Story Teller: A Contextual-based Educational Augmented-Reality Application for Preschool Children

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Abstract

An augmented reality (AR) application, Story Teller, is designed to teach preschool children some Chinese words. In order to train their motor skill, holdable items are used as the AR markers, which can be combined to construct a story. To retain children's interest, varying stories may be presented in different location and time.

Author Keywords

Augmented Reality; Interactive Education; Context.

ACM Classification Keywords

Human-centered computing -> Interaction design

Introduction

Augmented Reality (AR) can enrich students' learning experience by means of blended and seamless learning [Akçayır and Akçayır 2017, Lucke and Rensing 2014, Pérez-Sanagustín et al. 2014]. Many studies have revealed positive learning outcomes from using AR applications in educational settings such as "Enhance learning achievement", "decrease cognitive load", "enhance spatial ability", etc. In the past decade, the number of research papers in educational AR has steadily increased especially after 2012; however, most studies targeted K-12 or college students using mobile

Figure 1: Physical items used for interaction in the Story Teller --- a bottle as the background scroll (left), a pouch as the play button (top-right), and a story dice (bottom-right).

Figure 2: Items in the current design prototype --- background scroll (left), story dice (bottom-center) and play button (bottom-right).

devices such as smartphones or tablets, which are preferred than bulky head-mounted displays (HMDs) or desktop computers [Akçayır and Akçayır, 2017].

Many educational AR applications exist today, such as Quiver, AR Flashcards, Augment, Alive Studios™, etc. [Quiver, 2018]. Our proposed AR application, Story Teller, is similar in that we target preschool children with the goal to teach them Chinese through telling varying stories depending on temporal and spatial data incorporated into a marker-based AR. However, instead of using papers/books as the AR markers, holdable items are proposed, because young children are also expected to develop their motor skill through grabbing, turning, and touching physical items. The stories are preloaded into the application and delivered according to four factors: time (e.g. morning or night), location (e.g. at home or school), AR marker, and user choice. Figure 1 shows some physical components for Story Teller, with the current prototype shown in Figure 2 and 3. Figure 4 shows the moment when we demonstrated them to public on campus.

Design Rationale and Related Work

Many early projects have integrated traditional way of teaching using old folklore literature via mobile AR application and interactive physical books, for example [Tomi and Rambli 2013]. The study claimed that users, including young children, could easily use such application without help. The authors also argued that smartphones and tablets are more pervasive and affordable compared to HMDs. Our design aligns with their idea in that we focus on tales and affordability. Moreover, we also consider daily-used items as the AR markers, as it is more convenient for children to carry and use them than an extra book.

Other works similar to ours are Educational Magic Toy [Yilmaz 2016] and Magic Story Cube [Zhou et al. 2004] in which a jigsaw puzzle and a foldable cube are used as the AR markers, respectively. However, the latter used HMD because smartphones were not widely available in 2004. In fact, many researches on educational AR have showed that children prefer pointing, responding, inspecting and turning behaviors while playing with the toys. Consequently, using holdable toys as AR markers is more favorable than using interactive books per se.

An interesting project, which evaluated augmented reality application using static and dynamic digital content, revealed that students were more likely to get higher grades through learning by using dynamic content [Diaz et al. 2015]. However, extensive animated contents shall be avoided as they require more computational resources. To substitute them, other modalities, such as background sounds and narrations, are used in our design.

Recent studies in early childhood education supported the claim that AR could facilitate children's cognitive development, superior level of cognitive access to complex visualizations, and consolidate the educational effects [Yilmaz 2016, Huang et al. 2016]. Another study on children with ADHD revealed that AR might help them to enhance their confidence and, in particular, apply learning material (target words) in real-life circumstance [Lin et al. 2016]. The authors concluded that the digital teaching material could enhance learners' attention through improving sensory stimulation using AR technologies and thereby promote efficiency in word recognition learning. However, the previously mentioned work neither involving temporal nor spatial context, which is an important feature in our design. We believe that providing different stories in

Figure 3: The prototype of video tangram --- a video screen will pop up to play a video clip when pieces are put together.

