Introduction To Extended Reality

Augmented Reality

Augmented reality 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.

Examples: Pokémon GO, ARLoopa, Ikea Place

Augmented reality is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies, the information about the surrounding real world of the user becomes interactive and digitally manipulated. Information about the environment and its objects is overlaid on the real world. This information can be virtual. Augmented Reality is any experience which is artificial, and which adds to the already existing reality or real, for example seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they are in space.

Purpose

AR software derives information about the surrounding environment from cameras and sensors. Implementing AI enhances the AR experience by allowing deep neural networks to replace traditional computer vision approaches. The elementary idea of augmented reality is to merge real-world objects and virtual objects.

Using this project, learning would be interesting and interactive for the users, and it is affordable for all age groups. This project is specially designed for toddlers and kids. Since we remember movies, videos, images for longer time than reading this project would be more helpful for visualizing objects.

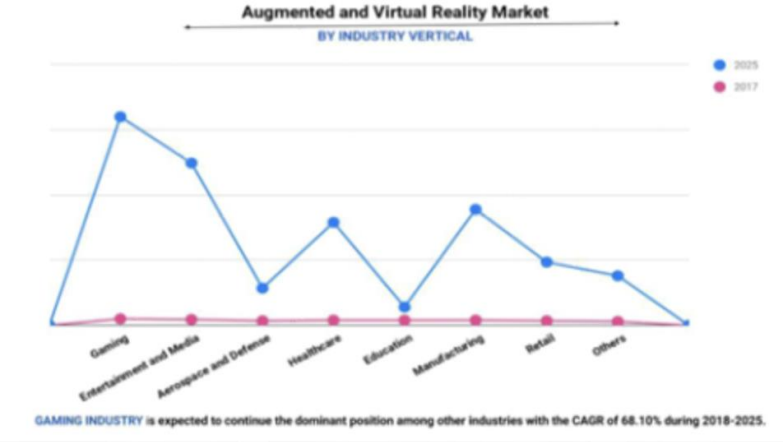
Augmented reality is used to either visually change natural environments in some way or to provide additional information to users. The primary benefit of AR is that it manages to blend digital and three-dimensional (3D) components with an individual's perception of the real world. AR has a variety of uses, from helping in decision-making to entertainment.

AR delivers visual elements, sound and other sensory information to the user through a device like a smartphone or glasses. This information is overlaid onto the device to create an interwoven experience where digital information alters the user's perception of the real world. The overlaid information can be added to an environment or mask part of the natural environment.

Scope

Covid-19 pandemic has significantly contributed towards the augmented reality technology market growth since more & more businesses have turned completely into the remote. Another reason for Augmented reality markets to grow fast will be factors like higher demand for smartphone-based augmented reality, growing takeovers and company mergers, advanced augmented reality technology, high demand for advanced tools in the entertainment sector, and more adoption of AR technology in education, health care, and retail industries. The augmented reality and virtual reality market size stood at approx. $15 billion in 2020 is projected to grow at a staggering rate of a CAGR 40%. It will touch around $450 billion by 2030.

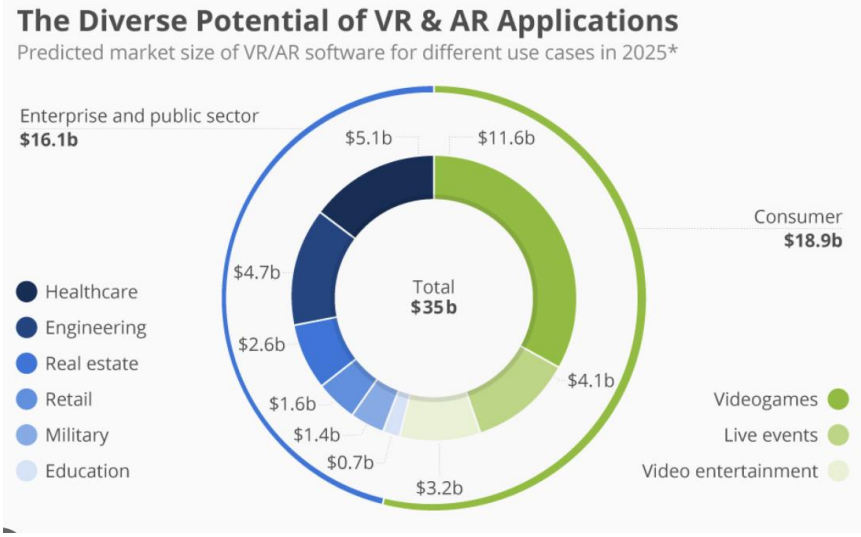
Many large enterprises show the highest growth in the augmented reality markets and are expected to maintain their dominance in the forthcoming years. Augmented reality has penetrated nearly every sector such as automotive, manufacturing, construction, airlines, healthcare, smartphones, education, real estate, sports, and more. The small and medium enterprises (SMEs) segment is expected to witness higher growth due to the AR technology such as lesser field staff, no expenses on training, inventory setups, faster solutions, and better customer satisfaction.



With so many applications and so much to offer, Augmented reality is a visionary advancement of technology catered to grab everybody's attention, when involved in experiencing it. As smartphones have become an integral part of our daily lives, it paves a great way for Augmented reality to become a consistent integral part too. As AR is already growing at a great pace, it has a lot more to offer in the future.

New technology and the world of children's literature have come together to create new types of books that are delighting children all around the world. Publishers are aware of the importance of digital technology in children's lives. And that's why they've created children's books with augmented reality. Despite its limitations AR is growing every single day with new applications. Companies are trying to inculcate AR to make their applications more interesting. As it keeps the blend between real life and digital content natural and not cut off from the real world, it holds a slight added advantage over Virtual reality. People can download Augmented reality-based applications on their smartphones (iOS and Android) which turns out to be more accessible than VR headsets.

An interesting Ted talk displaying a glimpse of the future through an Augmented reality headset is very informative and gives a full idea on the future that Augmented reality has to offer.



Study of existing system

The Past

Taking about the origin of Augmented reality, it can be traced off to around 1990 by the work undertaken by Professor Tom Caudell as part of a neural systems project at Boeing. This project was focused on finding new ways to help the company's engineering process and involved the use of virtual reality. Hence, giving birth to the innovative idea of Augmented reality.

Initiatives taken in the past, led to the rise of Augmented reality from application to application. From 1990 to 2016, AR has definitely evolved and spread its wings in innumerable sectors to explore its fullest scope in real-time applications.

The Present – Current Applications

Currently, Augmented reality has a vast number of application areas in various sectors and categories. With each sector getting explored with the the fullest scope of implementing AR technology. From retail businesses to health sectors, AR has helped in every way which makes the processes of these sectors easier. Here is a list of the sectors where Augmented reality can be, and is being applied:

• In the retail sector, where it can change the whole shopping experience by bridging the gap between the online and physical store.

• In the health sector, it gives an understanding of the human body with multimedia representation helping the doctors in undertaking surgeries and looking at the patient's condition in a more detailed manner.

• Enhanced GPS systems are using Augmented reality to make it easier to get from point A to B making it a natural fit for Navigation.

• Predicted visuals of constructed properties can be formed before the construction is even done. This results in an early visual of the predicted output or result as AR aids in visualizing building projects.

• Augmented reality is used for complementing academic curriculums. It acts as an additional digital feature on textbooks, as the data can be explained in an audio/video format. The reading material can be turned into the desired multimedia platform.

• Augmented Reality can provide the surgeon with hidden information, such as showing the heartbeat rate, the blood pressure, the state of the patient's organ making the medication process more precise.

• The first application of augmented reality to television was weather forecasting using visualizations. It has become the most common way of broadcasting the weather till this very day.

• Augmented reality has also become common in sports telecasting. Tracked camera feeds, scorecards, visual layovers on the screen. It's all Augmented reality.

• Augmented reality provides gamers with the chance to experience gameplay in a much more interesting way. Pokémon Go has set an example for the standards of Augmented reality.

• AR is also used for package previews. If there's a sealed product and you can't open it, AR allows you to get a preview of what's inside the package.

• Augmented reality applications can provide travelers with real time informational displays regarding a location and its features. Hence, making it applicable for tourism or sightseeing.

• AR can serve as a tool used by the military. From the soldier's point of view, people and various objects can be marked with special indicators to warn of potential dangers. Augmented reality caters to all of these sectors and many more. The best and biggest part about AR is that it bridges the gap between digital and real worlds. Thus, it can be applied effectively for real-time efficiency in any sector.

Applications

Retail

Augmented reality has found a strong foothold in the retail industry. With the use of this technology, businesses are using it to provide a new level of interaction between the customers with their products, either online or in-store. AR apps provide the shoppers instant product information and comparison with other retailers when they point their mobile phones, which allows them to set a preference for their requirements.

