Building EdTech Solutions with AR

Lizanne Fernandes[1], Savita Jamdarkhani[2], Merlyn Joseph[3], Saniya Mulla[4], Ruchita Suranagi[5], Kedar Sawant[6], Sagar Naik[7]

[1,2,3,4,5] *Department of Computer Engineering Agnel Institute of Technology and Design, Assagao, Goa*
[6,7] *Assistant Professor, Department of Computer Engineering Agnel Institute of Technology and Design, Assagao, Goa*

---***---

Abstract - *In our world today, the unusual shift to home learning has had a profound impact on students. AR-enabled eLearning applications render augmented objects on screens and play 3D examples of concepts that allow students to learn and engage easily* (Silva, 2019, 1)[1]. *The application can capture the image of objects from the real environment and provide a detailed description of the object. Students find theoretical information without any visuals or relatable examples difficult to understand. As a result, many concepts remain unclear and out of reach for students. This is where AR applications come to the rescue, visually transforming information and creating order from the chaos. The AR App will enable students to wander around objects like a 3D CPU on the screens of their smartphones/tablets and interact with it, click on it for labeling of parts, rotate it and play around with it.* (Silva, 2019, 1) [1]

Key Words: Augmented Reality, 3-dimensional, Education, Image Target, Technology.

1. Introduction

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.(Lintern, 2017)[10] Designers create inputs ranging from graphics to GPS overlays and more in digital content which responds in real time to changes in the user's environment, typically movement, to sound to video. (Antonioli et al., 2014, 1)[6] AR must also meet three basic characteristics:

1. Real-time interaction.
2. Accurate 3D registration of real and virtual objects.
3. Combination of real and virtual world (Softtek, 2021)[3]

Types of Augmented Reality
Marker-Based Augmented Reality

AR applications based on Marker use target images that are markers, to position objects in a given space. The application places the 3D digital content considering the user's field of view is determined by using markers. Markers were used in early-stage AR technologies.

In order to superimpose the 3D virtual object, the Marker-based AR applications are often linked to a specific physical image pattern marker in a real-world environment. Thus, the cameras must continuously scan the input and place a marker for image pattern recognition in order to create its geometry. In case the camera is not properly focused, the virtual object will not be displayed. A marker-based image recognition system requires several modules consequently, such as camera, image capture, image processing and marker tracking, among others. Generally, this is a simple and inexpensive system to implement in filters through a custom application to recognize specific patterns through a camera.

Marker less Augmented Reality

Virtual 3D objects positioning in the real image environment by examining the features present in the data in real time is allowed by Marker less AR. This type of guidance depends on the hardware of any smartphone, be it the GPS or accelerometer, camera, among others, the job is completed by the augmented reality software.

With this model, there is no need for an object tracking system due to recent technological advances in cameras, sensors and AI algorithms. Thus, it works with the digital data obtained by these sensors capable of recording a physical space in real time.

1.1 Project Objective

Students can achieve better results through visualization and full immersion in the subject matter with the help of AR in education. So, instead of reading theories about something, students can see it with their own eyes, in action. The potential of Augmented reality can be used to replace paper textbooks, physical models, posters, and printed manuals. It offers less expensive and portable

learning materials. Education has become more accessible and mobile due to AR.

Therefore, the objectives of the research are:

i. To create an educational application using augmented reality technology.

ii. To provide users a new interactive technology to be practiced in the educational sector.

iii. To build an augmented reality mobile application, an effective means of educating and entertaining young people of all ages.

iv. To produce interactive learning application using AR the abstract concepts are materialized to help students understand and visualize challenging subjects.

1.2 Software and Hardware Requirements

Software Requirements: There are various different software used in the development of the project, the main being unity which is a tool used for developing android apps and AR core, an SDK which focuses on AR. The secondary software which we're using is Blender which is a software used to create 3d models of our products which then will be used by AR core render it.

Hardware requirements: An AR Core supported device, RAM-Minimum 4GB, Camera -Minimum 5MP, Mobile, Tablet, Computer.

2. Literature Survey

2.1 Introduction to Augmented Reality

The paper mentioned, proposed by R. Silva, J. C. Oliveira, G. A. Giraldi presents an overview of basic aspects of Augmented Reality (AR) and the main concepts of this technology. The paper gives information on the fields in which AR is applied nowadays and main AR devices (Silva, 2019, 1) [1].

