Augmented Reality Based Learning Application

School of Computing Science & Engineering

Human Computer Interaction-CSE4015

Slot - A2+TA2

B.Tech CSE

Final Report

Submitted by

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Under the guidance of
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Acknowledgement

We would like to give our special thanks with full gratitude to our course professor **Prof. Joshwa Devadas** who gave us the golden opportunity to do this wonderful project on the topic Augmented reality Based Learning App, which also led us in conducting research through which we got to know about so many new concepts in the course of **CSE4015 Human Computer Interaction**. We are thankful to them.
We would like to express my gratitude towards members of **Vellore Institute of Technology** for their kind cooperation and encouragement which helped me in completion of this project.

DECLARATION BY THE CANDIDATES

We the undersigned solemnly declare that the project report **Augmented Reality Based Learning Application** is based on our own work carried out during the course of our study under the supervision of **Prof. Joshwa Devadas.** We assert the statements made and conclusions drawn are an outcome of our project work. I further certify that

I. The work done in this report is original and has been done by us under the general supervision of our supervisor.

II. We have abided by the guidelines provided by the university in writing the report.

III. Whenever we have used materials (text, theoretical analysis, and data) from other sources, we have given their details in the references and due credit to them in the text of the report.

IV. The work has not been submitted to any other Institution for any other degree/certificate/diploma in our university or any other University of India or abroad.

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Abstract

This ongoing Covid crisis has greatly impacted the education culture of our country. A new online learning culture has rapidly grown among our teachers and students. Learning experience has been restricted to 2D learning only. It has become much more difficult for teachers to keep their students engaged and maintain interest in subjects among students.This has come out as a major problem especially among small childrens. Students having attention disorders face similar problems.

The aim of this project is to design an AR Learning app for teachers aimed at promoting fun based learning. Currently teaching is taking a monotonous track where teachers either teach through a book or presentation both of which are 2-D image based printed educational modes in which understanding and retaining concepts is quite difficult. To tackle this situation, we shall be using augmented reality to make this process much interactive and friendly. Augmented Reality (AR) refers to displaying virtual images over real-world objects. Seeing models in Augmented Reality helps the children to engage in a fun way using the virtual world. Motivation behind our plan to design AR learning comes from the idea.

Introduction

This project aims to make learning fun for children and making it easy for the children to remember various things using Augmented Reality and 3D models with which they can interact with in a fun way. This also increases children's memory capacity as they can relate the words to the 3D model and seeing it before their eyes makes it easy for them to remember it for a longer time period. Our application can be further developed to provide a better representation of complex chemical models and games which can highly enhance analytical and problem solving skills of students.They can be highly helpful for children having Attention Disorders. Research shows that online games help children with attention disorder. The following was the result of the professor at Nottingham University.

This not only relates to models whereby children have to remember aspects in order to solve the game, memorize critical sequences, or track narrative elements.It also supports fast Strategic Thinking & Problem-Solving. Children should think fast in most of the 2D games. Also they have to think ahead of the current situation to solve the puzzle and complete levels. This helps children increase their thinking ability and develop their logic, it also helps in increasing their accuracy and thinking outside the box.

REQUIREMENT ANALYSIS:

- Target User Community

Primary stakeholders aka our end users (any person with stable hands) are :

- Kids (5-13): the game helps in improving fast strategic thinking and problem solving and 3-D demonstration is very useful for educational purposes.
- Teenagers (14-20): really helpful for them to view the 3-D structures of important models like chemical structures.
- Adults/office going people (21-50): Artists can use it to visualize their designs in 3-D.In medical field,demos can be used to view micro structures in detail.Civil Engineers can use it to view the building's structure at every floor without even going there inreality.
- Elderly (50+): Games are really helpful for them to improve their attention disorders which fade with age.

- Required User Actions/Skills:

1. Users need to have the application installed in their mobile phone.
2. Users need to have a smartphone that has Augmented Reality (AR) supported cameras.
   2.1. Most of the modern smartphones have this capability.
3. Users should have knowledge of how to navigate the interface of the application.
   3.1. Tutorials can make this step easier for users who have problems navigating the interface of the application.
4. Most of the users like a simple and easy to use user interface.
   4.1. User interface design and planning should be done before implementing.
   4.2. User surveys can help shape the user interface design decisions.
5. Users also may not appreciate technical possibilities (or impossibilities).

5.1. User feedback from time to time through the app.

- Example Use of Application:
  1. It can be used in primary schools to enhance the learning experience of the students.
     1.1. Students will be able to learn and remember things taught if they get to see it in 3D.
     1.2. With AR they will be able to see it right in front of them, this can make the learning experience epic and more memorable.
  2. Teenagers can use the app to visualize models of chemical compounds, geometric structures or biological diagrams.
     2.1. Some chemical compound diagrams can be hard to understand because most of the organic compounds are 3D.
        2.1.1. Viewing in AR can help understand the overall structure of the compound more effortlessly.