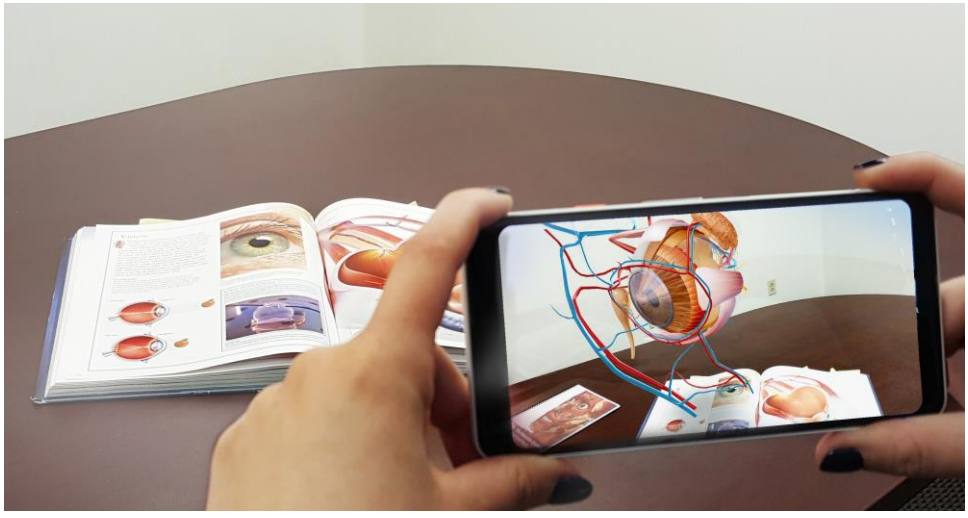
Real Estate

The developers of AR technology create elaborative visual presentations which immerse potential clients for a specific property, a feature which was not available in the past. Some of the dealers are still using it for visualizing the empty room or space in the way you can decorate it. These virtual tours can give property buyers the power to create a more informed decision and help them to decide whether a home is worth looking forward to or not.

Medical

Surgeries used to have a high mortality rate. Now, with AR, procedures can be much safer than before. AR can assist doctors and specialists, providing them all the necessary information when trying to save patients' lives.

As physicians operate, they can be more aware of organ location, meshes of the vein, and diagnosis reports, appearing right in front of their eyes.



Proposed System

Accessible learning materials: Augmented reality has the potential to replace physical textbooks, models, posters. It offers portability and inexpensive learning materials. As a result, education becomes more accessible and mobile.

No special equipment is required: Unlike VR, augmented reality doesn't require any expensive hardware. In addition to it, with most of the young generation knowing how to use smartphones, it is easier for them to use AR in their education with just their smartphones.

Higher student engagement and interest: Interactive AR learning has a significantly positive impact on most of the students. It keeps them engaged throughout the lesson and makes learning fun and effortless.

Faster and effective learning: AR in education helps students to achieve better results through the best visualization of their subjects. A picture is worth a thousand words. Thus, instead of reading theory about a concept, students can practically watch it.

Practical training: Apart from schooling, professional training courses can also avail themselves of the benefits from the use of AR. It can help the students to master the practical skills required for a certain job.

Medical student training: To practice heart surgery without risking people's hearts is a tough job. But it is easily possible with AR.

With the help of our project kids can learn more about 3D models and information related to the displayed objects of encyclopedia. In the existing system, augmented reality was not that well known to people but with raising demand for virtual or interactive learning the demand for augmented reality-based apps also surged. There are very few apps present in the market to fulfill the demand. Our app is available for download in Android version and is very user friendly and it also helps in learning the 3D models of human body in more interactive way for medical students.

Requirements

Software requirements

Unity -

The engine can be used to create three-dimensional (3D) and two-dimensional (2D) games, as well as interactive simulations and other experiences. The engine has been adopted by industries outside video gaming, such as film, automotive, architecture, engineering, construction.

Visual Studio-

The Visual Studio IDE is a creative launching pad that you can use to edit, debug, and build code, and then publish an app. Over and above the standard editor and debugger that most IDEs provide, Visual Studio includes compilers, code completion tools, graphical designers, and many more features to enhance the software development process.

Paint 3D for 3D models

Sketchfab(used for importing 3D models into unity)**-**

Sketchfab is a 3D modeling platform website to publish, share, discover, buy and sell 3D, VR and AR content. It provides a viewer based on the WebGL and WebXR technologies that allow users to display 3D models on the web, to be viewed on any mobile browser, desktop browser or Virtual Reality headset. The Unity to Sketchfab Exporter lets you publish your 3D content directly from Unity to Sketchfab's 3D viewer by selecting any 3D content with just a few clicks.

C sharp-

The language is intended to be a simple, modern, general-purpose, object-oriented programming language. C# is used for developing web-based applications. Its core concepts help build an interactive environment and provide functionalities that the dynamic web platform requires. By the help of C# programming language, we can develop different types of secured and robust applications:

- Window applications
- Web applications
- Distributed applications

Vuforia Developer Engine-

Vuforia is an augmented reality software development kit (SDK) for mobile devices that enables the creation of augmented reality applications. It uses computer vision technology to recognize and track planar images and 3D objects in real time. This image registration capability enables

developers to position and orient virtual objects, such as 3D models and other media, in relation to real world objects when they are viewed through the camera of a mobile device. The virtual object then tracks the position and orientation of the image in real-time so that the viewer's perspective on the object corresponds with the perspective on the target. It thus appears that the virtual object is a part of the real-world scene.

