Augmented Reality and Games in Education

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ABSTRACT

While there has been many efforts to create augmented reality games that are educational, many of these games rely on having markers that are pre-determined by the developer. We present a design for a game that attempts to teach children basic math like counting which takes on a marker-less approach. The app was developed on LuminAR, a projected augmented reality system developed at the Media Lab.

Author Keywords

Education; Augmented reality; Games;

THE PROBLEM SPACE

Everyday, teachers, researchers, and developers contribute their ideas and inventions towards the cause of more interactive learning environments. Currently, tablets and apps are the go-tos for creating content for interactive learning but as interests in augmented reality technologies grow, more and more discussions are revolving around how augmented reality could impact education and how more engaging contents can be created for education. We focus in the area of educational games in this project and discuss our approach towards creating more engaging experiences in learning.

RELATED WORK

As the idea of incorporating augmented reality into education gain traction, a few trends in the area of AR games have emerged. We discuss a few of them here:

1. **Wearable devices.** This form of AR games usually involves wearing a pair of goggles or glasses in which a virtual reality is overlaid on the real world. Amongst these devices, the most abitious initiative come straight from Google, who unveiled its Project Glass back in 2012. [1]

2. **Hand-held devices** When these hand-held devices are held up, users can view information overlaid on the objects they are observing. The idea is similar to wearable devices, except these devices are hand-held rather than worn. Second Surface developed at the Media Lab, Layar and Junaio, are examples where smart phones and tablets are used as the device of choice. [2] [3] [4]

3. **Marker-based projected AR.** This form of AR games is the most similar among the 3 to our approach, where a camera overhead tracks a user's actions and projects onto the user's physical space. These products also track pre-determined markers as cues to initiate responses from the system. ARPool developed at the RCVLab in Queen's University demonstrates a projector-camera system that guides a pool player by projecting calculated paths on the surface of the pool table. [5]

Our approach derives some of the ideas from these work but rely on a projected augmented reality rather than a screen-based approach. We also attempt to eliminate the use of markers in our games.

THE APPROACH

We designed a game for children in the age range between 3 to 7, to learn basic math using the LuminAR platform. LuminAR is a projected augmented reality system consisting of a depth sensor, projector and an on-board computer in an integrated product. Currently, the modes of interactions supported by the system are multi-touches, contour tracking, snapshots and markers tracking. We mainly utilize multi-touches and contour tracking in our game.

Using the LuminAR system, the overhead sensor observes the interaction space below the projector and detects the appearance of contours in the space. By tracking the contours, we have information on the number of objects in the space and our game uses this information to teach/prompt users to count the number of items they see.

USAGE

Our target users are children who are just beginning to learn basic math like counting, addition, substraction and multiplication. We aim for a design language that is relevant to that age range and easy to understand such that they can play the games even without the direct guidance of parents.

IMPLEMENTATION

Our design uses Duplo blocks and characters that children are already familiar with from Duplo. Different scenarios such as loading a train with blocks form the background storyline for each level in the game.

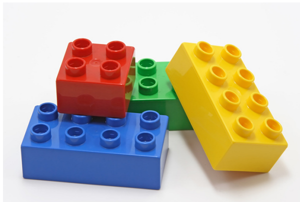

Figure 1. Duplo blocks.

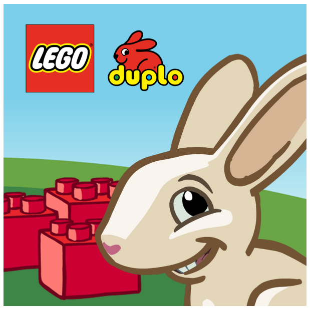

Figure 2. Duplo characters.

There are 3 modes in the game. The first mode prompts the user to place duplo blocks in a white box indicated by the projected scene. The system then tracks and reports the number of blocks it detected. This is where users first learn to associate the numbers shown in large font to the number of blocks placed in the box.

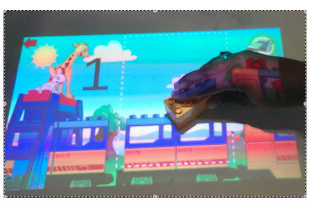

Figure 3. 1st mode in the game.

The second mode attempts to familiarize the user with the 3 basic math operations : addition, substraction and multiplication. In this mode, three white boxes are projected in the scene to form a simple math equation with one operation.

Figure 4. 2nd mode in the game.

As the number of blocks detected in each white box changes, the game calculates and reports if the equation is valid for the chosen operation.

The third and last mode repeats the same process in the 2 previous modes but the scenarios are now posed as a question. Users are prompted to produce the answers to the questions shown. For example, the first level in this mode would project a number and prompt the user to place blocks in the white box to match the number shown. As the users progress through the problems, a math equation would be shown instead and the user would have to fill in the number of blocks that would satisfy the equation.

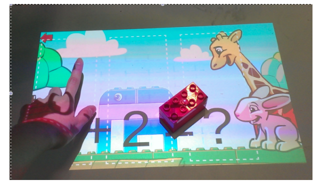

Figure 5. 3rd mode in the game.

The game is implemented as a web application that sits on top of Lens, a Javascript library that allows developers to create augmented reality applications using standard web development tools. Lens serves as the bridge between the web application and the back end of LuminAR which handles the AR vision computations. As such, the game can be easily modified during the development process and adding a new mode in the game is equivalent to adding a new web page.

So far, a new contours module has been written in Lens to translate and communicate the detection of contours handled by the back end. The 3 modes of the game described above has also been developed using this new module. To further improve on the existing implementation, new modes of the game remains to be developed and more animations could be added to give the game a more interactive feel.

WHAT I'VE LEARNED

The response from users so far has generally been positive. The biggest challenge so far has been to stabilize the tracking of contours to provide consistent results every time. Most of this challenge was mitigated by tweaking parameters that determine when a new contour is detected. Other mitigations involves designing the game around these limitations. For example, a user is prompted to "request the answer" from a duplo character rather than being given the response automatically. This helps reduce errors where the number of contours detected fluctuate as hands are detected in the space. More work remains to be done to improve the tracking of contours however.

On the application end, the second mode in the game seem to create confusion even among adult users. The process of experimenting with different equations and getting responses as to whether the equations are valid did not seem to be an intuitive process to the users. In general, the last puzzle mode of the game where equations are posed as questions seem to be a more intuitive approach to a game for users.

CONCLUSION / EVERYDAY LEARNING

While duplo blocks were utilized in the design of our game, we are not limited to detecting only duplo blocks since we do not use markers in our tracking. Duplos were a means to creating an atmosphere that is familiar to children in the game and we can extend our application to use everyday objects.

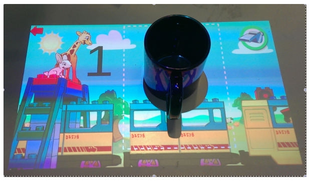

Figure 6. 2nd mode in the game.

As we progress, we envision scenarios where children can learn new concepts not only in designed / fictional scenarios in application games today but also using everyday objects.

REFERENCES

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