     2.2. Similarly geometric structures and biological diagrams can be easily understood if viewed interactively in AR.
  3. More 3D models can be added to the application for visualizing it in AR.
     3.1 This might be useful in cases when users want to visualize their models in AR.
- Acceptance Criteria:
  1. User interface should be easy enough to be understood by users of all demographics.
  2. Application should be able to load the models in a reasonable amount of time across all supported devices.
  3. Application should give useful error messages on crash or any other unexpected behaviour from the user.

Task Analysis:

Aim of task analysis is to determine the actions taken by the user when using the application. Also the order in which they should do these tasks to accomplish the root task. Also the knowledge necessary for the users to efficiently operate the applications.

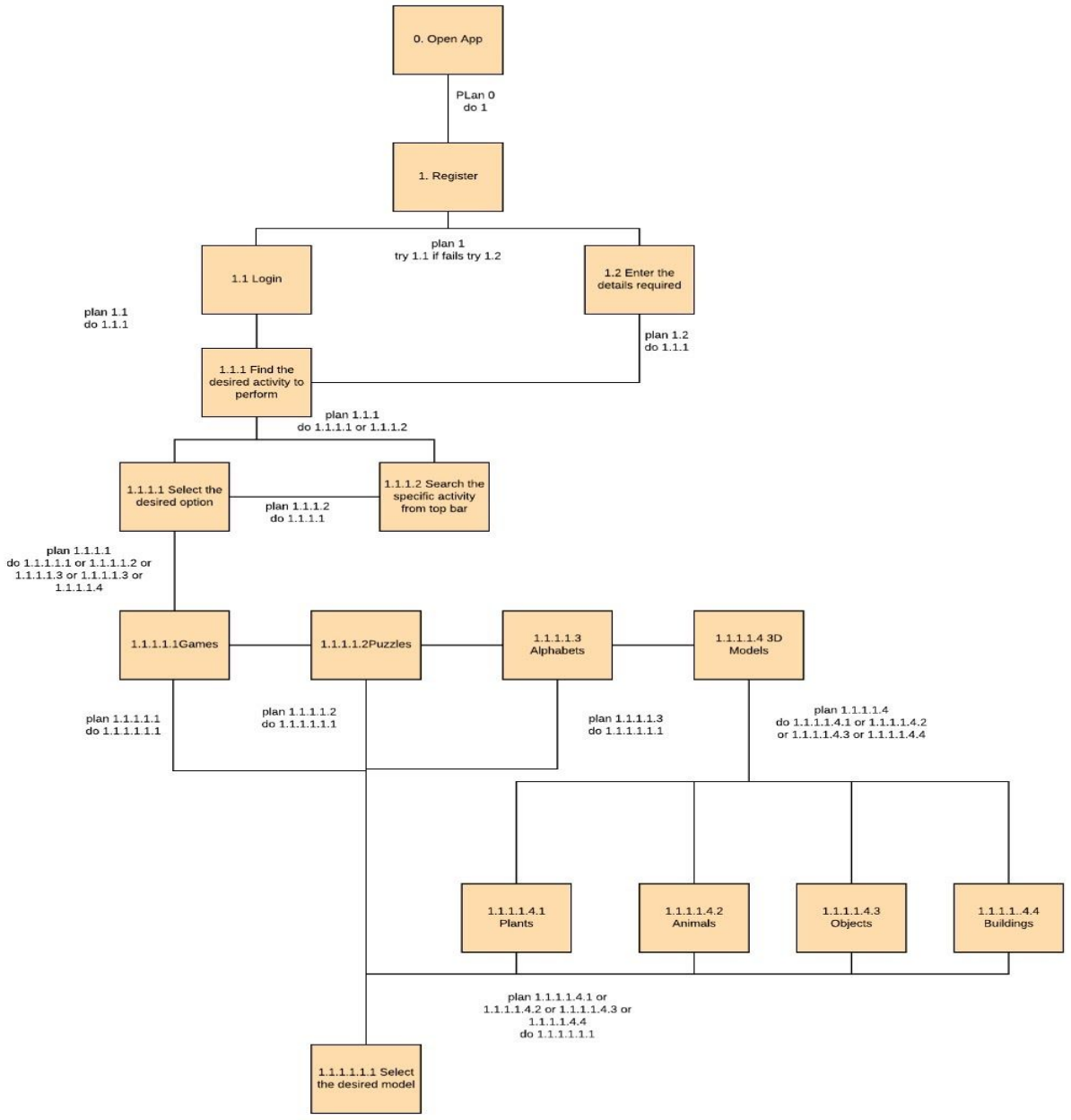
Textual HTA for using the applications:
Hierarchy description:

0. Open Application
1. Register
    1.1 Login
        1.1.1 Find the desired activity to perform
            1.1.1.1 Select the desired option
                1.1.1.1.1 Games
                1.1.1.1.2 Puzzles
                1.1.1.1.3 Alphabets
                1.1.1.1.4 3D Models
                    1.1.1.1.4.1 Plants
                    1.1.1.1.4.2 Animals
                    1.1.1.1.4.3 Objects
                    1.1.1.1.4.4 Buildings
                1.1.1.1.1.1 Select the desired model
            1.1.1.2 Search the specific activity from the top bar
    1.2 Enter the required details

Plans:

Plan 0: do 1, register.
Plan 1: try 1.1 to login, if fails 1.2 enter the required details.
Plan 1.2: do 1.1.1, find the desired activity.
Plan 1.1.1: do 1.1.1.1 select the option or 1.1.1.2 search for the activity.
Plan 1.1.1.1: do anyone of 1.1.1.1.1 games or 1.1.1.1.2 puzzles or 1.1.1.1.3 alphabets or 1.1.1.1.4 3D models
Plan 1.1.1.1.1: do 1.1.1.1.1.1 select the desired model.

Plan 1.1.1.1.2: do 1.1.1.1.1.1 select the desired model.
Plan 1.1.1.1.3: do 1.1.1.1.1.1 select the desired model.
Plan 1.1.1.1.4: do 1.1.1.1.4.1 select plants or 1.1.1.1.4.2 select animals or 1.1.1.1.4.3 select objects or 1.1.1.1.4.4 select buildings.
Plan 1.1.1.1.4.1 till 1.1.1.1.4.4: do 1.1.1.1.1.1 select the desired model.



AR application survey

*Required

1. Rate your PPT /textual based learning experience: *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

2. How important is image visualization for you in learning? *

Mark only one oval.

- ◯ Not Important
- ◯ Necessary
- ◯ Very important
- ◯ Don't Know

3. Would you prefer learning through experience or through a book? *

Mark only one oval.

- ◯ Through experiance
- ◯ By using a book

4. Will a 3-Dimensional model over a 2-Dimensional figure/text enhance your learning? *

Mark only one oval.

- ◯ Yes ofcourse
- ◯ Maybe
- ◯ No, i don't think so

5. If given an app which converts 2-D models to 3-D, would you able to use it conveniently? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Depends on the application

User Expectations

You are given an app which converts a 2-D model to 3-D by taking a picture of it and converting it to 3D. Help me with designing the app by laying down your requirements.

6. What functionality according to you is a must have in this augmented reality app? *

Mark only one oval.

- ◯ works in low brightness
- ◯ gives complete visualization irrespective of pov
- ◯ accuracy in portraying in a 3-D model
- ◯ Other: _____

7. What is your top priority in any application? *

Mark only one oval.

- ◯ User Interface
- ◯ Ease of Use
- ◯ More functionalities
- ◯ Accuracy

8. Are you willing to pay for such an app/ Are you willing to pay more for added functionalities? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Cost is not a constraint

9. Are you willing to switch your daily learning experience with this AR model ? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

10. Rate your overall experience using this application? *

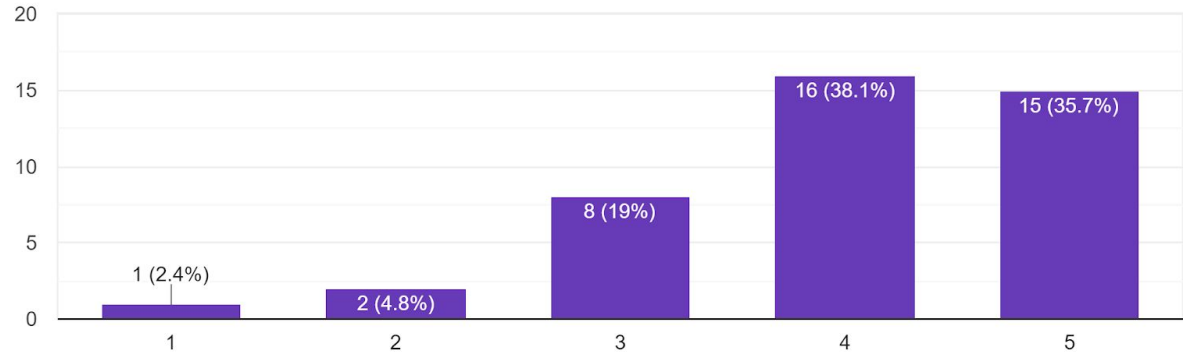
Mark only one oval.