Hardware requirements

RAM – 16GB

Processor- Intel i5

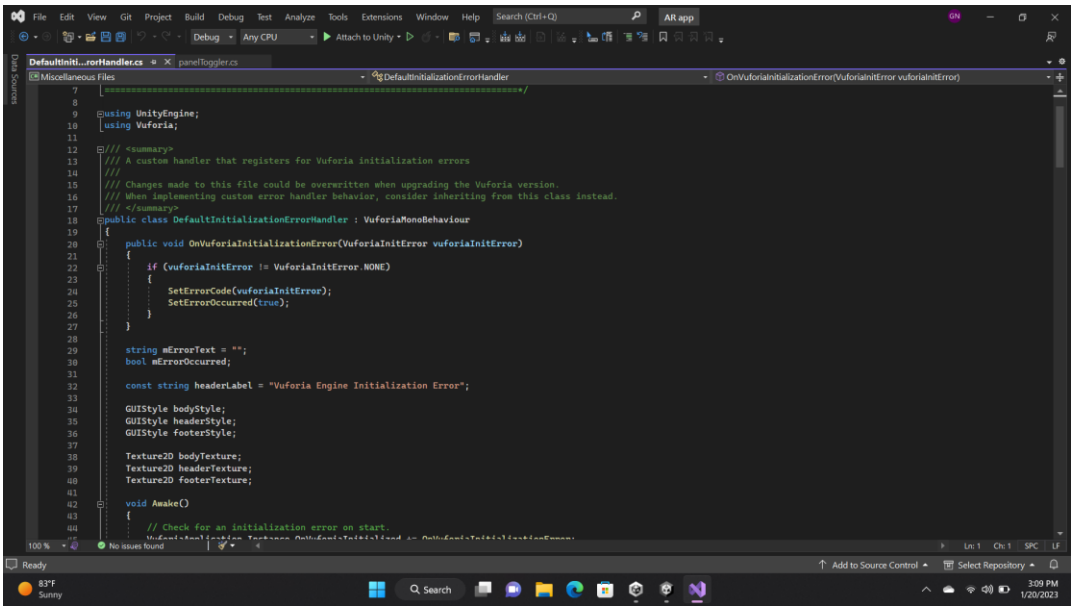
Smart Phone

Laptop

Code Templates

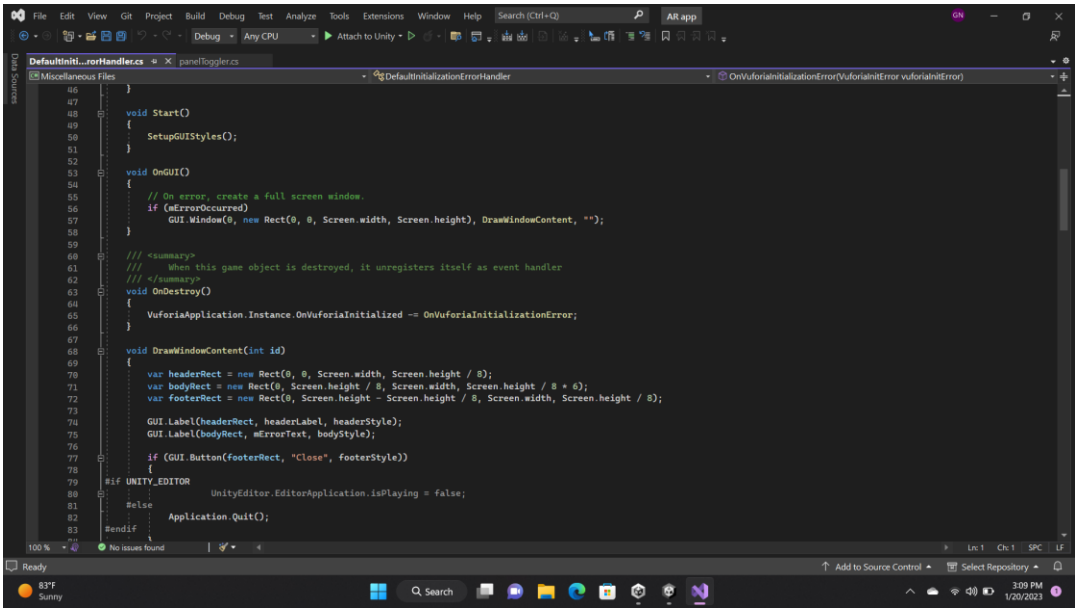
Code for AR camera-

First, we are initializing the AR camera with respect to image target in the scene.



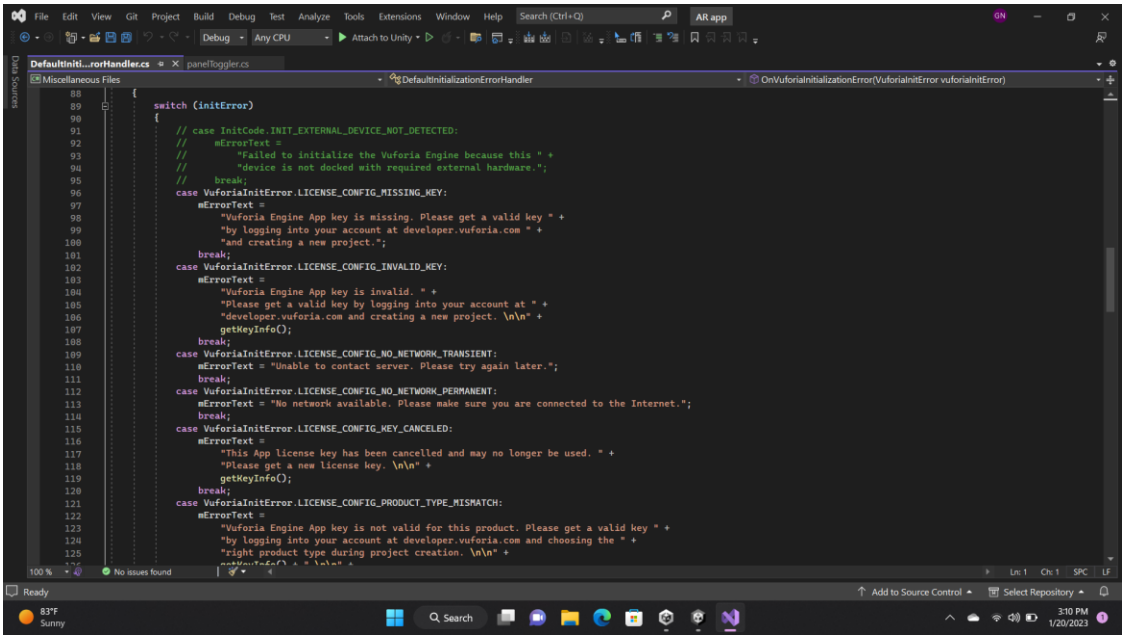
```
/*============================================================================*/

using UnityEngine;
using Vuforia;

/// <summary>
/// A custom handler that registers for Vuforia initialization errors
///
/// Changes made to this file could be overwritten when upgrading the Vuforia version.
/// When implementing custom error handler behavior, consider inheriting from this class instead.
/// </summary>
public class DefaultInitializationErrorHandler : VuforiaMonoBehaviour
{
    public void OnVuforiaInitializationError(VuforiaInitError vuforiaInitError)
    {
        if (vuforiaInitError != VuforiaInitError.NONE)
        {
            SetErrorCode(vuforiaInitError);
            SetErrorOccurred(true);
        }
    }

    string mErrorText = "";
    bool mErrorOccurred;

    const string headerLabel = "Vuforia Engine Initialization Error";

    GUIStyle bodyStyle;
    GUIStyle headerStyle;
    GUIStyle footerStyle;

    Texture2D bodyTexture;
    Texture2D headerTexture;
    Texture2D footerTexture;

    void Awake()
    {
        // Check for an initialization error on start.
```

Then we load the image targets to the scene.

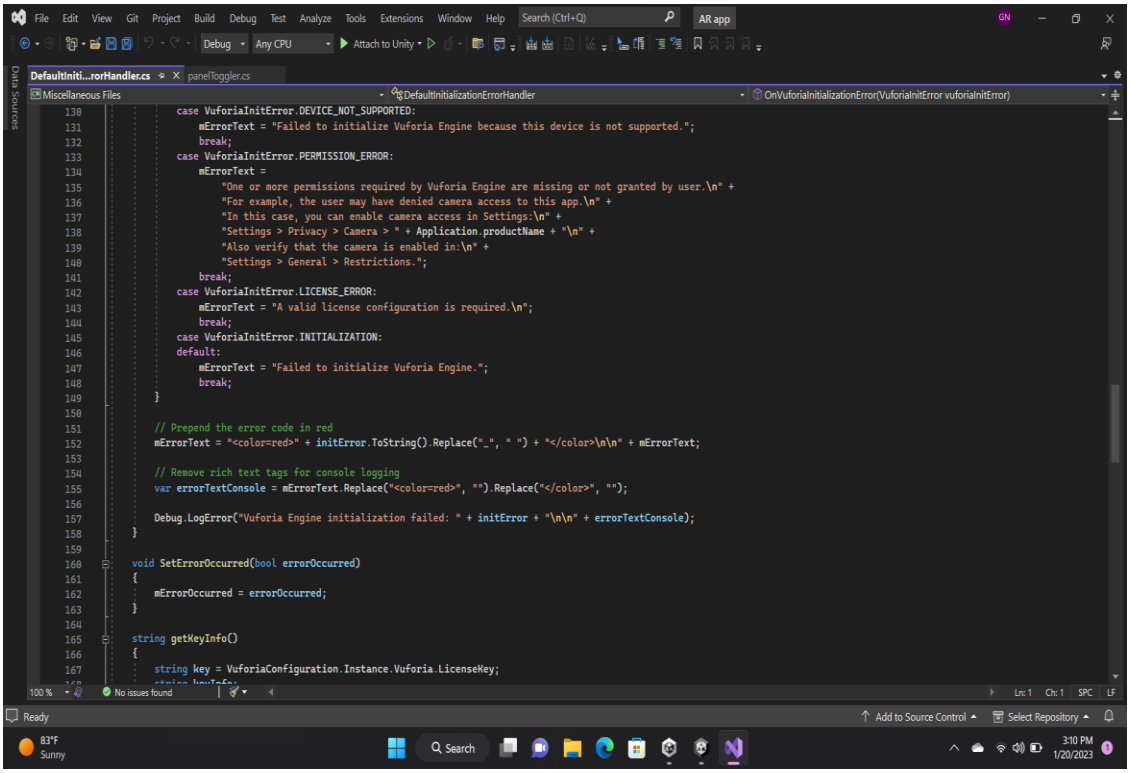


```
    }

    void Start()
    {
        SetupGUIStyles();
    }

    void OnGUI()
    {
        // On error, create a full screen window.
        if (mErrorOccurred)
            GUI.Window(0, new Rect(0, 0, Screen.width, Screen.height), DrawWindowContent, "");
    }

    /// <summary>
    ///     When this game object is destroyed, it unregisters itself as event handler
    /// </summary>
    void OnDestroy()
    {
        VuforiaApplication.Instance.OnVuforiaInitialized -= OnVuforiaInitializationError;
    }

    void DrawWindowContent(int id)
    {
        var headerRect = new Rect(0, 0, Screen.width, Screen.height / 8);
        var bodyRect = new Rect(0, Screen.height / 8, Screen.width, Screen.height / 8 * 6);
        var footerRect = new Rect(0, Screen.height - Screen.height / 8, Screen.width, Screen.height / 8);

        GUI.Label(headerRect, headerLabel, headerStyle);
        GUI.Label(bodyRect, mErrorText, bodyStyle);

        if (GUI.Button(footerRect, "Close", footerStyle))
        {
#if UNITY_EDITOR
                UnityEditor.EditorApplication.isPlaying = false;
#else
            Application.Quit();
#endif
```

