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Application of Augmented Reality to Interactive Learning Systems

Pallavi P. Ahire[1], Pankaj A.Salunkhe[2]

Dept. of Electronics and Telecommunication Engineering, SES's Group of Institution Faculty of Engineering Diksal, Karjat

[2]Professor, Dept. of Electronics and Telecommunication Engineering, Yadavrao Tasgaonkar Institute of Engineering and Technology Chandai, Karjat

Abstract: ***Researchers and engineers are pulling graphics out of our television screen or computer display and integrating them into real-world environments. This new technology is called Augmented Reality. The goal of Augmented Reality is to create a system in which the user cannot tell the difference between the real world and the virtual augmentation of it. Augmented Reality (AR) allows educators and students to unlock or create layers of digital information on top of the physical world that can be viewed through an Android or iOS device. Here, we present an augmented reality learning system that enables users to experience an interactive flower garden with the assistance of interactive agents in the augmented picture. Learning deepens, not just through reading and listening, but also through creating and interacting. We overlay virtual flower garden over a physical book and offer a collaborative environment that allows a learner to interact with the agent. To evaluate the effectiveness of the proposed system, we implement it on a mobile device and enable users to experience the collaborative task with the animated character. Through evaluation, we hope to demonstrate that the interactive agent could be a promising technology for motivating users to engage in learning systems.***

Keywords: Augmented Reality Learning System, Augmented Reality in Gardening Environment, collaborative learning environment

1. Introduction

As the importance of interaction in educational systems rose, subsequent demands from consumers for interactivity have been on the rise. Researchers have applied animated agents into learning environments to enhance human learners' interactive experiences, for a variety of human learning tasks [1] [2]. They enabled these animated agents to provide learners with advice in response to problem-solving activities in a believable manner. The presence of agents induces a learner's motivational role on their learning experiences [3]. Since AR technology make users experience computer generated content embedded into real environments [4], it can allow agents to coexist with users in the same real space. The agents in AR settings express guidance suitable for learners' problem-solving situations directly.

Augmented reality can complement a standard curriculum. Text, graphics, video and audio can be superimposed into a student's real time environment. Textbooks, flashcards and other educational reading material can contain embedded "markers" that, when scanned by an AR device, produce supplementary information to the student rendered in a multimedia format. Augmented reality technology also permits learning via remote collaboration, in which students and instructors not at the same physical location can share a common virtual learning environment populated by virtual objects and learning materials and interact with another within that setting.

This resource could also be of advantage in Primary School. Children can learn through experiences, and visuals can be used to help them learn. For instance, they can learn new knowledge about astronomy, which can be difficult to understand, and children might better understand the solar system when using AR devices and being able to see it in 3D. For teaching anatomy, teachers could visualize bones and organs using augmented reality to display them on the body of a person.

Mobile apps using augmented reality are emerging in the classroom. The mix of real life and virtual reality displayed by the apps using the mobile phone's camera allows information to be manipulated and seen like never before. Many such apps have been designed to create a highly engaging environment and transform the learning experience. Examples of the mobile apps, that leverage augmented reality to aid learning, include Sky View for studying astronomy and AR Circuits for building simple electric circuits.

2. Augmented Reality Learning Systems

The augmented reality learning system that we present here provides the learner with an opportunity to simulate flower gardening over a physical book. We offer them with an augmented scene, consisting of simulation factors, virtual flowers through their mobile devices with a camera so that the learner can experience the learning environment directly. We allow users to explore environmental considerations of gardening with user interface. To improve learners' engagements in gardening, we augment a picture with an interactive agent that assists users in achieving desired goals in the gardening environment. Specifically, it allows users to seamlessly interact with an interactive agent with their mobile devices. Figure 1 describes the overview of the augmented reality learning system.

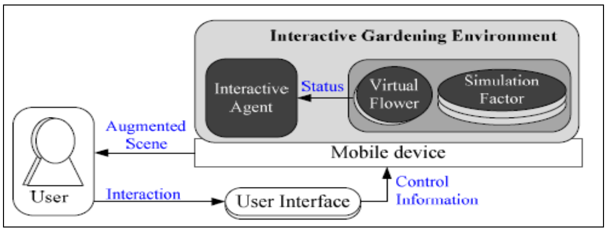

Figure 1: Augmented reality learning system

2.1 An Interactive Agent

An interactive agent is developed based on the framework for designing interactive agents in interactive learning environments [7]. The agent has the ability to perceive changes by a user's actions in the learning environment. It generates peer-like responses in accordance with the agent's own beliefs, desires, and intentions [8]. Consequently, the agent generates problem-solving advice with peer support in an autonomous way.