	1	2	3	4	5	
Fair	◯	◯	◯	◯	◯	Great

Survey Form Responses

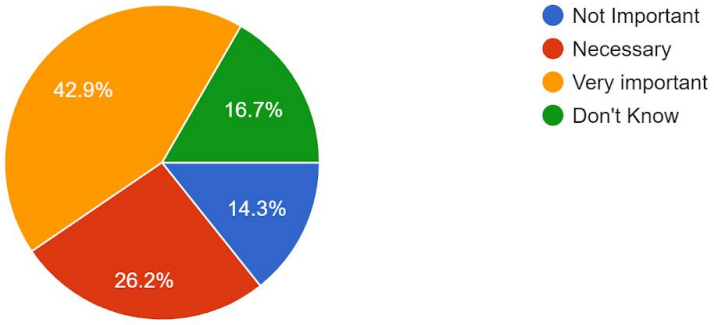
Rate your PPT /textual based learning experience:

42 responses



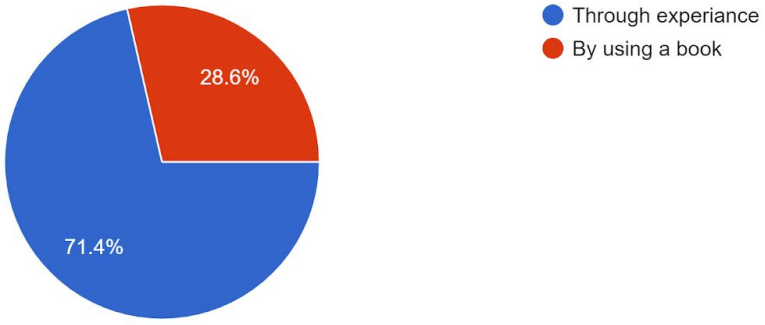
How important is image visualization for you in learning?

42 responses



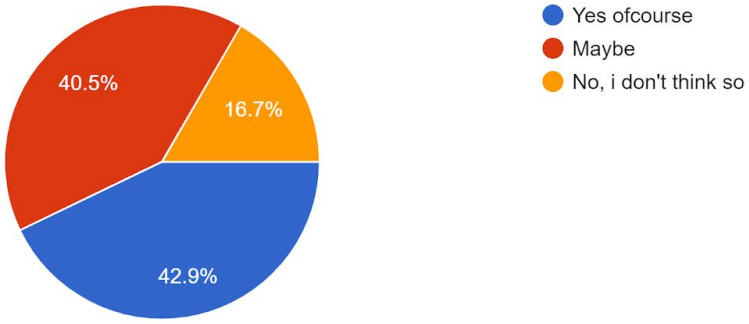
Would you prefer learning through experience or through a book?

42 responses



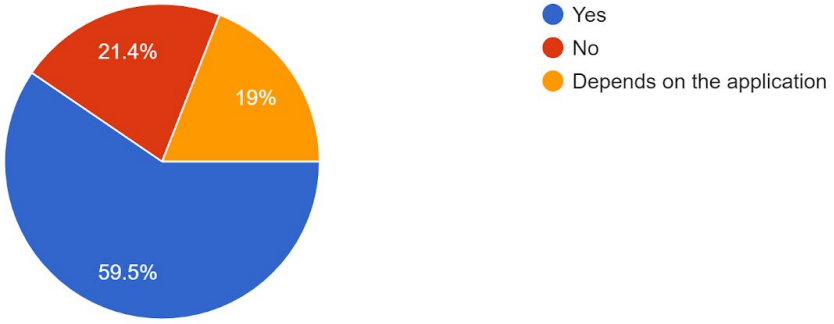
Will a 3-Dimensional model over a 2-Dimensional figure/text enhance your learning?

42 responses



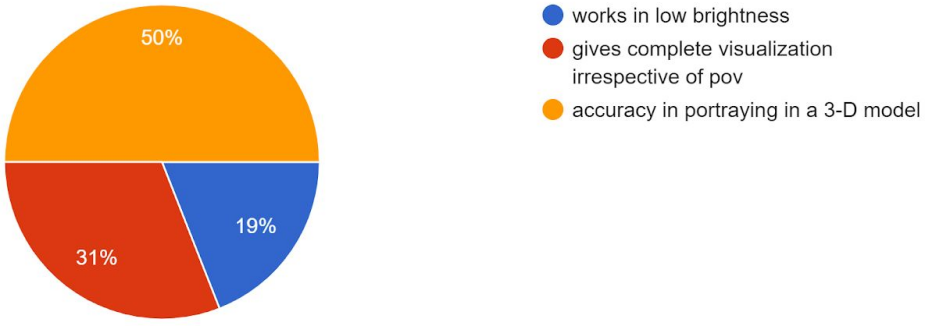
If given an app which converts 2-D models to 3-D, would you able to use it conveniently?