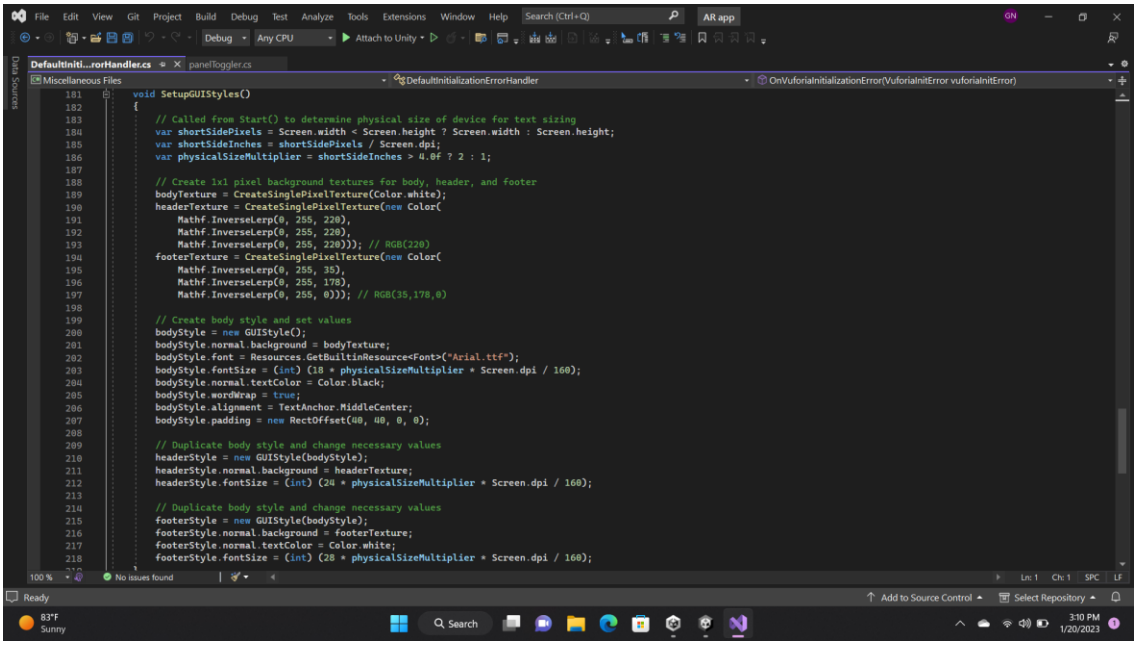
Download the required databases for image targets.



Connect the unity engine to Vuforia developer portal.

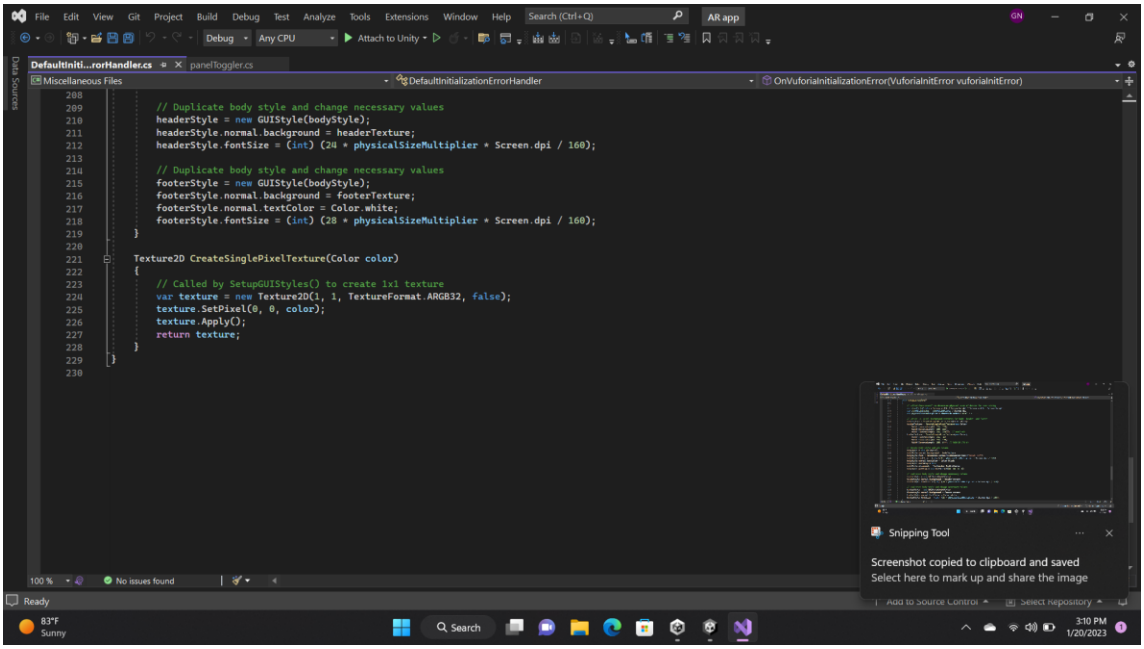


Importing 3D models from Sketchfab and uploading them to image targets.



```
void SetupGUIStyles()
{
    // Called from Start() to determine physical size of device for text sizing
    var shortSidePixels = Screen.width < Screen.height ? Screen.width : Screen.height;
    var shortSideInches = shortSidePixels / Screen.dpi;
    var physicalSizeMultiplier = shortSideInches > 4.0f ? 2 : 1;

    // Create 1x1 pixel background textures for body, header, and footer
    bodyTexture = CreateSinglePixelTexture(Color.white);
    headerTexture = CreateSinglePixelTexture(new Color(
        Mathf.InverseLerp(0, 255, 220),
        Mathf.InverseLerp(0, 255, 220),
        Mathf.InverseLerp(0, 255, 220))); // RGB(220)
    footerTexture = CreateSinglePixelTexture(new Color(
        Mathf.InverseLerp(0, 255, 35),
        Mathf.InverseLerp(0, 255, 178),
        Mathf.InverseLerp(0, 255, 0))); // RGB(35,178,0)

    // Create body style and set values
    bodyStyle = new GUIStyle();
    bodyStyle.normal.background = bodyTexture;
    bodyStyle.font = Resources.GetBuiltinResource<Font>("Arial.ttf");
    bodyStyle.fontSize = (int) (18 * physicalSizeMultiplier * Screen.dpi / 160);
    bodyStyle.normal.textColor = Color.black;
    bodyStyle.wordWrap = true;
    bodyStyle.alignment = TextAnchor.MiddleCenter;
    bodyStyle.padding = new RectOffset(40, 40, 0, 0);

    // Duplicate body style and change necessary values
    headerStyle = new GUIStyle(bodyStyle);
    headerStyle.normal.background = headerTexture;
    headerStyle.fontSize = (int) (24 * physicalSizeMultiplier * Screen.dpi / 160);

    // Duplicate body style and change necessary values
    footerStyle = new GUIStyle(bodyStyle);
    footerStyle.normal.background = footerTexture;
    footerStyle.normal.textColor = Color.white;
    footerStyle.fontSize = (int) (28 * physicalSizeMultiplier * Screen.dpi / 160);
}
```

The scene changes to game scene and we have to display the marker in front of AR camera.

