Little Bear – A Gaze Aware Learning Companion for Early Childhood Learners

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Abstract. Computing devices such as mobile phones and tablet computers are increasingly used to support early childhood learning. Currently, touching the screen is the most common interaction technique on such devices. To augment the current interaction experience, overcome posture-related issues with tablet usage and promote novel ways of engagement, we propose gaze as an input modality in educational applications for early learners. In this demonstration, we present the Little Bear, a gaze aware pedagogical agent that tailors its verbal and non-verbal behaviour based on the visual attention of the child. We built an application using the Little Bear, to teach the names of everyday fruits and vegetables to young children. Our demonstration system shows the potential of gaze-based learning applications and the novel engagement possibility provided by gaze-aware pedagogical agents.

Keywords. Gaze, Touch, Pedagogical Agent, Early-childhood learning, Vocabulary building, Games, Mobile devices, Engagement.

1 Introduction

Touchscreen devices such as Apple iPad and Microsoft Surface tablets are increasingly applied in early childhood pedagogical environments, such as preschools and kindergartens. Growing popularity and access to mobile devices provide exciting opportunities to design innovative, ubiquitous, and constructive learning experiences for young children. While the immense potential of such devices for early childhood learning is well accepted, there are also many concerns regarding touch-based interaction on such devices in an early childhood learning environment.

There are several challenges in designing engaging and intuitive touch-based applications for young children. Plowman and Mcpake [12] note that if children do not understand what they need to do, the interactivity offered by such devices may be

* This work was done when Nitendra Rajput was working for IBM Research.

counter-productive to learning. This requires careful design of the stimuli and prompts, to make the interaction intuitive [5]. In addition, the underdeveloped fine motor skills and finger dexterity in children [6] lead to difficulty performing certain touch gestures [11], lead to slower and error-prone interactions [15] and cause accidental or unintended touch [10], affecting the overall interaction.

Another concern regarding the use of a mobile device is to balance the placement of the device for optimal touch interaction and considerations of neutral posture of the child. Straker et al. [14] studied posture and muscle activity of children while using desktop computers and tablets and found that touch-based interaction on a tablet is linked with asymmetric spinal and strained neck postures. Similar concerns regarding posture and prolonged tablet use are also raised by teachers and parents [4]. Researchers have proposed several recommendations to overcome the problem, by promoting task variations [14] and encouraging elevated placement of the device which promote neutral viewing postures [16]. In turn, elevated placement of the device may make the touch interaction difficult.

A third challenge in designing learning applications for children is that children have very limited attention spans and easily get distracted by environmental factors (e.g. noise from the hallway, or a colourful object in the tablet screen of a peer) [2]. Luna [9] note that the younger the children, the more easily they get distracted. It is hence important that educational applications designed for early learners are aware of children's attention and that they employ ways to reorient the attention when the child is distracted, to facilitate learning.

We propose gaze as a viable and potentially beneficial input modality in learning applications for children. Unlike explicit touch-based interaction that inherently requires the device to be placed close to the child, by using gaze, the child can interact with the device at a distance, enabling the device to be optimally placed to promote better posture.

Applications that are aware of the visual attention of the child could implicitly adapt themselves, by integrating learning with their curious visual exploration providing a rich and embodied experience. In addition, gaze has a strong association with attention and gaze-aware learning applications can also keep track of the attention of the child and employ means to reorient the attention when the child is distracted.

There are two distinct ways of using gaze information in learning applications. First, by using gaze as the only interaction modality, which could be useful in simple interaction tasks. Second, by using gaze in combination with conventional touch-based interaction, which could be suitable when more complex interactions are required. In this demonstration, we will focus on applications that use gaze as the only input modality. To showcase the interaction and engagement possibility offered by the modality, we designed Little Bear, an animated pedagogical agent capable of oral communication that is also aware of the visual attention of the learner.

Animated pedagogical agents or virtual characters designed to teach or guide users, provide engagement and motivational benefits in learning applications. However, Kramer and Bente [7] note that current generation of agents do not exhibit sophisticated non-verbal communication nor do they exert a social influence. They envision that agents that are more aware of the emotional and cognitive state of the user and show

capacities for non-verbal communication, may have more pedagogical value. Gaze-aware agents have been studied in previous research for children with special needs [8,13] and for adult users [3]. The novelty of our system is that the Little Bear, uses the gaze information to adapt its verbal as well as non-verbal behavior and exhibit emotional states as a mean to reorient attention of the child, when distracted from the learning activity.