42 responses



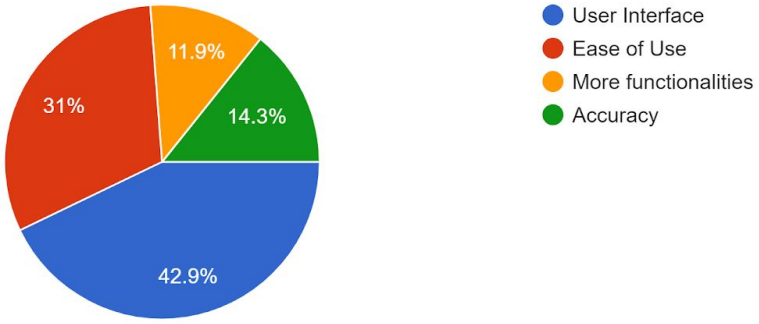
What functionality according to you is a must have in this augmented reality app?

42 responses



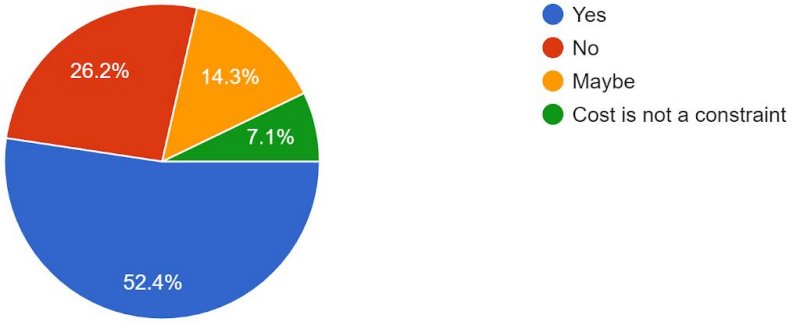
What is your top priority in any application?

42 responses



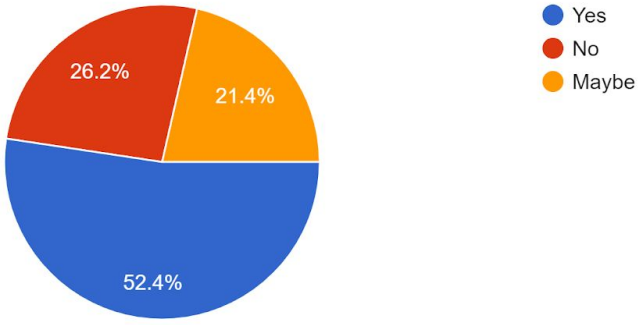
Are you willing to pay for such an app/ Are you willing to pay more for added functionalities?

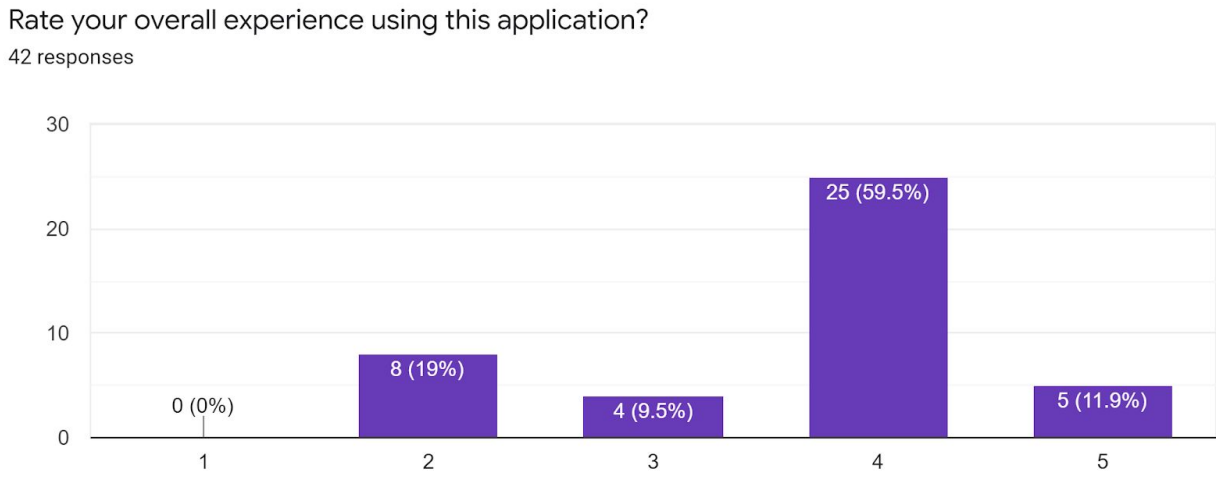
42 responses



Are you willing to switch your daily learning experience with this AR model ?