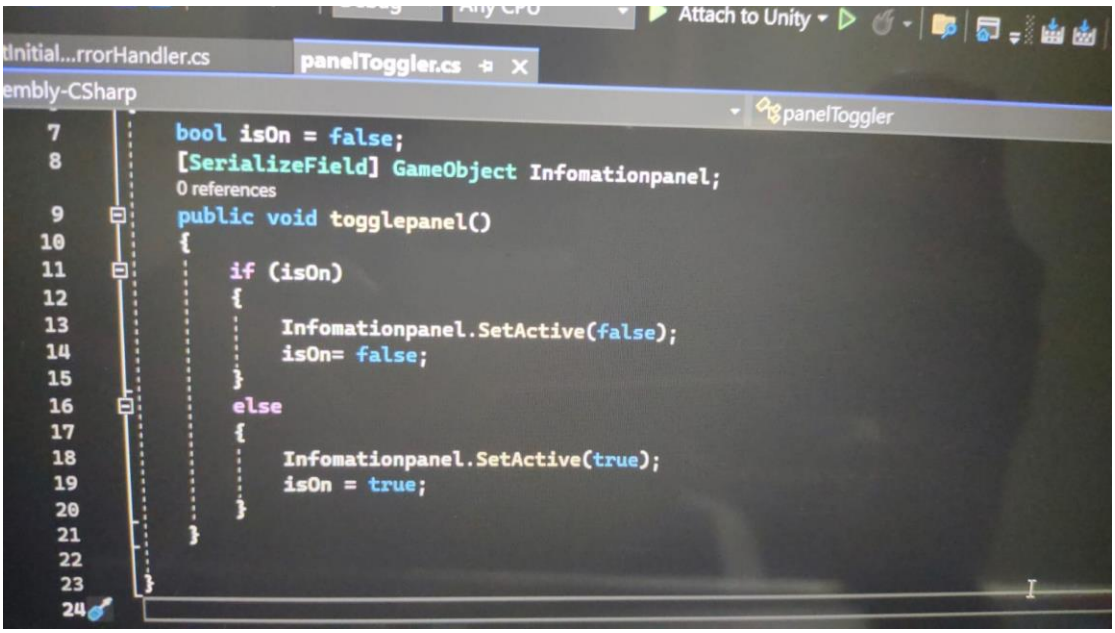


```
    // Duplicate body style and change necessary values
    headerStyle = new GUIStyle(bodyStyle);
    headerStyle.normal.background = headerTexture;
    headerStyle.fontSize = (int) (24 * physicalSizeMultiplier * Screen.dpi / 160);

    // Duplicate body style and change necessary values
    footerStyle = new GUIStyle(bodyStyle);
    footerStyle.normal.background = footerTexture;
    footerStyle.normal.textColor = Color.white;
    footerStyle.fontSize = (int) (28 * physicalSizeMultiplier * Screen.dpi / 160);
}

Texture2D CreateSinglePixelTexture(Color color)
{
    // Called by SetupGUIStyles() to create 1x1 texture
    var texture = new Texture2D(1, 1, TextureFormat.ARGB32, false);
    texture.SetPixel(0, 0, color);
    texture.Apply();
    return texture;
}
}
```

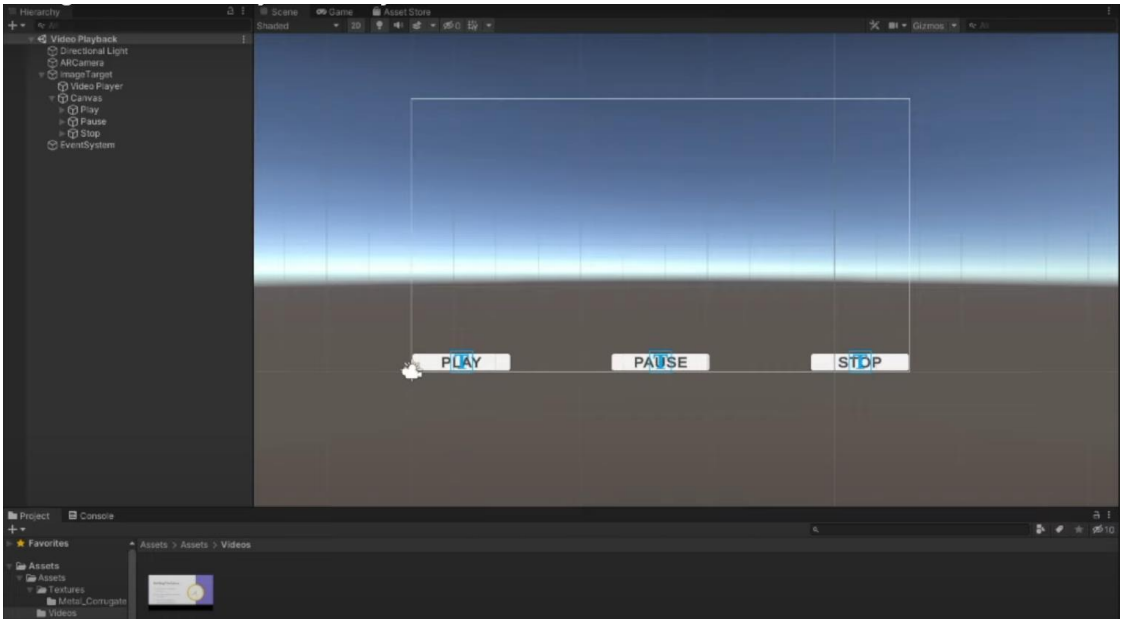
Snipping Tool

Screenshot copied to clipboard and saved
Select here to mark up and share the image

Code for Virtual Buttons (to control audio and video of information snippet)



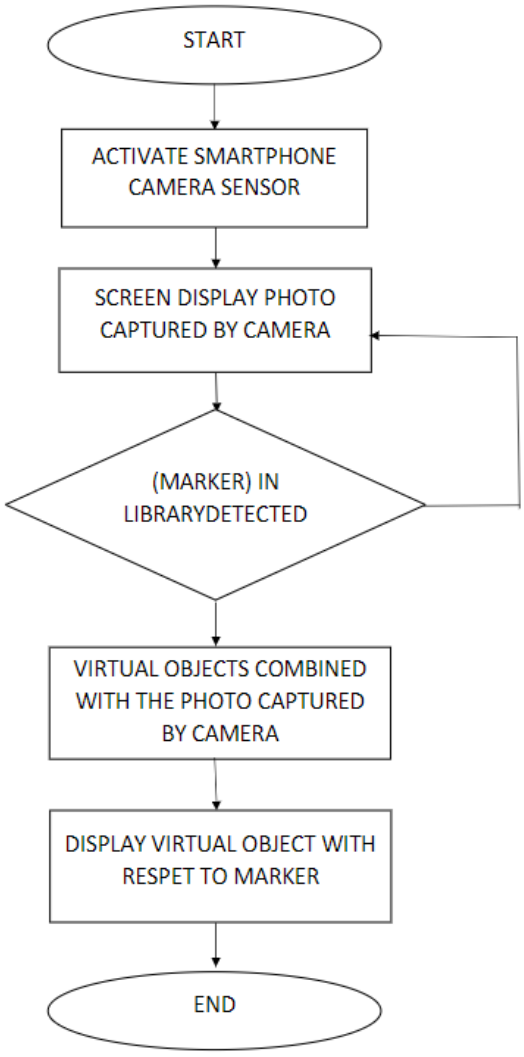
After executing the virtual buttons code,it displays the button created.



Then we have to add the information related to the object and add the necessary audio clips.

