Augmented Gardening System with Personalized Pedagogical Agents

Sejin Oh and Woontack Woo

***Abstract*—Recently, many researchers have studied on animated pedagogical agents to improve students' learning experience in educational systems. In this paper, we describe how personalized pedagogical agents can be applied into AR educational applications. We have developed the augmented gardening system which provides users with opportunity to explore physiological and environmental considerations that govern flowering via their mobile devices. The users can interact with a bluebird, as an animated pedagogical agent, which is superimposed over a physical marker. The bluebird assists them in achieving the goals with personalized guidance suitable for their background and experience on the gardening.**

***Index Terms*— Augmented Reality, Edutainment system, Pedagogical agent, Personalization**

I. INTRODUCTION

Animated pedagogical agents can provide students with advice in response to their problem-solving activities. The agents have *persona effect* which their presences have a positive effect, such as, motivational role, etc, on student's learning experiences [1]. Thus, many researchers have applied the animated agents into their educational systems for improving the student's abilities.

Although the animated pedagogical agents have progressed, they lack a connection to the real environment where the user exists. Since Augmented Reality (AR) technology improves the inconveniences, there are studies on augmented animated characters in educational applications. In the Welbo system, an animated agent guides and helps HMD wearing users to simulate virtual furniture in an MR space [2]. The AR Lego exploits the augmented agent to educate an untrained user to assemble LEGO Mindstorms robot [3]. Wagner, et al. introduces an AR character which teaches users about art history in an educational game [4].

Since augmented animated agents are located to the same real space where users exist, it makes users reduce the spatial gap to the agents, and offers more positive benefits on their learning abilities in educational systems. However, the augmented agents only provide users with uniform feedbacks regardless of the users' profile about the systems. Sometimes the feedbacks are unnecessary to users since they are not proper to assist them. To offer more effective help to users, it needs to give them customized guidance suitable for their profile. In our work, we are interested in improving users' learning abilities by personalizing pedagogical agents' responses in accordance with the users' characteristics. Thus, we design the personalized pedagogical agents and apply them into AR educational applications.

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Sejin Oh is with the Gwangju Institute of Science and Technology, Gwangju 500-712, S.Korea (e-mail: sejinoh@gist.ac.kr).

Woontack Woo is with the Gwangju Institute of Science and Technology, Gwangju 500-712, S.Korea (corresponding author to provide phone: +82-62-970-2226; fax: +92-62-970-2204; e-mail: wwoo@gist.ac.kr).

II. AUGMENTED GARDENING SYSTEM

We have developed the augmented gardening system that allows users to experience the flower gardening with an augmented bluebird. In this system, there are two actors, gardener (participant) and guidance (bluebird), who work as a team. It provides the participant with opportunity to explore physiological and environmental considerations that govern flowering. Thus, Participant enables to simulate a specific method, such as, sprinkling water, giving the fertilizer, to bloom the flower. In addition, participant can interact with a bluebird, an animated pedagogical agent, which is superimposed over physical markers in the real space. The bluebird assists the participant in achieving the goals with personalized responses according to the participant's background and experience about the gardening.

A. Personalized pedagogical agents

In our system, the pedagogical agent generates autonomous behaviors to provide a user with problem-solving advices. The agent has the capability to perceive changes generated by the user's interaction and to present certain responses to the changes in real time. Moreover, since the agent is anthropomorphic, it expresses fully animated visual responses and text-based verbal actions suitable for problem-solving contexts.

Especially, the pedagogical agent customizes its feedback suitable for a user's profile to improve the user's learning experiences. In our system, when a user wants to get personalized advices, the user is needed to fill out a questionnaire, which contains the set of questions for extracting the profile, such as background and experience on the gardening. Then, the agent shows different guidance proper to a user's profile as it interacts with the user. For example, the pedagogical agent gives an experienced user simple advice,

such as, simply sprinkling water, taking the sun, to assist the flowering. On the other hand, it provides a beginner with more detailed guidance, such as sprinkling a half cup of water, and then taking the sun during ten minutes, to help the user get knowledge of the gardening. Ultimately, we expect that the personalized advices of the pedagogical agents can better the participants' learning experience in educational applications.