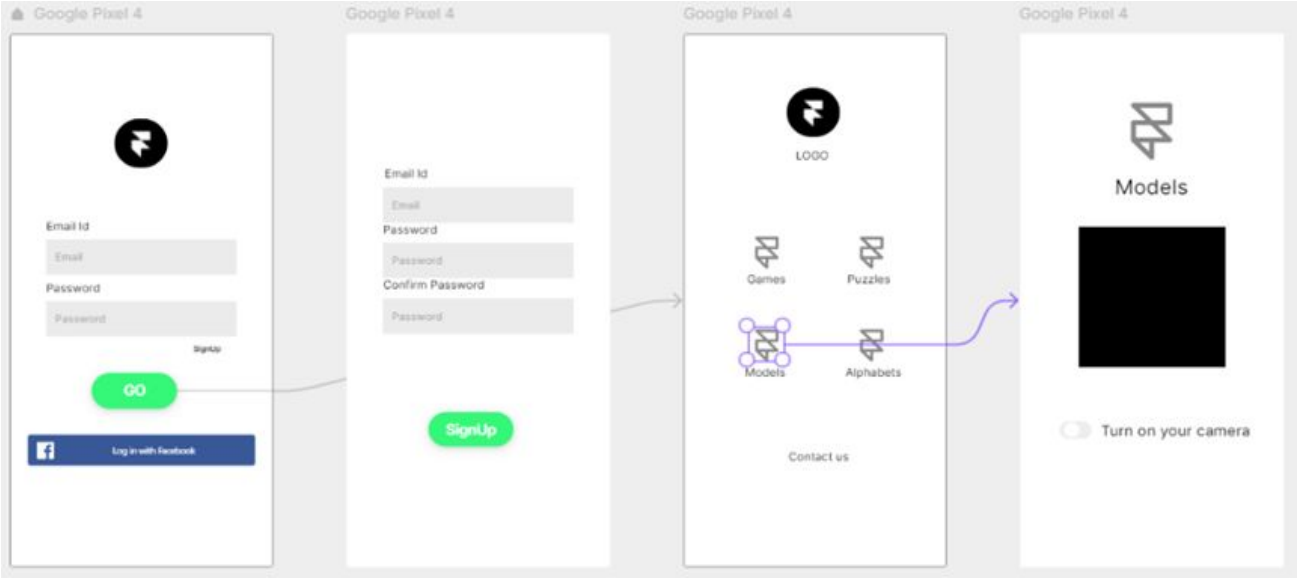
42 responses





The survey conducted gave us crucial information regarding the people's view with respect to the field of our project. Almost 70% of the people responded that learning with image visualisation is important for grasping the concept behind any topic. About 72% of the people in our survey accepted that learning is not necessarily done through books but the experience along with it is what gives an edge to a person over others learning through conventional strategies. As many as 80% people think that 3D models are more informative and would help in understanding concepts and enhancing analytical skills. More than half of the people in the survey are willing to pay for the services provided by us which includes learning concepts through augmented reality which will help in visualizing concepts for children in a 3D model so that they could easily grasp the information. Coming to the expectation of the potential customers, accuracy of the model generated through AR with proper visualisation. Also, people expect the software should also work in low brightness which will be a bit challenging. 42.9% of the voters demand the UI to be user friendly as the application developed is to be used by people in all age groups so that no one is facing any difficulty in accessing the maximum services provided by it. These things will be our top priority in the development process. Although many people are satisfied by the current ppt/ textual based learning but this is not the general case, many children face difficulties in the early stages due to any medical or hereditary issues. These children will be our main target and we will try our best to give them a best learning experience so that they can compete with the other normal children.

Storyboard



Modules involved in the app:

These modules have been implemented in the current version of the project:

1. Loading models in the Augmented Reality scene.
    - This module uses Unity ARFoundation package to interface with native AR libraries, ARCore for Android and ARKit for IOS.
    - AR scene is created by using ARSession and ARSessionOrigin.

2. A list menu of pre-installed models in application.
    - The models have been categorised into three parts named as Animals, Buildings and Vehicles.
    - Each of these models are further categorised in order to be more informative about them.
    - When a specific model is selected, the camera opens and the model is displayed