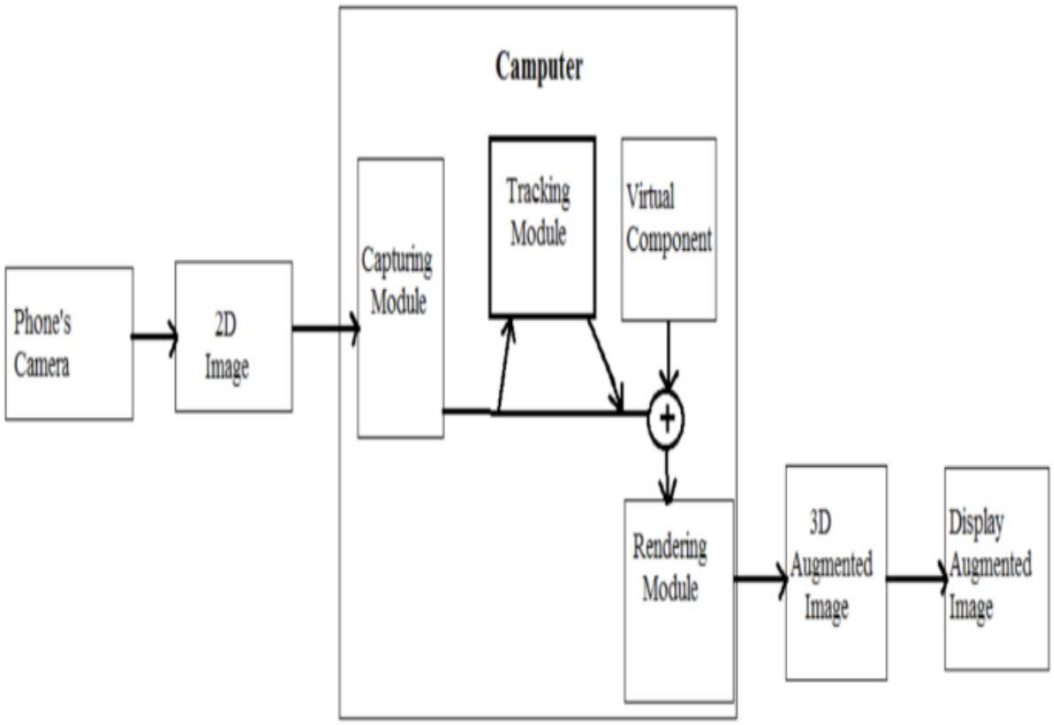
SOFTWARE DESIGN-

FLOWCHART-

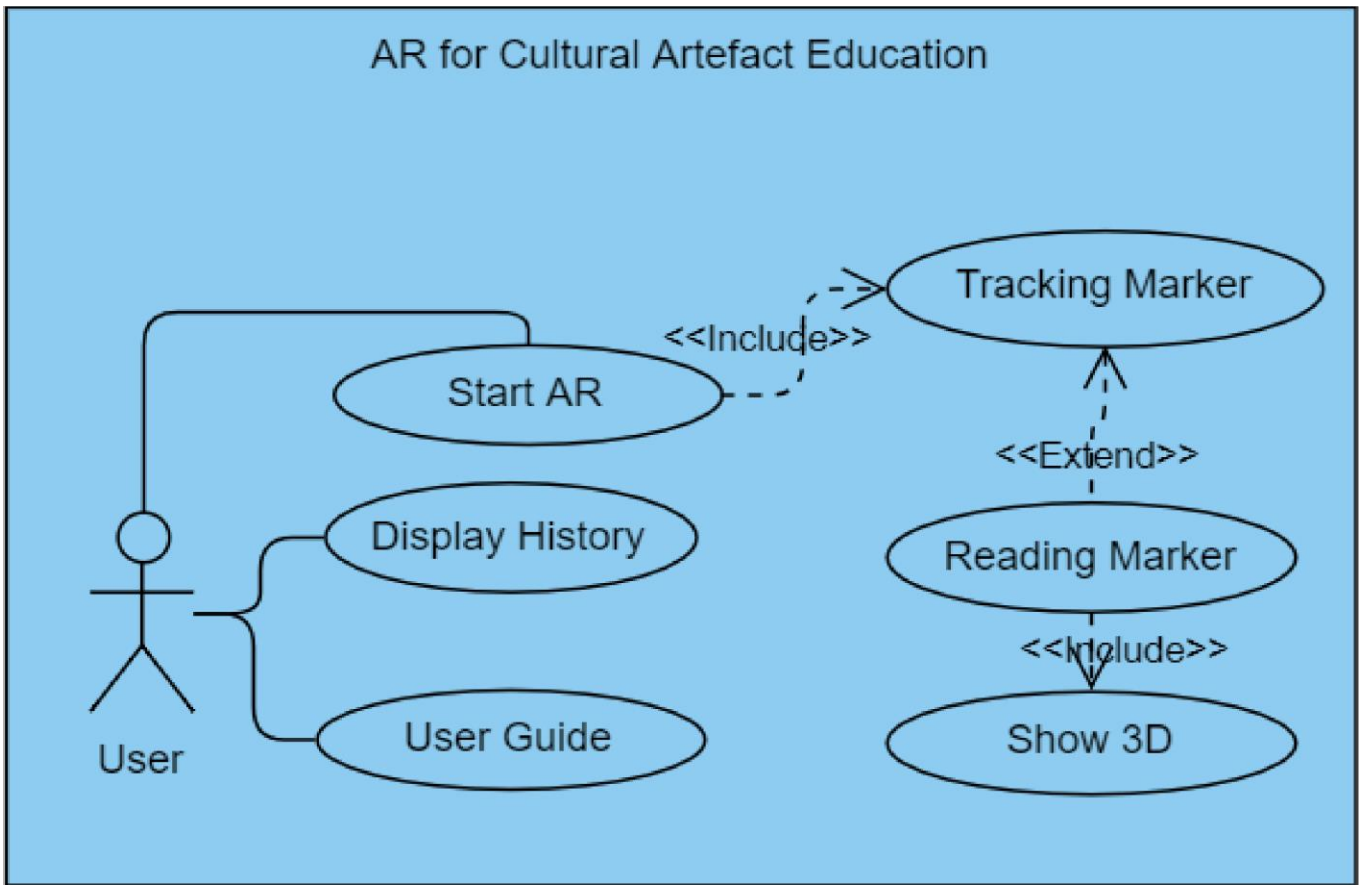


ER DIAGRAM-

-


Camputer
Phone's Camera
2D Image
Capturing Module
Tracking Module
Virtual Component
Rendering Module
3D Augmented Image
Display Augmented Image

UML DIAGRAM-


AR for Cultural Artefact Education
Tracking Marker
<<Include>>
Start AR
<<Extend>>
Display History
Reading Marker
<<Include>>
User Guide
Show 3D
User

Testing

As Augmented Reality use cases grow, we must develop new testing strategies to test the AR applications.

Test Case Scenarios

The test scenarios are based on interacting with the real world and ensuring the best experience for end-users.

Testing involves moving around the environment to achieve the feedback required to further create and locate anchors.

Below is a list of test scenarios that were curated to test AR apps:

Accessibility features

- Test locating anchor for users with special needs
- Test with voice-over feature

Lighting conditions

- Test with various lighting conditions of the environment
- Test by varying the brightness settings in the iOS or Android device

Objects in the environment

- Test placing an anchor with multiple items on the environment
- Test removing one item at a time and start locating the anchor until it breaks
- Test placing objects between the anchors and real-world

Surface in which the anchor is placed

- Does the surface affect the anchor being placed? Suppose the doors get laminated or replaced etc.
- Test the anchor creation and location with surfaces made of highly reflective materials like glass, or with repetitive patterns

Multi-user experiences

- How does the anchor behave when multiple users are trying to locate it?
- Record the behavior of anchors in Single and multiple sessions

Wayfinding (connecting anchors in a stepwise fashion)

- Test interaction between multiple anchors

Checking the motions: Fast and slow

- What if the user is moving constantly to locate the anchor — the user is given feedback on the movement until 100% environment scanning is achieved
- When the user opens the app and starts scanning around the room, he is given feedback about the progress from 0% until 100%
- When the movement is slow or non-existent, the feedback is *Not enough motion*
- When the movement is too fast, the feedback is *Motion is too quick*
- When the movement is moderate, the user is given feedback with a progress indicator and the message, *Keep moving*
- The users must be given the right feedback while scanning the entire space to be able to create and locate anchors with clear precision.
- Motion Sickness in case of using the HoloLens

Gesture recognizer

- Test the anchor behavior with various gestures and hand movements
- Test the anchor behavior when an anchor gets moved, touched, or scrolled down

Memory and battery conditions

- Test with various battery conditions and record the performance
- Test with different iOS or Android versions

Proximity

- Test various proximities to locate and create anchors

Lighting conditions and time zones

- Test the anchors across various time zones (Morning, Evening) under natural and artificial lights

With and without Wi-Fi and location services

- Test locating anchors with various permutations and combinations of turning on and off the Wi-Fi and location services
- e.g., Scenario: The user tries to locate a preset (static) anchor from a 360-degree perspective. The user should be able to locate the anchor with precision while walking around the anchor from all directions.

Unit testing in AR

Many researchers are trying to figure out how to do more automated unit-type testing in augmented reality projects.

So far, they've been able to launch their app in Xcode and inject a still image.

This helped them to test the ability to detect object. They've used this approach to put up the still image and give it a few different variations– like a black and white version or a blurry version– and test it to see if it's still interpreting the text correctly.

Remember, breaking down a complex feature into smaller pieces and testing them separately is probably one of the better overall testing strategies you can use.

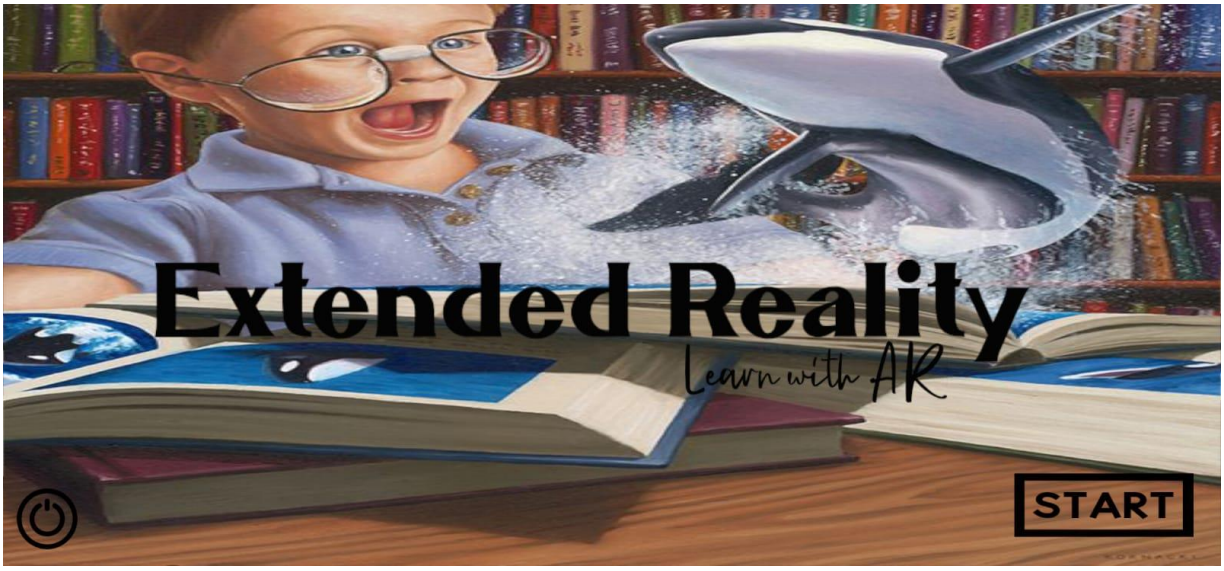
For example, having your developers decouple your application objects from the input device will allow you to simulate test input without actually using the physical AR/VR controllers.

