Senior Project, Spring 2017

TAM: multi-Touch, mid-Air and Motion for Virtual and Augmented Reality Version 6.0

Learning Data Structures with Augmented Reality for Computer Science Education (K-12)

Student: Tom Lam, Florida International University

Mentor: Francisco Ortega PhD, Florida International University

Instructor: Francisco Ortega PhD, Florida International University

Problem

Education comes in many forms and expressing them effectively is currently the biggest concern due variations in teaching styles and methods. In conjunction with Augmented Reality (AR), it is possible to use AR as a tool for education, using the virtual world to describe concepts and illustrate diagrams that would be far too time consuming to create by hand or limited in scope due to the many different combinations of situations possible.

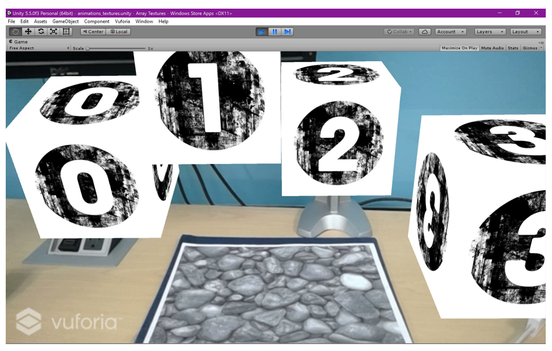
Solution

Using software frameworks for video game designing and AR plugins to assist with AR marker training and recognition allows 3D environment modeling. From there, it is possible to represent any 3D object and allow it to be manipulated such that the student can learn from how the constructs work and understand topics at their own pace.

Implementation

The application will be built in the Unity Game Engine with the Vuforia AR plugin. Unity will allow the creating and manipulating of 3D objects in the virtual environment with Vuforia assisting with AR marker recognition and training. The AR marker will be saved to an Image Target Database utilized by Vuforia to allow marker tracking and recognition. The application will then be deployed to a Windows-based platform with a front or rear-facing camera.

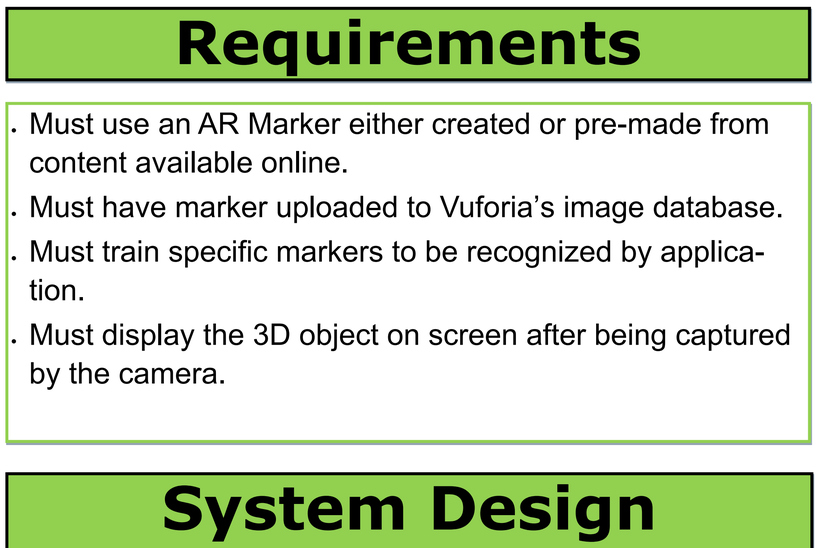
Screenshots



Requirements

- Must use an AR Marker either created or pre-made from content available online.
- Must have marker uploaded to Vuforia's image database.
- Must train specific markers to be recognized by application.
- Must display the 3D object on screen after being captured by the camera.

System Design



Research Part 2

Much of Augmented Reality (AR) technology is still in the infancy stage, where content has yet to fully mature and not all the possible uses have been fully explored. Despite this, many have begun attempting to use augmented reality for the purposes of education and studies show that they prove to be beneficial. Augmented reality-based education not only allows the student to learn faster but also leaves the student more motivated to learn. Students develop skills quicker, allowing topics and ideas to be more easily understood compared to traditional methods like lectures and it provides students easier understanding to complicated topics. However, it is possible for the student to grow curious about the learning environment only to lose interest after repeated use. Augmented Reality-based education is best utilized in conjunction with an instructor.

Verification

In order to validate our application's features we used Unity Test Tools to cover assertions, integration, and unit testing. Agile already lends itself to the development of test-driven features, since a feature-complete Sprint results in a deployable (tested) feature. Using Vuforia also made testing simpler because we did not have to test the image recognition capabilities of the packet, nor every augmented reality marker incorporated into the Image Target Database. We only had to test scene transitions (in Unity) and UI elements such as buttons, scrolling lists, etc.

Research Part 1

The research is based on the Empirical Modeling, a conceptual framework for computing based on principles and tools for making construals. Construals are interactive digital artifacts that embody configurations of observables, dependencies, and agencies encountered in the situations to which they refer to; within the context of Computer Science education, construals describe emergent properties of axiomatic concepts. For example, a student can know the rules of Sudoku, but until they play it a couple of times—the concept will remain unfamiliar and purely abstract. In the Sudoku game, the construal is the rows, columns, and subdivided squares on the paper representing the culmination of the games' rules. In our application, the construal is the AR visualization representing the concept of an array data structure.

The ICAP Framework

For each of the 4 modes of overt engagement behavior, we can postulate a different set of cognitive processes producing different changes in knowledge

Chi, M.T.H. (2009). Active-Constructive-Interactive: A conceptual framework of differentiating learning activities. *Topics in Cognitive Science, 1(1)*, 73-105.

Instructional or Learning Tasks	PASSIVE *Oriented toward & Receiving*	ACTIVE *Selecting and/or Manipulating*	CONSTRUCTIVE *Generating or Producing*	INTERACTIVE *Collaborating in Dialogue*
Cognitive Processes	*Store* information In isolated way	*Activate* prior relevant knowledge *Store* new information w prior knowledge	*Activate* prior relevant knowledge, *Infer* new knowledge *Store* new information with activated & inferred knowledge	*Active, Infer, Store* Integrate and Build on other's Knowledge
Changes in knowledge as a result of cognitive processes	**Recall** In same context	**Apply** Similar problems or situations	**Transfer** Solve or explain dissimilar problems	**Innovate** Invent or discover new solutions & explanations
Understanding of the learning materials	Minimal	< Shallow	< Deep	< Deepest
	P	< **A**	< **C**	< **I**

Axiomatic

Empirical Modeling

Both

Summary

Learning Data Structures with Augmented Reality for Computer Science Education attempts to assist educators in providing better learning environments with a tool that can not only decrease time needed to create illustrations on white boards by hand, but also allows better comprehension of knowledge in a fun and interactive manner. This promotes learning and self-motivation, aspects which are difficult to achieve when topics like computer science often require complex and difficult details to be understood. Research shows that a tool like this should be used in conjunction with the supervision of an instructor, where the instructor can provide additional clarification in the event that student encounters difficult material and requires assistance. It is not recommended to use the AR application as a repetitive tool. Overuse of the AR application may result in a lost of interest and eventually abandoning the AR application entirely.

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