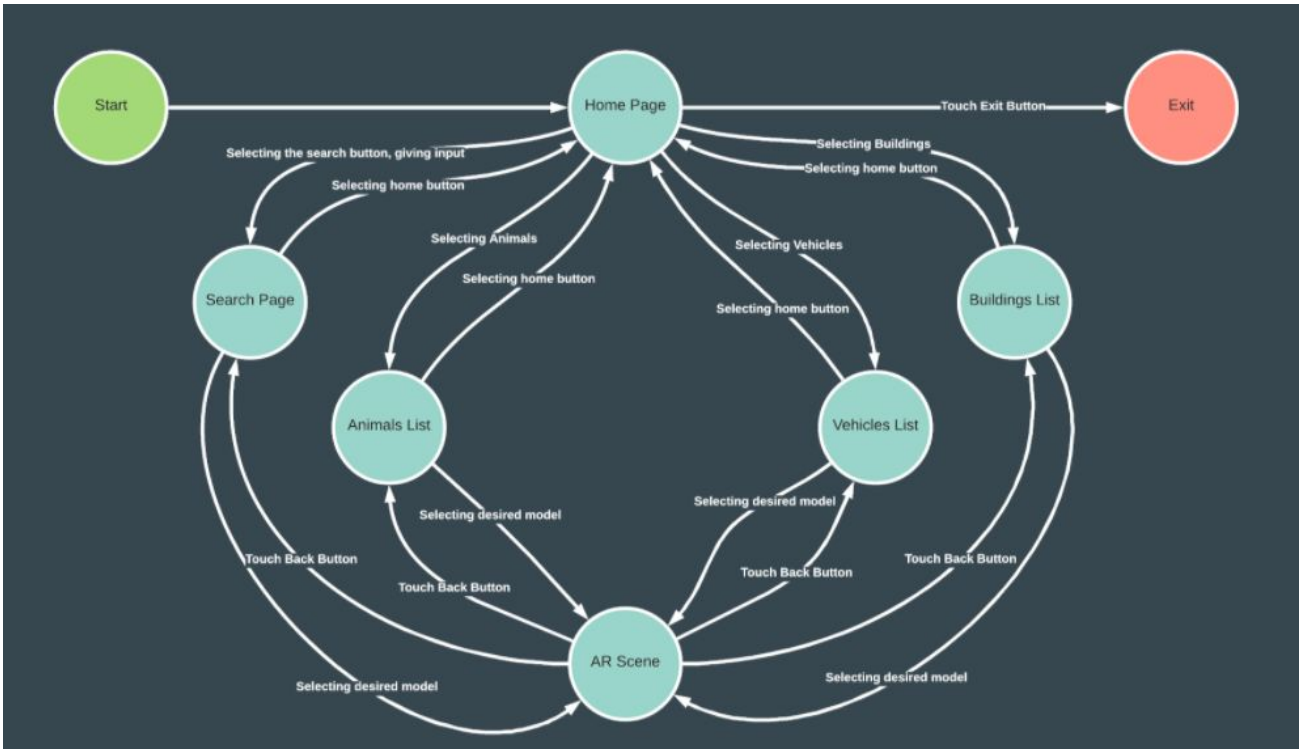
3. Plane Detection and Raycasting.
    - Plane detection helps in detecting horizontal and vertical planes in the real world.
    - After the plane is detected then using raycasting, ray is emitted from the device camera into the scene and point of collision with location and rotation is used to instantiate the model on the plane.
    - If the plane is not detected then the model will not be instantiated.

4. Loading models across scenes.
    - Models are selected and loaded from one scene to another.
    - Models get destroyed once the camera is closed to save memory on the device.

5. Resizing the model in real time
    - The model displayed in Augmented Reality can be resized by using a slider.
    - It can go from 0.5x the size of the instanced model to 2x the size of the instanced model.

6. Rotating the model in real time to view it from multiple points
    - Instanced models can be rotated to view from multiple points by simply swiping across the screen of the device.
7. Info about the model
    - Touching the ‘info’ icon on the Augmented Reality screen will open a little card with the information about the model.
    - It will also provide links to useful websites.

Process flow of the proposed application:



Code:

1) Model Loader C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class ModelLoaderScript : MonoBehaviour
{
    //bool sceneLoaded = false;
    static PlaceObjectOnOrigin debugPlacer;
    static PlaceObjectOnPlane placer;
    static GameObject modelToPlace;

    [HideInInspector]
    public int lastSceneIndex;

    [Tooltip("(DEBUGGING)Turn it on if only normal camera is enabled in
ARScreen scene.")]
    public bool debug = false;

    private void Awake()
    {
        DontDestroyOnLoad(this);
    }

    private void OnEnable()
    {
        SceneManager.sceneLoaded += OnSceneLoaded;
```

```
        SceneManager.sceneUnloaded += OnSceneUnload;
        Debug.Log("Wake Up");
    }

    private void OnSceneLoaded(Scene scene, LoadSceneMode mode)
    {
        //sceneLoaded = true;
        if (scene.name == "ARScreen")
        {