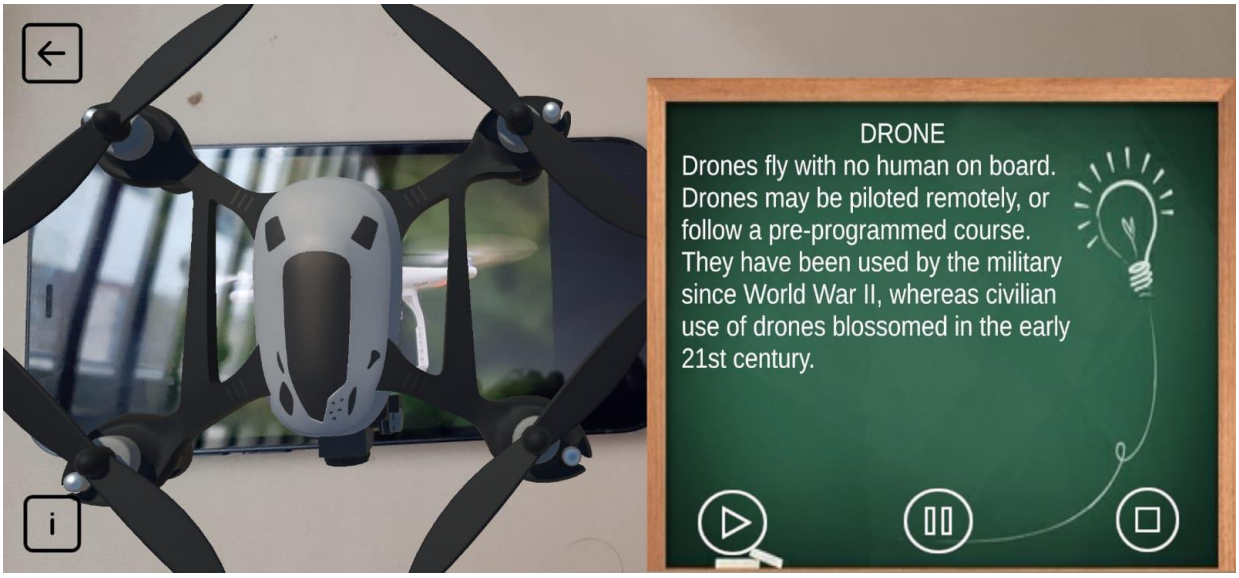
Tools for testing

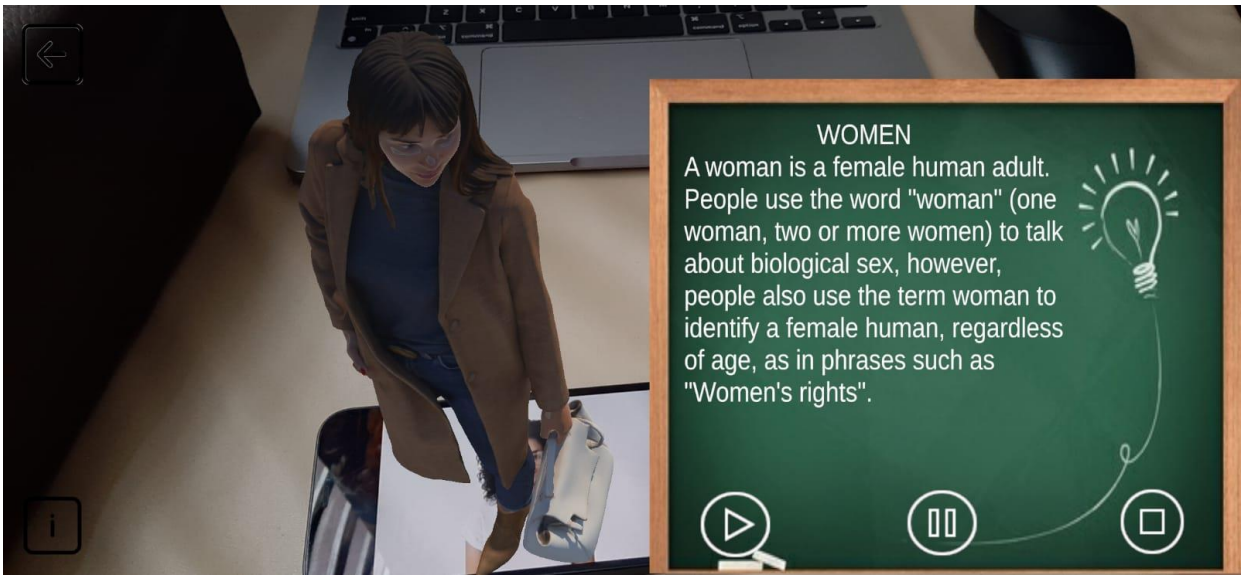
- Espresso(kotlin)
- IDE: Android Studio