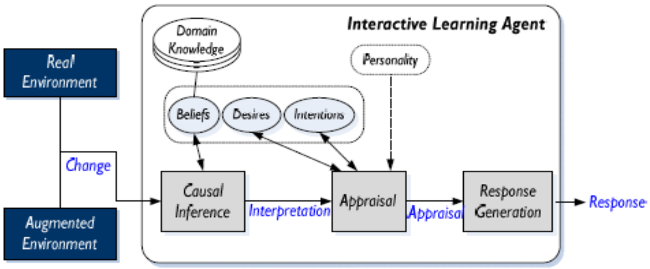

Figure 2: The response generation process of the interactive agent

We model the three explanatory variables, personalization, permanence, and pervasiveness, potentially affecting the explanatory style in this process. We adjust the degree of the variables in accordance with personality factors. In this way, the agent attributes responsibility for the occurrence of an event, and blames or gives credit for the circumstance in different ways. The agent can also adjust the extent of influence of previous circumstances by the degree of pervasiveness. Therefore, the same situation can be evaluated differently according to an interactive agent's personality. Based on the Ortony, Clore, and Collins Model [9], the interactive agent generates appropriate emotional responses to appraisal results. Here, we examine simple examples of mapping from situations and emotions. A pessimistic agent respects a learner when he/she is cautious during an appropriate situation, and reproaches itself when the learner is not. However, an optimistic agent shows opposite responses to these same situations.

2.2 Augmented Reality in the Gardening Environment

To support the users in simulating environmental considerations when gardening, we provide a user interface that enables users to choose specific factors such as water, light, and fertilizer that they can apply to a virtual flower in the augmented environment. We also provide users with a simple interaction metaphor for applying the selected factor to the virtual flower. Then, according to the user's request, the status of the augmented flower is changed in real time. Thus, participants not only experience gardening, but also learn about the influences of a specific environmental factor on the flower.

We allow a user to collaborate with an interactive agent by assigning collaborative problems pertaining to flower gardening. To achieve assigned tasks, the user tries to select an appropriate simulation factor and apply it to an augmented flower. Since the interactive agent coexists in the user's learning environment, it expresses problem-solving peer support in real time. Moreover, it offers pedagogical guidelines to assist the user in solving the problem.

2.3 Working of Interactive Agent

A learner may have the mission help to- bloom to achieve the goal blooming, there are two possible solutions: apply-water and apply-fertilizer. Apply-water consists of the primitive tasks; select-water and sprinkle-water, and apply-fertilizer is composed of select fertilizer and sprinkle-fertilizer. Sprinkle-water and sprinkle fertilizer have the effect blooming-is-helped which is a desired goal for both the agent and the participant. However, sprinkle-fertilizer has an undesirable side effect for flower gardening, which is root-becomes-weak. Assume that the learner interacts with an optimistic agent, and it chooses the method apply fertilizer and performs the subtasks select-fertilizer and sprinkle-fertilizer. As a result, the undesirable outcome root becomes- weak occurs. First, the interactive agent knows that the participant is the causal agent for this effect. The agent also infers that the participant has foreknowledge about the possible effects of the action and intended to achieve the consequence. Then, the agent externalizes an undesirable state and assigns the responsibility to the participant as the causal agent for the outcome. Finally, the agent reproaches the participant for being blameworthy for the undesirable state root-becomes-weak.

3. Methodology

We develop an augmented reality learning system on an ultra mobile personal computer (UMPC) containing a camera. As shown in Figure 3, we allow users to explore an interactive flower garden over a physical book that describes contents related to gardening. To augment the interactive gardening environment on the book, we exploit BazAR, an open library based on computer vision technology for feature point detection and matching, to track pages of the book [10]. Then, we overlay each page with the virtual gardening environment, composed of a virtual animated flower and selected environmental factors such as water, light, and fertilizer. In this scenario, we visualize the interactive agent as an animated character and enable users to interact with the character. In this way, the character assisted users to solve problems through anthropomorphic expressions, i.e., animated movements, texts, and sound effects.

Figure 3: The implemented augmented reality learning system over a physical book.

We provide a user interface to enable users to simulate environmental considerations in a garden. In prototype, users could see the virtual gardening environment using their mobile devices. To allow users to select a specific factor affecting the growth of the flower, we design a ring-type controller attaching a fiducial marker, which is exploited using ARToolkit [11]. Thus, the users can choose a factor and apply it to the augmented flower with the controller. When a user approaches the controller located near a 3D computer graphics model augmented over a page of a book, the 3D model is transmitted and overlaid on the controller, thereby allowing the user to know which factor was selected. In addition, we allow users to apply the selected factor to the augmented flower through simple actions. Then, according to the applied factor, the augmented flower shows several changes through animation sequences of 3D models, such as growing up, withering, and waving. Hence, participants can not only experience gardening, but also learned the effect of different factors on the flower.

(a) (b)

Figure 4: Applying a selected factor to a flower: (a) Watering and (b) Fertilizing the flower.

(b)

Figure 5: Examples of the implemented agent's expressions: (a) A positive response to the user's appropriate action and (b) A negative response when the user chooses an improper factor for flowering.

4. Conclusion and Future Work

In this paper, we describe an augmented reality learning system that enables users to experience an interactive flower garden with the assistance of an interactive agent. To support interactive experiences, the agent perceives the users' actions and then responds like a companion through nonintrusive expressions. By observing learners' responses to the implemented system, we can find the participants' interest and motivation that engages them in the learning environment.

However, the implemented system has limitations. There is insufficient commentary for users to fully feel the peer support to social events. Therefore, we need to customize the agent's responses with respect to individual differences to offer more effective support in learning environments. Furthermore, we plan to evaluate how much an interactive agent affects users' learning experiences in more complex tasks.

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