Figure 4: The prototype set on a desk (top); a child tried the prototype (bottom).

different places and time will stimulate children's curiosity to explore their environment and keep their interest in learning.

Story Teller

Story Teller is modeled around the premise of being a "director' on the stage, setting up different components provided to exhibit the story. Its three components are background, story dice, and play button. A cylinder-shape item and paperboard are selected as two ways to show background. In our current prototype it depicts some trees to represent forest. Once detected, the system will play audio of the forest environment. The story dice may contain six different images, one on each side (six animals in our prototype). Once detected, the system will play relevant sound and show an associated animated 3D model. After pressing the play (virtual) button, the system will play the audio story.

Similar to most interactive storytelling applications, we adopt a state-transition model to generate different stories, that is, stories are delivered according to the order of input markers and other contextual information (states).

Another feature in our application is video tangram (Figure 3), which consists of some images in a story (a wolf and three little pigs in our prototype). Each partition can reveal its 3D model, such as the wolf, stick house, wood house and brick house. By finding the cue of the clipped image, integrating all of them, the video of the story will start to play on top of the integrated images.

Ultimately, by manipulating the components under the device camera user should learn the story with ample tactual and aural sense.

Component Design

The components of Story Teller are shown in Figure 5. It comprises of AR platform, speech synthesizer, map API, story picker, UI module, and databases.

AR platform includes image recognition and tracking, used to inform the system when an AR marker (image) is recognized, track and superimpose 3D asset(s) onto it. It will also detect virtual button covered by a user's finger (or other items).

Speech synthesizer is used to read the story or other instruction/feedback to users. Both male and female voices are considered in our prototype.

Map API is primarily used to detect point-of-interests (POIs) near the user. An initial scanning is required to retrieve the geo-data of POIs so that the application could work offline afterward. The data collected from JSON include the geotag of POIs and their types, such as "school", "shopping_mall", "restaurant", "zoo", etc. They will be stored in database to customize the story. For example, when a user is within 10 meters from a "restaurant", the story played will be a hunger panda looking for bamboo, and so on. GPS is required here.

Story Picker chooses a story based on the *scenario* (states) determined by the location of user, system time, and the list of AR markers registered into the system. Some example scenarios are: (home, morning, summer, tiger>>pig), (restaurant, evening, winter, chicken>>rabbit>>pig), etc. Story picker is activated every time the user touch play button. Each scenario may associate with more than one story, selectable by touching the play button repeatedly. 3D assets may change following the scenario, for example the forest may appear in different color in a day (see Figure 6).

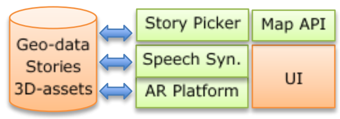

Figure 5: The components of Story Teller

Figure 6: The same forest is shown with different colors in a day; morning (left), evening (middle), late night (right).

The building environment for the prototype is Vuforia 7.1.35, Unity 2018.1.1 and Xcode 9.4. The execution environment is iOS 11.4.

The project demo is available at: https://www.youtube.com/watch?v=Gl9ucriW9k0

Prototype

Vuforia [2018] is used as the AR platform, but the augmented environment itself was created in the Unity [2018], using models from the Unity Asset Store.

The augmented scene was developed with a central idea on Chinese word learning. A phone holder is used so users can freely use their both hands to manipulate the component. In fact, we have also tried Google Cardboard as to provide a more immersive environment; however, the headset failed to provide fluent user experience due to visual discomfort. Note, the prototype extensively consumes the CPU power and occupies relatively large memory capacity (160 MB).

Demo

The project was demonstrated on campus and around ten people had tried it. During the demo, a young boy could quickly manipulate the AR markers without much help. One primary area of improvement found from the demo is the need for a better introduction, because many users did not know how to play with it.

Future Work

A specific avenue for future work would be the reuse of 3D assets and redesign them to fit the limited memory capacity. In addition, personalized stories to fit various user ages have also been suggested.

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