E-learning System using Augmented Reality

Siddhant Patil
Student
Dept. of Information Technology
D. J. Sanghvi College of Engg.
siddhantpatil17@gmail.com

Chiquitha Prabhu
Student
Dept. of Information Technology
D. J. Sanghvi College of Engg.
chiquitha.prabhu@gmail.com

Omkar Neogi
Student
Dept. of Information Technology
D. J. Sanghvi College of Engg.
omkarneogi2@gmail.com

Abhijit R. Joshi
Faculty
Dept. of Information Technology
D. J. Sanghvi College of Engg.
abhijit.joshi@djsce.ac.in

Neha Katre
Faculty
Dept. of Information Technology
D. J. Sanghvi College of Engg.
neha.mendjoge@djsce.ac.in

Abstract – Virtual reality replaces the existing world with a simulated one. Augmented reality is, however, in real time. The emerging field of Augmented Reality opens up avenues in numerous fields with education being no exception. Our paper proposes an e-learning system for three-dimensional geometry, which makes use of Augmented Reality to enable the user to comprehend the three-dimensional geometry concepts faster and better. It facilitates the students understanding of three-dimensional geometry, which can be difficult when attempting to do the same in two-dimensional space. Based on the marker, the system generates the three-dimensional object and blends it in the real world footage. The system allows the user to manipulate the object through virtual buttons, while also allowing him/her to access the object's properties. Furthermore, the system provides interactive videos to aid the users understanding as well as a quiz by which the user can assess his/her knowledge of the three-dimensional concepts.

Keywords – Augmented Reality, augment, geometry

I. INTRODUCTION

Augmented reality (AR) is a concept that deals with the combination of real-world and computer-generated data (virtual reality), where computer graphics objects are blended into real world footage at real time. As a result, the technology functions by enhancing one's current perception of reality. Markers pasted on real world objects are captured by a camera and processed by a computer with the help of image processing routines. A software code searches each frame for the marker and if found, calculates the position of the camera relative to the markers. Once the position is identified, a 3D virtual object is superimposed on the marker in the real video. As a result, when the user sees the real world video, he sees the virtual 3-D object superimposed on the real world. Hence, we can say that augmented reality adds virtual content to the real environment. Due to this advantage of Augmented Reality, we decided to use augmented reality in order to help the user understand the intricate concepts present in the static form of geometry, where the teaching and learning techniques are still limited to 2D visualization. Use of Augmented Reality can complement a student's understanding of 3D Geometry. Since it works directly in 3D, it will enable a user to comprehend the 3D Geometry concepts faster and better. The beneficiaries include Math teachers as well as students appearing for competitive exams as well as school exams [1].

II. REVIEW OF LITERATURE

A. Existing Systems

In this section, we will be covering various approaches or systems currently being available to learn three-dimensional geometry.

1) *Traditional Approach:* A common method used for learning geometry is with the help of power point presentations. A teacher will display the shape and the operations done on the shape on the screen with the help of a projector and the students learn from what the teacher explains. The teacher can either create videos of the operations to be performed on the object or can perform the operations in front of the students. Some other existing systems are as follows:
2) *Geometry Learning Tool for Elementary using Augmented:* This tool supports the creation of augmented reality based applications by detecting and registering the virtual objects in real time [2]. One can use this tool to teach the elementary children to measure angles using a protractor. Four colored cards are used viz., red, blue, green and lime. These colored cards act like markers. The red card is used as the pivot point, the green and blue card will act as a target point and the lime card will be used to show how big the angle. Pivot point should not move

because it will become the center point of the coordinate system. After the web cam detects the red marker card, now the students can show the blue or green marker to the web cam. If it is a blue marker, then the intersect line will appear from the positive x coordinate. If it is a green marker, then the intersect line will appear from the negative x coordinate. After displaying the intersect line, now with help of protractor, student can measure the angle between the intersect line. To check the correctness of their answer, a lime marker is shown. This triggers the function, which displays the measure of angle on the screen.