2.2 Augmented reality for history education

This paper shows an instructive mobile application-based system model on Augmented Reality which is used to learn history through augmented videos. In this application scanned images are demanded from users and it will show the history related to that particular image (Raghaw & Paulose, 2018, 1) [7].

2.3 The Magic Book

The Magic Book interface makes use of books as the main interface objects. When the user looks at the pages through an Augmented Reality display, they see three-dimensional virtual models appearing out of the pages. In the VR view users are free to move about the scene at will and interact with the characters in the story. Thus, users can experience the full Reality-Virtuality continuum (Billinghurst et al., 2001, 3) [5].

2.4 Design of Augmented Reality for Engineering Equipment in

Education

This research shows a design of an Augmented Reality (AR) on engineering equipment for education called (AREEE) with an android phone. AREEE applications with smartphones are used to scan the target and display some AR 3D models on engineering equipment. On the smartphone's screen, the 3D model can be interacted with, and users can rotate the model to look at it from a different angle and tap to display the specifications of the equipment and other information about the equipment (Kassim & Zubir, 2019, 1) [8].

2.5 Augmented Reality Applications in Education

The paper mentioned proposed by Misty Antonioli, Corinne Blake, and Kelly Sparks focuses on how this technology can be applied, the problems surrounding the use of this technology. AR can be used to enhance content and instruction within the traditional classroom. This paper also states a few challenges of AR in education. These challenges include training the student as well as the educator, making AR tools user-friendly (Antonioli et al., 2014, 1) [6].

3. Existing Systems

Immersing learners in the real world and making them interact with it, is mostly inconvenient. Although the natural world is three-dimensional, we prefer to use two-dimensional media in education which is very convenient, familiar, flexible, portable and inexpensive. But it is static and does not offer dynamic content. Computer generated three-dimensional virtual environments can be used like VR headsets but these scenes require high performance computer graphics which are more expensive than others. Although lots of opportunities virtual worlds may present for teaching and learning, it is hard to provide an appropriate level of realism. When users are completely immersed in this environment, they become disconnected from the real environment. So, it gives you virtual things by modeling the real world you're experiencing. (Kesim & Ozarslan, 2012, 1) [9]

With the app, the user can visualize the object in a space of their customized dimension and place the object where they want to. An existing application is Assemblr EDU.

Assemblr EDU enables you to make more interactive, collaborative & fun learning activities with 3D & AR. Classroom. 3D/AR View. In its Computer Hardware section only two computer hardware were implemented.

We also found that the App hangs a lot and does not have many examples (assemblr edu, 2019) [4]. Another similar App is Computer History AR. It focuses only on History of Computers i.e., Different generations of computers. There are no categories to browse through and the interactivity level is less.

4. Proposed System

The app is simple yet descriptive in a way that the users will be able to visualize the Concept which they are trying to learn. User Interface and ease of usability is of the utmost importance for any app or software. That being said, the users will simply have to click, select, tap and scan the 2D objects.

Users will have to first sign up if he/she is a new user or sign in. Then the user will have to select through a selection of 3D objects in each section. The concepts will be segregated into 5 different predefined categories.

Computer Hardware, Computer Networks, AI problem Solving, Visualization of Searching algorithms, Game Section. Then the user will select the category he/she wants to visualize by simply tapping on it.

The camera button is displayed to scan the target 2D image. After the user scans the image, the app will then deploy a 3D model of the selected product to be viewed in all the angles.

The product will then be deployed through the AR software which will augment the product in the real-life dimensional room after which the users can place it anywhere, they want. The 3D model will be displayed along with the labeled parts and useful links and pdfs will also be attached, for each model the voice explanation is provided.

Other options will also be incorporated in the app such as rotation, zoom -in, zoom-out the 3D Model, this helps the user to play with the model and helps them to understand the concept easily.

4.1 Methodology

The system basically uses a smart phone's built-in camera which supports AR to view the real world observed by the human eye and places the 3D model on the screen.

