed with Q2, "The tool with AR markers is easy to use." Meanwhile, 14% chose the statement, "Neither agree nor disagree," and 5% chose the statement, "Disagree."
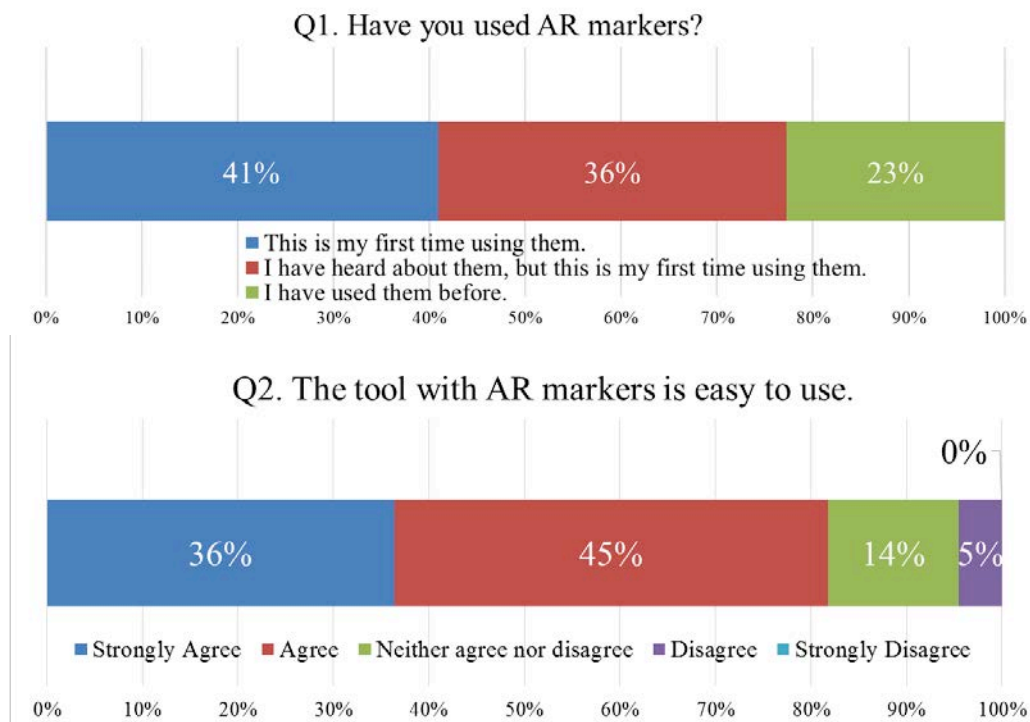
Figure 6: Results of the questionnaire on the tool with AR markers

The results indicate that the tool with AR markers was easy to use as learning materials for many participants, although for nearly 80% it was their first time. The participants who did not agree with Q2 proposed some ideas on the application of AR markers. Based on these comments, AR markers had a positive impact on them.

Regarding the activities with AR markers in this experiment, some participants stated, "These activities with physical responses might help elementary school children to concentrate on their activities." In this experiment, a map of the hospital printed on paper was used. These maps can be easily replaced to produce various locations, such as a school map, a building map, and a town map, and so on.

Furthermore, regarding the comments on the possibility of the application of AR markers to various educational fields, several application fields were mentioned. These included educational uses such as problems concerning plain/solid shapes, multiplication tables, special local products found on the map of Japan, an escape route in the event of an emergency for children, and confirmation of daily/weekly schedules for elderly people.

These results suggest that the activities with AR markers had a positive impact on the participants. This conclusion demonstrates the possibility of implementing task-based activities with AR markers. That possibility would broaden the variety of activities not only in language learning but in other educational fields as well.

Movement of an AR-tagged Object

In the experiment, the time logs and the positional information of the AR markers were successfully tracked and saved. The results of the experiment show that the system recognizes the current position of the AR marker. The movement of the AR-tagged object and the time logs can be tracked and saved in the system.

These logs show learners' detailed performance. That information will assist teachers to understand the behavior of the individual learner in these activities. For example, although a learner was eventually able to reach the appropriate destination on the map in the experiment mentioned above, we can observe that it may take some time to get to that destination. These logs may help understand learners' current level in detail and provide learners with sufficient feedback. The logs may offer a good approach to evaluate and support learners' growth.

From the learners' perspective, they can also monitor where they need improvement, determine what they already know, and what else they need to know in any given situation. These logs may help learners to know more about themselves.

Meanwhile, the ability to track an AR marker sometimes suffers from the problems when the marker is occluded and cannot be seen in its entirety. AR technology relies on optical sensors for the marker tracking, most commonly by using a web camera. Good results can be achieved with evenly distributed light. Fluorescent lamps on the ceiling of the classroom, however, may prevent AR-marker identification and detection. We should take measures to prevent occlusion problems. Evenly distributed light is preferable in the classroom environment in order to facilitate AR-marker identification and detection.

Conclusion

In this paper, we investigated a method of implementing a task-based foreign language learning system by using AR markers. That method focused on two objectives: (1) AR markers can be applied to integrate some objects into the language system as learning materials in task-based language activities; (2) Movement of an AR-tagged object used in the activities can be recognized and tracked by the system, based on the positional information of the AR marker.

In the experiment, 22 participants used the tool and experienced the activities with an AR marker after receiving the necessary instructions on its use. Subsequently, they were asked to complete a two-item questionnaire and to comment on the potential application of AR markers to various educational fields.

We found that the tool with AR markers was easy to use as learning materials for many participants, and had a positive impact on their experience. This result suggests that the tool with AR markers has the potential to achieve task-based style activities and would broaden the variety of activities in other educational fields in addition to language learning.

The learning logs including time logs and the positional information of the AR markers were successfully tracked and saved in the system. These logs show learners' detailed performance, and will assist teachers and evaluators to understand a part of the learner's behavior in these activities. From the teachers' perspective, these logs may help provide learners with sufficient feedback. Further, they may offer a good approach to evaluate and support learners' growth.

At the same time, AR-marker tracking sometimes suffers from the problems caused by the amount of light. Fluorescent lamps on the ceiling of the classroom may prevent AR-marker identification and detection. We should seek to resolve occlusion problems. For example, evenly distributed light is preferable when trying to identifying and detecting AR markers.

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