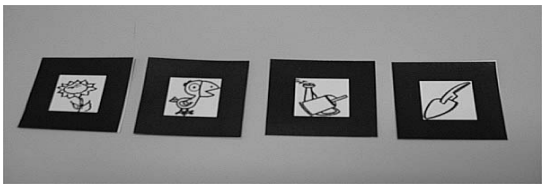
III. IMPLEMENTATION

We have implemented an augmented gardening system on Sony UMPC as a convenient mobile device with a digital camera. To detect physical markers and augment 3D models over the markers, we exploited OSGART combining Open Scene Graph and ARToolkit. We also used Cal3D, open source character animation library, for implementing character animation. Thus, users can easily see the virtual gardening system over physical markers through their mobile device. They also can experience the augmented system and interact with an animated bluebird in real space where they exist. The bluebird expresses the animated movement and displays the text as its verbal actions. Figure 1 shows the overview of the implemented augmented gardening system over a physical book.

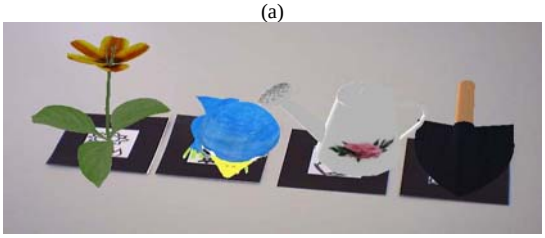
Figure 1 Augmented gardening system over a physical book.

Users can simulate the effect of physiological and environmental factors on gardening. It enables them to select simulated factors, such as, water, nutrition, light, etc, through physical objects attaching markers. As shown in Figure 2 (a) each marker indicates its function through an understandable picture. For example, if an object is the controller for adjusting an amount of water, an included marker displays a sprinkler. In addition, when a user picks up a specific marker, as shown in Figure 2 (b), he/she can see an augmented object, like a scoop, a sprinkler, over the marker. Thus, the user can easily select a specific factor, which he/she wants to simulate its effect, and apply the factor to the augmented flower. According to a selected factor, the augmented flower shows several changes, such as growing up, withering, waving, etc, through detailed animation. Therefore, participants can virtually experience the gardening, and learn the influences of several factors on the flower gardening.

The augmented bluebird shows personalized advices to assist users to achieve their goal, i.e., coming out the flower. In our system, we assume that the bluebird has the capability to detect the status of an augmented flower and the users' commands. Then, the bluebird changes animated movements and text-based verbal actions as advices to help the users accomplish their goals. Moreover, the bluebird customizes the degree of movement and displayed texts suitable for their background, experience on the gardening.



(a)



(b)

Figure 2 (a) Physical markers in our implemented system (b) augmented models over the markers

IV. CONCLUSION AND FUTURE WORK

In this paper, we focused on improving users' learning experience by personalizing the agents' responses suitable for the users' profile in educational systems. We have developed the augmented gardening system which enables users to explore physiological and environmental considerations that govern flowering through their mobile devices. The users can interact with a bluebird, an animated pedagogical agent, which is superimposed over a physical marker in real space. The bluebird assists them in achieving the goals with personalized guidance suitable for their background and experience on the gardening.

This work is still in its early stages. The current implemented bluebird limits to exhibit advices through simple movement and texts. Thus, it is not enough to allow participants to understand a bluebird's advices about problem-solving contexts. Therefore, we are planning to improve the bluebird's expression for advancing participants' comprehension on about the bluebird's advices. Furthermore, we will evaluate the effectiveness of personalized pedagogical agents in AR educational applications through usability tests.

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