First step is the creation of the 3D models using Blender. The next step is to convert the 3D models into an interactive AR element using Unity3D software. We need to set up the scenes in Unity 3D for the User Interface of the application like buttons, text areas, background image and virtual object selection. Through identifying and tracing the surface area, the imported 3D virtual model is placed in the real-world view along with the description and other multimedia content. Because Android smartphones have a touch-screen interface function, the users can easily interact with the augmented virtual content.
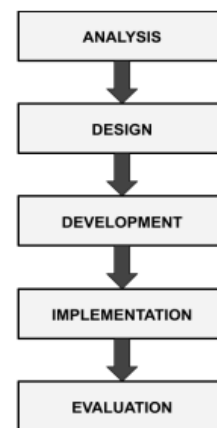

Figure 1: ADDIE Model

In order to ensure effective learning outcomes from educational courseware or mobile application education development, careful planning is required before the development process begins. ADDIE Instructional Design Model is used in this mobile AR application development methodology. The ADDIE model for instructional system design (ISD) is a basic model that can be applied to any kind of learning solution. The ADDIE model has five steps, namely, analysis, design, development, implementation, and evaluation as illustrated in Figure 1. (*ADDIE Model*, 2010) [2]
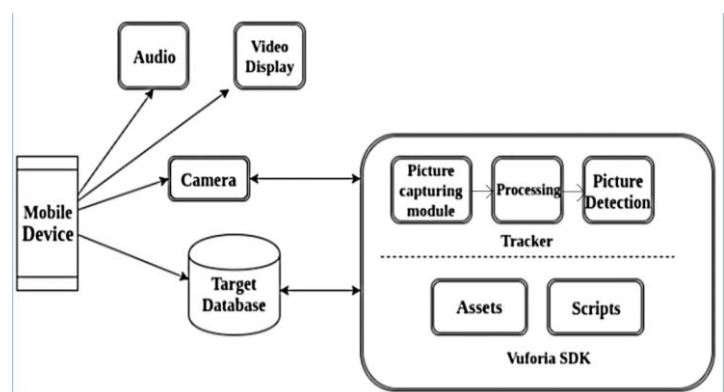
4.1.1 Block Diagram

Figure 2: Block Diagram

This application is developed by using Unity3d and Vuforia Augmented Reality Software Development Key (ARSDK). Here Unity3D is used to create the application and Vuforia AR SDK is used to link the Augmented Reality camera and the image tracker. Tracker is used to detect the image target which is stored in the database. Assets and Scripts working along with access to the Target Database is explained in detail in the same section after describing the model. As shown in Figure 2, the first step is to open the application camera and scan the targeted image using a mobile device. Once the image is scanned, it is sent to the picture capturing model for recognition. If the image is recognized it is sent to the processing model. Processing model then detects the marker position and sends it to the tracker model. Tracker model then identifies the marker and sends it to the rendering model. Rendering a model using picture detection will mark a virtual object to the marker and hence the augmented video will be played.

4.1.2 Use Case Diagram

Figure 3: Use Case Diagram

Figure 3, describes the use case diagram of the application where the user interacts with the application using an Android device that supports AR camera. Initially we select the model in which we are interested, then scan the surroundings using a device camera and place the model.

4.4.3 Activity Flow
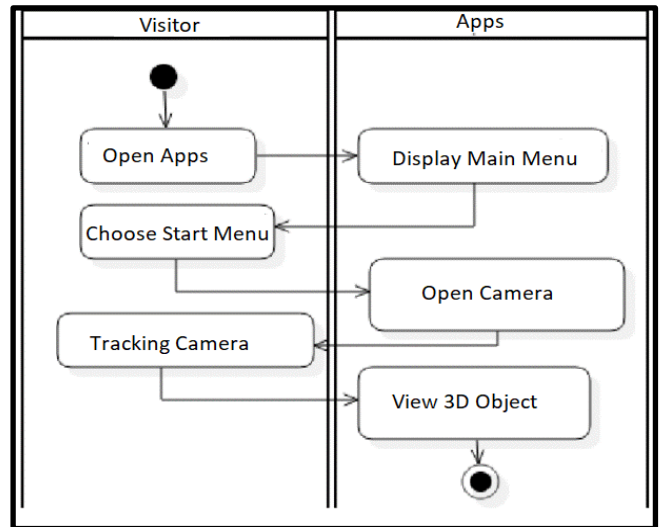
Figure 4: Activity Flow Diagram

The user opens the app, chooses the module option from the start menu, points the camera to the image target then a virtual 3D model is overlaid on the image target in the real world.