3) *Interactive E-Learning System using Pattern Recognition and Augmented Reality:* This is an interactive e-learning system, which uses pattern recognition and augmented reality [3]. At the time of learning, the system provides realistic audio-visual contents to students. The system has various components such as image recognition, color and polka-dot pattern recognition, and augmented reality engine with audio-visual contents. The system uses web camera to capture the current page of textbook on PC. Then the system identifies the images on the page, and augments some audio-visual contents on the monitor. For interactive learning, the system uses the color-band or polka-dot markers. One is supposed to put this marker to the end of a finger, which is used as the mouse cursor to indicate the position in the textbook image. As soon as the marker is located on the predefined image objects in the textbook, appropriate interactive audio-visual contents are augmented on it. This e-learning system is used in the educational courses in the elementary school and found satisfactory results.
4) *Multimedia Augmented Reality Interface for E-Learning (MARIE):* MARIE is closely related to Magic Book, a powerful augmented reality interface [4]. The system is built using a lightweight Head Mounted Display (HMD), a small camera and a computer. The system uses some of the functionality of the AR-Toolkit and computer vision techniques to effectively compute the real camera position and orientation relative to predefined marked cards. A custom built see-through HMD is provided to user. As per the learning context, the user places a set of predefined markers on the table and looks at the markers through the HMD so that multimedia information is mixed with the real environment in real time. The teaching material presented to student is divided into appropriate units and a marker was created for each unit. This helps in users to select right markers associated with the teaching material. Now, it is left with the teacher to devise the right learning strategy for students. That is, the order in which the students should use the markers for seeing the learning material in an AR environment.

B. Issues in Existing Systems

Some the issues in the existing systems discussed above are -

1) In traditional approach, teacher used Power Point Presentations for displaying shapes and performing various operations on it. Due to this, students do not get to understand the shapes the way they want to. Their understanding is one - dimensional and is restricted to whatever the teacher will display on the projector screen. The students don't get any practical experience of performing operations.
2) Sometimes teachers use physical samples of cubes, spheres and other such shapes while teaching, to help students visualize the structure in a 3D space. But it is inconvenient for the teacher to carry the specimens around. It is difficult for the teacher to provide personal attention to the students in a class of approximate 60 students. Hence, it is very rare that a student gets a specimen to himself/herself to analyze and it's not feasible for every student to get a specimen to himself. This results in inability to perform operations like slicing through the shape, increasing/decreasing dimensions, etc.
3) The system, Multimedia Augmented Reality System for E-Learning, works by scanning a marker from a page and superimposing a virtual 3D image on the marker. The over dependence on markers make this system obsolete. The new system that will be developed will search for shapes drawn on the page and understand the shapes itself to superimpose a virtual image on the object drawn. The fineness in the edges of the marker depends upon the intensity of the marker light, if not properly lit the threshold process gives jagged edges and makes it difficult to distinguish between the contours. The system fails during occlusion, i.e., the covering of the marker by an external object. This system when made using OpenGL software takes a longer time to create as the objects have to be coded, the same thing can be done using blender that reduces the rendering time.

Looking at the various issues in the existing systems, it was decided to develop an e-learning system using augmented reality for effectively teaching three-dimensional geometry.

III. OUR APPROACH

The main concept of our educational system is to collate educational content with information technology. This helps students study concisely with auxiliary visual contents that are played on the personal computer or any other specific

terminals. Our goal is to design a mentoring system for self-studying, which lets the students learn the visual contents interactively. When the images and objects on the text pages are recognized, the related contents are played or augmented on the display.