2 Demonstration application

Fig 1. Agent based learning application. The application can be interacted using gaze. The red boxes indicate the gaze reactive area.

We designed an application with the "little-bear", a bear-like animated pedagogical agent. The application was set in a garden-like 3D environment, where the agent would take the child for a walk, and the application was designed to teach children the names of some everyday fruits and vegetables. Different fruits and vegetables would appear on screen at pre-defined locations during the walk, which the child could interact with by using gaze. When the child glanced at a specific fruit, the bear spoke an interesting detail about the fruit. The speech was powered by IBM Watson text to speech service, and further customized by choosing the parameters for the speed of speech, pitch and pauses between words, to make the speech feel natural, fitting to the character and easy to understand. The agent also exhibited realistic lip movement and blink behavior to complement the speech.

For accurate gaze tracking, we used Tobii EyeX, an off-the-shelf video-based gaze tracker. The agent used the gaze information to adapt its verbal and non-verbal behaviour. For example, when the child is distracted and does not look at the screen, the character becomes sad (see Figure 2a) and uses speech to attract attention by saying, "*I become sad when you do not look at me*."

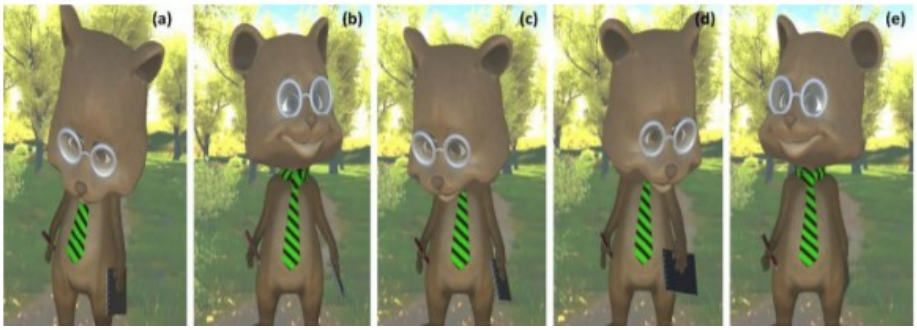

Figure 2. Agent non-verbal behaviour in response to visual attention of the child. (a) A frame from the sad animation. (b)-(e) head orientation of the bear changes based on the visual attention of the child (agent looks where the child is looking).

A fixation of more than 500ms on a fruit resulted in its activation and the agent spoke an interesting detail about the fruit (e.g. *you are looking at apple* or *apple is red in color*). The fixation duration was selected, based on previous works that suggest that the normal median gaze fixation duration for children in an image viewing task is 300 ms and that children have difficulty fixating at a target for longer durations. The speech after the activation of a fruit lasted for roughly 3-6 seconds, during which the application did not respond to any other gaze fixations. Choosing a relatively short fixation duration for activation allowed our application to be implicitly reactive to the interest/visual attention of the child, without requiring an explicit gaze action. When the character was not speaking, the head of the character would orient towards the direction the user was looking at, giving an implicit feedback of gaze tracking and helping establish joint attention. When the character was speaking, the head of the character was oriented directly ahead, abiding by the established social conventions of eye contact during face-to-face conversation.

3 Summary

In this paper, we described the challenges of using touch-based interaction on mobile devices for children and how gaze input could be used as a beneficial input modality in educational applications for children. We further presented the little-bear, a gaze aware pedagogical agent that tailors its verbal and non-verbal behavior in response to visual attention of the user. Our demonstration system will allow others to experience the potential of gaze-based interaction. The demonstration and the related user study [1] shows the novel engagement possibilities of a gaze aware pedagogical agent.

4 Requirements for the demonstration setup

The requirements for the demonstration setup are a desk, access to power sockets for the tablet, and preferably a demonstration area with no direct sunlight, or other intense sources of infrared light, immediately in front of, or behind, the user.

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