5. Implementation and Results

5.1 Computer Hardware Module

A. Motherboard
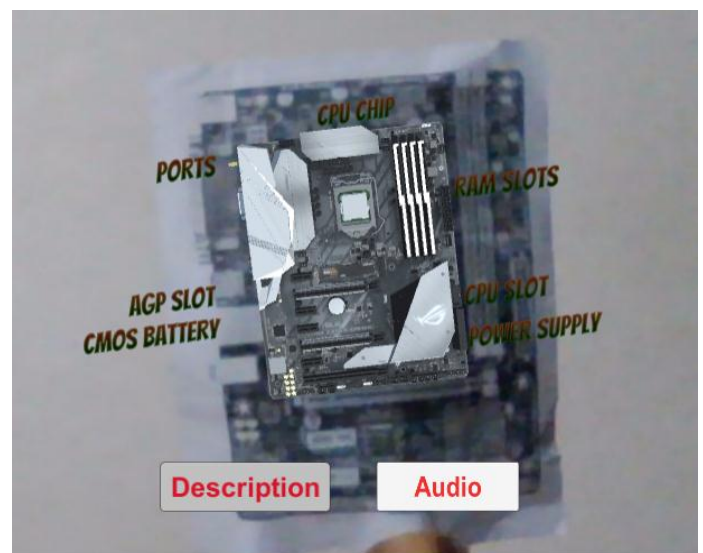
Figure 5: 3D model of a motherboard

B. Mouse

Figure 6: 3D model of a mouse

C. Keyboard

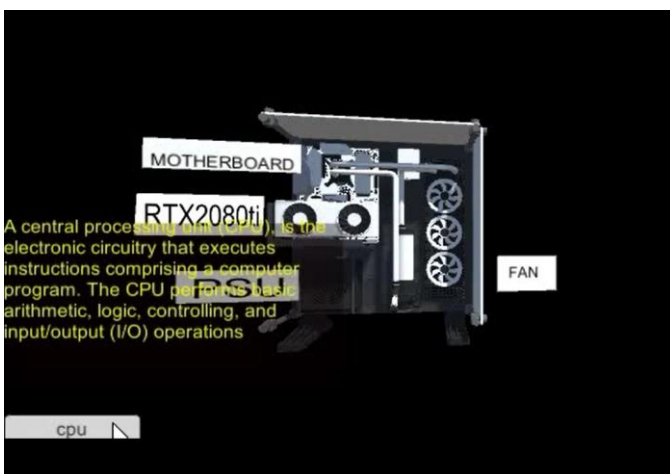*Figure 7: 3D model of a keyboard*

D. CPU

Figure 8: 3D model of a CPU
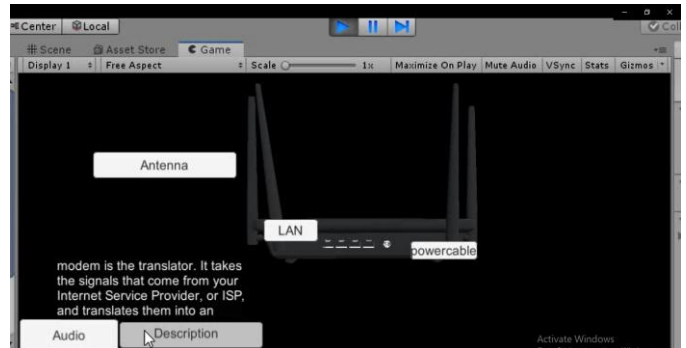
5.2 Computer Networks Module

Modem

Figure 9: 3D model of a modem

5.3 AI Problem Solving Module

The module includes visualization of various searching/pathfinding algorithms. Each of the algorithms is explained with a high level of visualization including interactiveness using AR which will help intelligence development. The algorithms will help build the user's core foundation and logic of different searching algorithms.

The AI problem-solving module also deals with various AI Problem Solving methods which are explained with a high level of interactiveness using AR which will help intelligence development. The included AI problem-solving methods are Dijkstra's algorithm, water jug problem, missionaries and cannibals' problem, 8- puzzle problem, Tower of Hanoi problem, and traveling salesman.