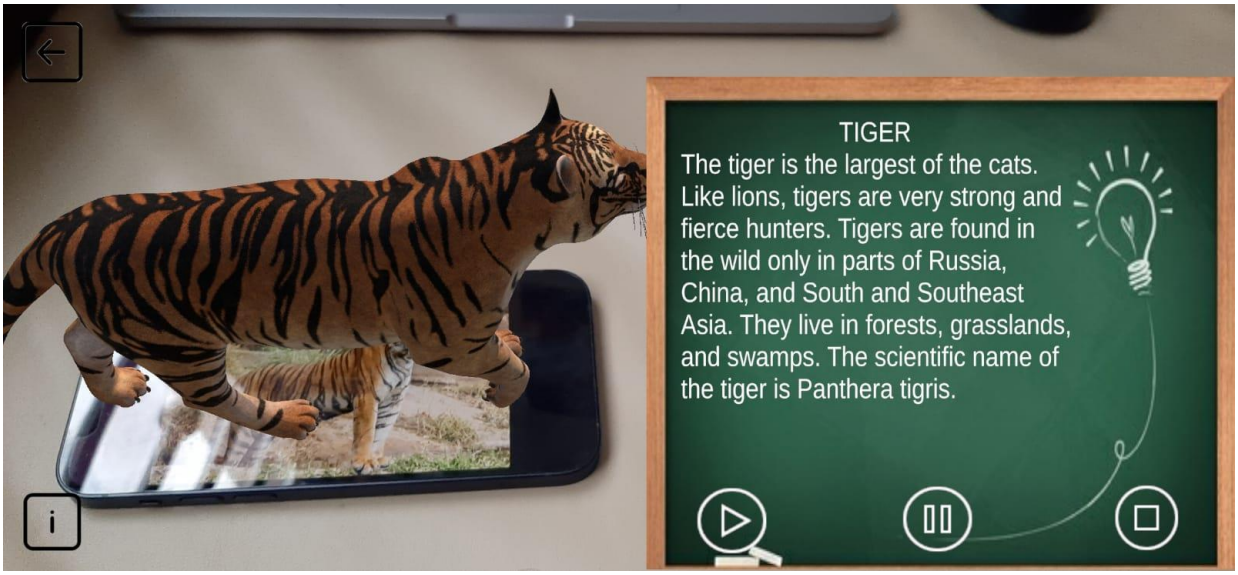
Outputs

Login screen



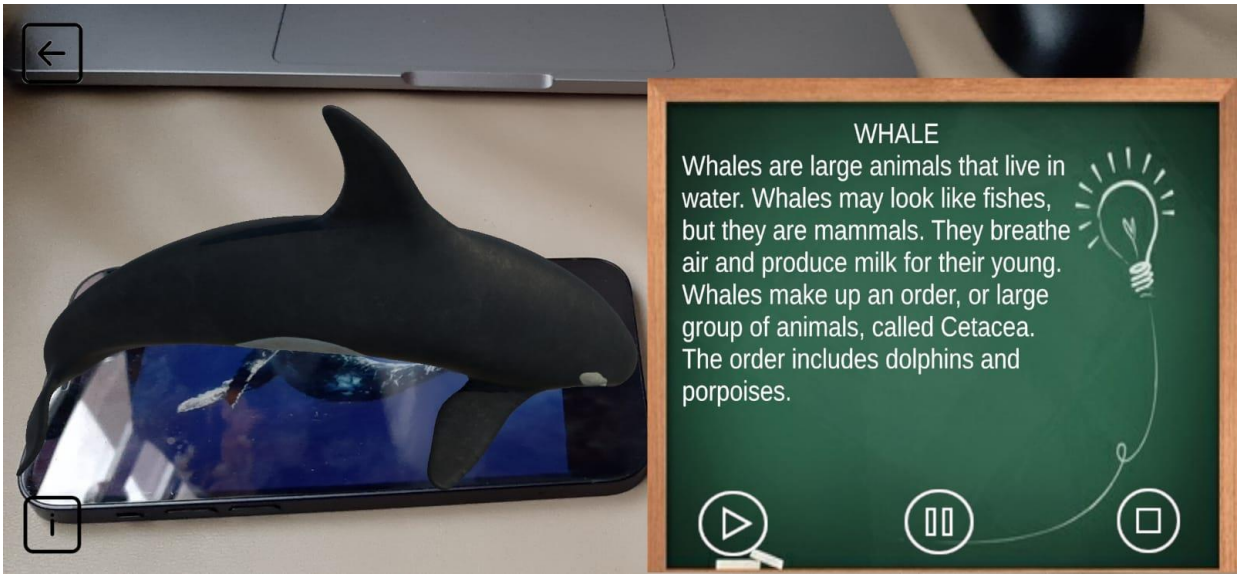



WOMEN
A woman is a female human adult. People use the word "woman" (one woman, two or more women) to talk about biological sex, however, people also use the term woman to identify a female human, regardless of age, as in phrases such as "Women's rights".

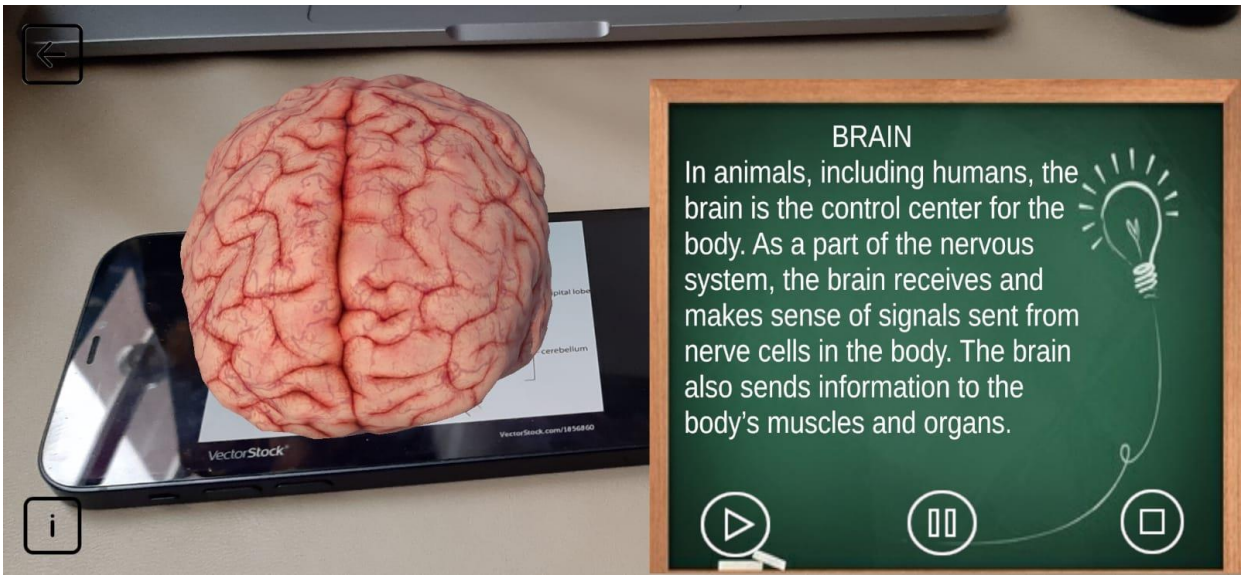

TIGER
The tiger is the largest of the cats. Like lions, tigers are very strong and fierce hunters. Tigers are found in the wild only in parts of Russia, China, and South and Southeast Asia. They live in forests, grasslands, and swamps. The scientific name of the tiger is Panthera tigris.

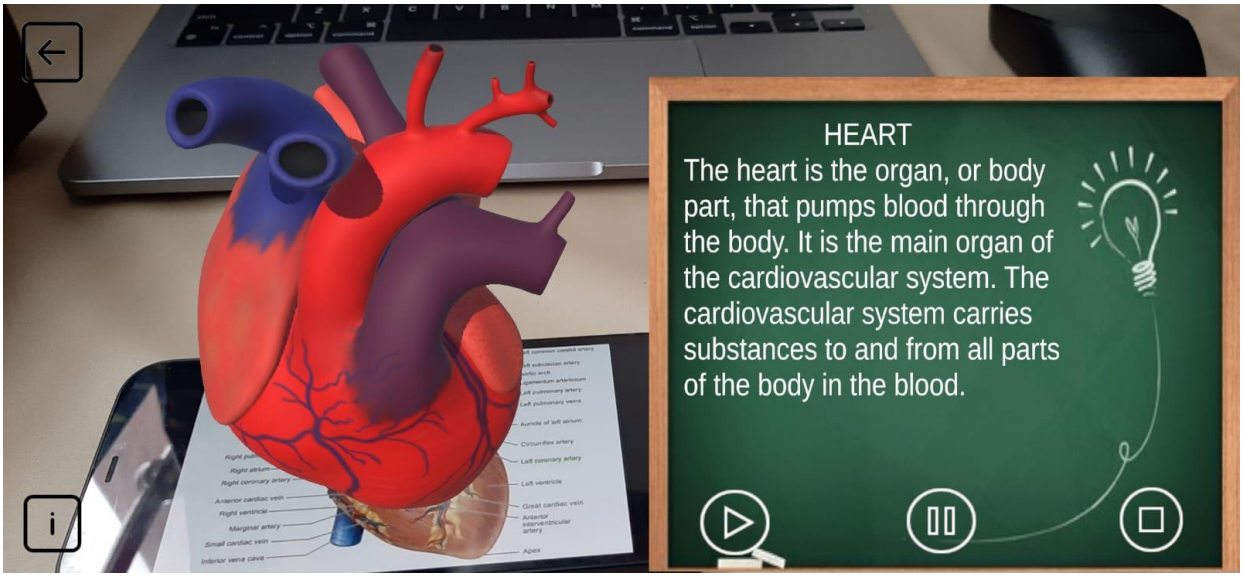
EAGLE
Eagles are large birds of prey, meaning that they hunt and eat animals for food. They are related to hawks, falcons, and vultures. Eagles have long held a special place in the human imagination because of their strength and soaring flight.

CHAIR
A chair is a type of seat, typically designed for one person and consisting of one or more legs, a flat or slightly angled seat and a back-rest. They may be made of wood, metal, or synthetic materials, and may be padded or upholstered in various colors and fabrics.


WHALE
Whales are large animals that live in water. Whales may look like fishes, but they are mammals. They breathe air and produce milk for their young. Whales make up an order, or large group of animals, called Cetacea. The order includes dolphins and porpoises.

The dog is one of the most popular animals in the world. It was one of the first animals to be domesticated, or trained for use by humans. The dog's scientific name is Canis familiaris. It is related to the coyote, wolves, foxes, and jackals.


BRAIN
In animals, including humans, the brain is the control center for the body. As a part of the nervous system, the brain receives and makes sense of signals sent from nerve cells in the body. The brain also sends information to the body's muscles and organs.
cerebellum
VectorStock


HEART
The heart is the organ, or body part, that pumps blood through the body. It is the main organ of the cardiovascular system. The cardiovascular system carries substances to and from all parts of the body in the blood.
Left pulmonary artery
Left pulmonary veins
Auricle of left atrium
Circumflex artery
Left coronary artery
Left ventricle
Great cardiac vein
Anterior interventricular artery
Apex
Right coronary artery
Anterior cardiac vein
Right ventricle
Marginal artery
Small cardiac vein
Inferior vena cava

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