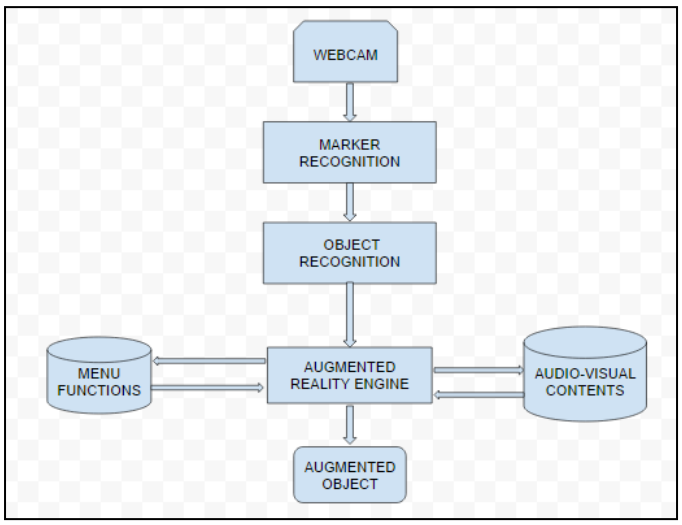

Figure 1: System Prototype

Figure 1 shows the architecture of our e- learning system. It consists of image recognition, i.e., marker recognition, virtual button recognition, and an augmented reality engine. When the camera captures the current page (real world live video), the e-learning system first identifies the images on the page, which act as markers, and then augments the corresponding visual contents on to the monitor, based on the marker's position and orientation. The markers are registered using the Vuforia SDK, which assigns a unique license key for the marker. Every marker is recognized uniquely, which allows the Unity Game Engine to process specific augmented outputs. Simply put, the live video stream is analyzed for each frame and processed to recognize the position and orientation of the markers. Once each video frame has been processed, the original image and the virtual object is combined and rendered using the augmented reality engine into the required augmented view.

Our e-learning system uses virtual buttons for interactive interaction of the user with it for better understanding. The Virtual Buttons are executed using the virtual buttons package present in Prefabs folder->Assets file. The user's fingers act like a mouse cursor to indicate the option chosen by the user. In doing so, the sensitivity of the virtual button has to be increased which leads to the output becoming more responsive to shadows. When the user hovers his finger over a specific button, the corresponding predefined menu function is performed. The functions consists of scaling up, scale down, rotate left, rotate right, move up, move down, move left and move right.

The properties of the object can be displayed on demand in the second module of the application. To activate this module, the student is required to hover his/her hand over the object. The camera recognizes the shadow of the hand and displays the properties of the particular object. The third module of the application deals with the presence of pop-up video playback. This part of the application uses the Text Recognition technology. Here, the particular word is already fed into the game engine and is assigned a specific video. When the camera recognizes that particular word is available in a particular font style, then it matches it to the assigned video and augments the video. This module helps students get an instant audio-visual help while understanding major geometric concepts. The presence of videos helps to develop a more immersive environment. The last module of our system consists of a self-evaluating quiz. The quiz contains various difficulty levels and each level has a series of questions that the user can answer based on the virtual buttons available. On hovering a finger over the virtual button, the corresponding answer is recorded and the next question is displayed. Once the quiz is over, the system displays the statistics of the user's performance, so as to monitor and improve his/her progress in geometry.

In this way, our approach to augmented reality self-learning application is devised to help students in learning complicated geometric concepts and provide them as an aid for self-learning capability and in turn recognize their strengths and weaknesses.

IV. WALKTHROUGH TUTOR

Our Augmented Reality system for learning three-dimensional geometry is built using C-sharp language and can be run on Mac OS or Windows 10 OS with Intel processor. One has to keep in mind certain important points while working with our 3D Geometry Augmented Reality tool.

1) For a computer system to run this application, Unity 3D software should be installed on the system.
2) The marker must be kept straight in front of the camera. It helps in clearly detecting the marker and recording its position and orientation.
3) The camera in question should be highly sensitive to recognize the inputs or the shadows that fall on the virtual buttons.

Now, let us take a walkthrough of our system as a user. Figure 2 shows the main screen of the application where the object is shown in its original dimensions in the center of the screen. The user is provided with three operations, which can be performed on the object. These operations are rotate, scale up and scale down.

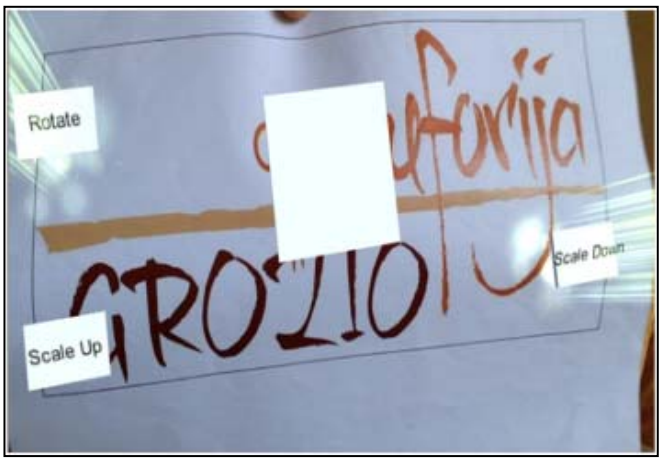

Figure 2: The Main Application Screen

Let us say, the user wants to learn how a three dimensional object would scale up. For this, he/she has to click on the scale up button. On clicking the scale up button, the object gets enlarged. Figure 3, shows the scaled object.