Dijkstra's Algorithm

The Dijkstra algorithm is also referred to as a single-source shortest path algorithm. The single-source means that only one source (start node) is given, and we have to find the path with lowest distance from the start node to all the nodes. (javatpoint, 2017) [11]
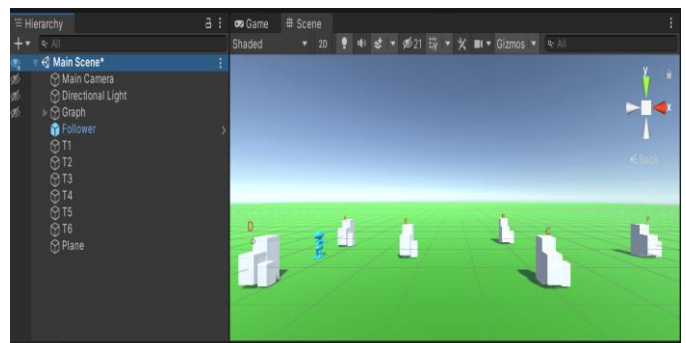
Fig 10: Unity interface with 3D game objects
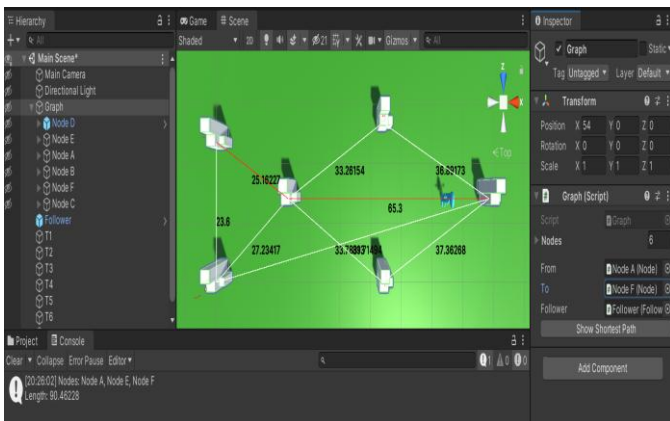
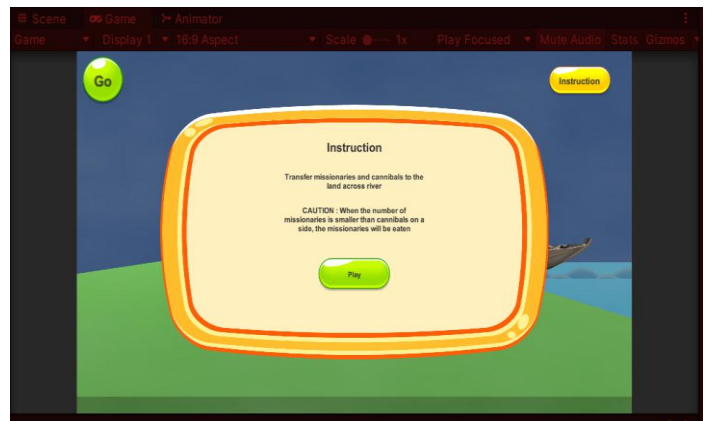*Fig 11: Highlights the shortest distance and displays the shortest path.*

5.4 Games Module

The game module focuses on testing the knowledge learned by the user in the other modules using various engaging and interactive games. Games include identifying hardware parts, reassembling of parts, water jug problem, missionaries and cannibals' problem, Tower of Hanoi problem, and applications of networking devices.

Missionaries And Cannibals Problem

Missionaries and Cannibals problem can be defined as a situation in which 3 missionaries and 3 cannibals want to cross from the left bank of a river to the right bank of the river. There's a boat on the bank, which at most carries only two people at a time and can never cross with zero people on the boat. If cannibals ever outnumber missionaries on either bank, then the cannibals will eat the missionaries. This problem can be solved using Breadth-first search.

Figure 12: Unity interface with 3D game objects

Figure 13: User interface of missionaries' vs cannibals' game, briefing the game rules.

Figure 14: Initial placement of the game object
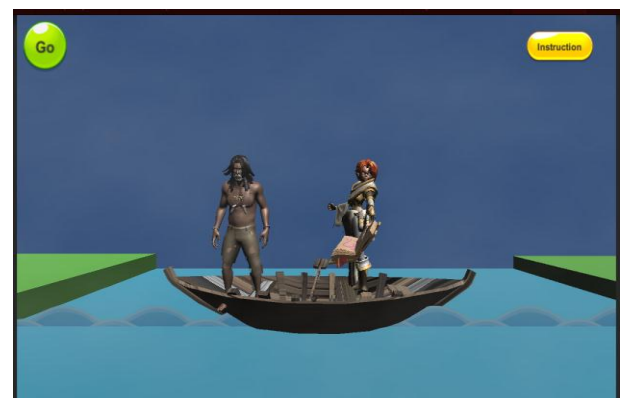
Figure 15: Game object boat moving from left land to right land on clicking the GO button.

Figure 16: Placement of two objects on the right land, in order to achieve the goal state, the player needs to place all the missionaries and cannibals successfully on the right land.

6. Conclusion

The AR-enabled E-Learning applications help create a comfortable environment for learners of any age group. Often learners face difficulties when it comes to perceiving theoretical information without any visuals or relatable examples, which results in incomprehensible outcomes. Augmented reality applications offer visual bliss by enabling learners to wander around 3D objects like CPU on their screens of smartphones/tablets and interact with it.

7. Future Scope

Research has shown that AR in near future will provide personalized, accessible and well-designed experiences. AR technology in education enhances and brings in benefits for learners, educators, institutions and content publishers. Following the Modern trends in educational technology and development, the application will add value in the near future.

8. Acknowledgement

REFERENCES

1) Silva, R. (2019). *Introduction to Augmented Reality*. National Laboratory for Scientific Computation, Av. Getulio Vargas, 333 - Quitandinha - Petropolis-RJ Brazil. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.63.4105&rep=rep1&type=pdf

2) *ADDIE Model*. (2010, August 1). Wikipedia. Retrieved June 30, 2022, from https://en.wikipedia.org/wiki/ADDIE_Model

3) Softtek. (2021, September 1). *What are the different types of Augmented Reality?* Softtek. Retrieved June 30, 2022, from https://softtek.eu/en/tech-magazine-en/user-experience-en/what-are-the-different-types-of-augmented-reality/

4) assemblr edu. (2019, January). Assemblr EDU - Augmented Reality (AR) for Classrooms. Retrieved June 30, 2022, from https://edu.assemblrworld.com/

5) Billinghurst, M., Kato, H., & Poupyrev, I. (2001). The MagicBook: A Transitional AR Interface. Washington Publishing Company. http://www.hitl.washington.edu/people/tfurness/courses/inde543/READINGS-03/BILLINGHURST/MagicBook.pdf

6) Antonioli, M., Blake, C., & Sparks, K. (2014). *Augmented Reality Applications in Education*. The Journal of Technology Studies. https://www.semanticscholar.org/paper/JOTS-v40n2-Augmented-Reality-Applications-in-Antonioli-Blake/861d51b1f24a343a9acaf651b67139ca3dc57441

7) Raghaw, M., & Paulose, J. (2018). *Augmented reality for history education*. International journal of engineering and technology. https://www.academia.edu/36333632/Augmented_Reality_for_History_Education

8) Kassim, M., & Zubir, M. (2019). *Design of Augmented Reality for Engineering Equipment in Education*. International Journal of Advanced Trends in Computer Science and Engineering. https://www.warse.org/IJATCSE/static/pdf/file/ijatcse15862019.pdf

9) Kesim, M., & Ozarslan, Y. (2012). Augmented reality in education: current technologies and the potential for education. Procedia - Social and Behavioral Sciences 47 (2012) 297 – 302. https://pdf.sciencedirectassets.com/277811/1-s2.0-S1877042812X00181/1-s2.0-

S1877042812023907/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEAUaCXVzLWVhc3QtMSJHMEUC
IQDSKfScdO7XVyLaTij5XpBDi97cUzEqa2EojMlvWKXe4gI
gKk8W%2BjlEzaPCtHEQYCESAmIHflJ8LassygzF%2FbQq
m

10) Lintern, G. (2017, June 25). *Augmented reality*. Wikipedia. Retrieved June 30, 2022, from https://en.wikipedia.org/wiki/Augmented_reality

11) javatpoint. (2017, January 1). Dijkstra's Algorithm - javatpoint. Javatpoint. Retrieved June 30, 2022, from https://www.javatpoint.com/dijkstras-algorithm

BIOGRAPHIES

	Final year Computer Engineering (BE) student at Agnel Institute of Technology and Design, Goa **Lizanne Fernandes**
	Final year Computer Engineering (BE) student at Agnel Institute of Technology and Design, Goa **Savita Jamdarkhani**
	Final year Computer Engineering (BE) student at Agnel Institute of Technology and Design, Goa **Merlyn Joseph**
	Final year Computer Engineering (BE) student at Agnel Institute of Technology and Design, Goa **Saniya Mulla**
	Final year Computer Engineering (BE) student at Agnel Institute of Technology and Design, Goa **Ruchita Suranagi**
	Assistant Professor at Agnel Institute of Technology and Design, Goa **Kedar Sawant**
	Assistant Professor at Agnel Institute of Technology and Design, Goa **Sagar Naik**