Figure 3: The Scaled Object

Similarly, if the user wants to study the rotation of a three dimensional object, then he/she clicks the rotate button. On clicking the rotate button, the user is presented with operations, which can be performed on the object. These operations are, namely, shift, rotate left and rotate right. Figure 4 shows the three dimensional object and the buttons viz., shift, rotate left and rotate right.

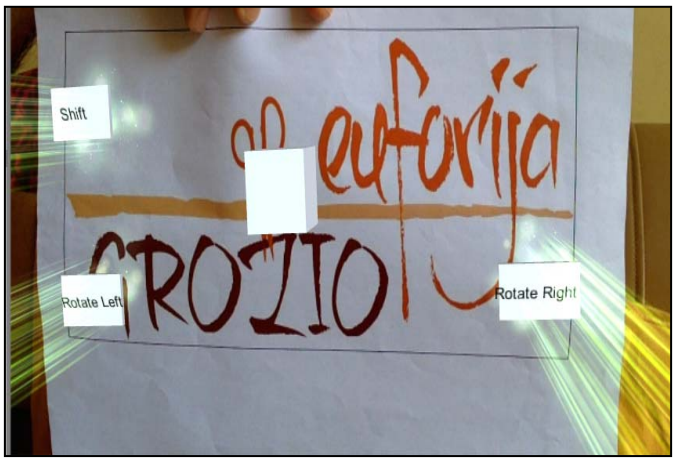

Figure 4: The Rotation Screen

Let us say, the user wants to visualize how a right rotated object would be seen after rotation. For this, he/she clicks the rotate right button. The object after being rotated right is shown Figure 5.

Figure 5: The Object after Rotation

After studying the basic concepts of three dimensional geometry, the user can also take a quiz to test his/her knowledge. The snapshot is shown in Figure 6.

Figure 6: The Screen for Quiz

Figure 6, shows the question presented to the user and four options for answer. If the answer is 'A', then the user has to click the button 'Answer A'. If the answer given by the user is correct, then the next question button is displayed to the user. This is shown in Figure 7. On clicking the next question button, another question with four options for the answer will be displayed to the user.

Figure 7: Next Question Screen

V. CONCLUSION

The current system of teaching 3D Geometry in schools and colleges needs revolutionary changes, which can brought out by widespread use of technology in every aspect of our lives. Our research will help students to develop an in depth understanding of 3D spaces and objects in the 3D spaces. The use of Augmented Reality in education is useful in this case, which helps the students to understand the lesson in a better way. Our e- learning system not only provides the students with visual augmented contents, but also improve the learning efficiency and concentration of students. The test provided is a diagnostic tool for a student's self-study. The interface created using markers is natural and riveting such that no special training is required to use the system. The system is convenient as the related videos provided can be revisited any number of times till the student is actually comfortable with the course in question. Thus, improves the learning experience.

REFERENCES

[1] M. Billinghurst, H. Kato and I. Pouprev, "The MagicBook: A Transitional AR Interface," in Magnetism, vol. 25, Elsevier, October 2001, pp. 745–753.

[2] J. Purnama, D. Andrew and M. Galinium, "Geometry Learning Tool for Elementary School using Augmented Reality," IEEE. Bali, pp. 145–148, August 2014.

[3] S. H. Lee, J. Choi and J. Park, "Interactive E-Learning System Using Pattern Recognition and Augmented Reality," IEEE Transactions on Consumer Electronics. Vol. 55, pp. 883–890, May 2009.

[4] F. Liarokapis, P. Petridis, P. F. Lister, and M. White, "Multimedia Augmented Reality Interface for E-Learning (MARIE),"World Transactions on Engineering and Technology Education. Brighton, England, vol. 1, no. 2, pp. 173–176, 2002.