GameObject.Find("EventSystem").GetComponent<InfoPanelManager>().display
Text = modelToPlace.GetComponent<ModelInfo>().getModelInfo();
            if (debug)
            {
                debugPlacer =
GameObject.FindGameObjectWithTag("DebugCamera").GetComponent<PlaceObjec
tOnOrigin>();
                debugPlacer.SetObject(modelToPlace);
            }
            else
            {
                placer =
GameObject.FindGameObjectWithTag("MainCamera").GetComponent<PlaceObject
OnPlane>();
                placer.SetObject(modelToPlace);
            }
        }
        Debug.Log("Loaded " + scene.name);
    }

    private void OnSceneUnload(Scene scene)
    {
        //sceneLoaded = false;
        lastSceneIndex = scene.buildIndex;
        Debug.Log("Unloaded " + scene.name);
    }

    public void LoadModel(GameObject model)
    {

GameObject.Find("SceneLoadManager").GetComponent<SceneLoaderScript>().d
isplayScene(4);
        modelToPlace = model;
        Debug.Log("Got Model: " + modelToPlace.name);
    }
}
```

2) Place Object on Plane C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEditor;
using UnityEngine.XR.ARFoundation;
using UnityEngine.XR.ARSubsystems;
using UnityEngine.SceneManagement;
```

```
public class PlaceObjectOnPlane : MonoBehaviour
{
    [SerializeField]
    ARRaycastManager m_RaycastManager;

    static List<ARRaycastHit> s_Hits = new List<ARRaycastHit>();

    bool isModelSet = false;
    bool isModelPlaced = false;

    GameObject m_ObjectToPlace;
    GameObject gameObj;

    Vector3 originalScale;

    private Vector2 fingerDown;
    private Vector2 fingerUp;
    public bool detectSwipeOnlyAfterRelease = false;

    public float SWIPE_THRESHOLD = 20f;

    Quaternion rotate;
    Quaternion current;


    private void OnEnable()
    {
        SceneManager.sceneUnloaded += OnSceneUnload;
    }

    private void OnSceneUnload(Scene scene)
    {
        isModelPlaced = false;
        isModelSet = false;
    }

    // Update is called once per frame
    void Update()
    {
        if (!isModelSet)
            return;

        if (Input.touchCount > 0)
        {

            if(!isModelPlaced)
            {
                Touch touch = Input.GetTouch(0);
                if (touch.phase == TouchPhase.Began)
                {
                    if (m_RaycastManager.Raycast(touch.position, s_Hits,
TrackableType.PlaneWithinPolygon))
                    {
                        Pose hitPose = s_Hits[0].pose;
                        float distance = s_Hits[0].distance;
```

```
                        GameObject model =
m_ObjectToPlace.transform.GetChild(0).gameObject;
                        if (distance < 3f)
                            model.transform.localScale = new
Vector3(distance / 2, distance / 2, distance / 2);
                        gameObj = Instantiate(m_ObjectToPlace,
hitPose.position, hitPose.rotation);
                        originalScale = gameObj.transform.localScale;
                        isModelPlaced = true;
                    }
                }
            }

            foreach (Touch touch in Input.touches)
            {
                if (touch.phase == TouchPhase.Began)
                {
                    fingerUp = touch.position;
                    fingerDown = touch.position;
                }

                //Detects Swipe while finger is still moving
                if (touch.phase == TouchPhase.Moved)
                {
                    if (!detectSwipeOnlyAfterRelease)
                    {
                        fingerDown = touch.position;
                        checkSwipe();
                    }
                }

                //Detects swipe after finger is released
                if (touch.phase == TouchPhase.Ended)
                {
                    fingerDown = touch.position;
                    checkSwipe();
                }
            }
        }
    }

    void checkSwipe()
    {
        //Check if Horizontal swipe
        if (horizontalValMove() > SWIPE_THRESHOLD)
        {
            //Debug.Log("Horizontal");
            if (fingerDown.x - fingerUp.x > 0)//Right swipe
            {
                OnSwipeRight();
            }
            else if (fingerDown.x - fingerUp.x < 0)//Left swipe
            {
                OnSwipeLeft();
            }
            fingerUp = fingerDown;
```

```
            }
        }

        float horizontalValMove()
        {
            return Mathf.Abs(fingerDown.x - fingerUp.x);
        }

        void OnSwipeLeft()
        {
            rotate = Quaternion.Euler(0, Mathf.PI*horizontalValMove(), 0);
            current = gameObj.transform.localRotation;
            gameObj.transform.localRotation = Quaternion.Slerp(current,
    current * rotate, Time.deltaTime);
        }

        void OnSwipeRight()
        {
            rotate = Quaternion.Euler(0, -Mathf.PI*horizontalValMove(), 0);
            current = gameObj.transform.localRotation;
            gameObj.transform.localRotation = Quaternion.Slerp(current,
    current * rotate, Time.deltaTime);
        }

        public void SetObject(GameObject obj)
        {
            isModelSet = true;
            m_ObjectToPlace = obj;
            Debug.Log("Object Placed " + m_ObjectToPlace.name);
        }

        public void ChangeSize(float m)
        {
            Debug.Log("Called ChangeSize m = " + m);
            gameObj.transform.localScale = new Vector3(m * originalScale.x,
                                                       m * originalScale.y,
                                                       m * originalScale.z);
            //Undo.RegisterCreatedObjectUndo(gameObj, "Created instance");
        }
    }
```

3)Place Object on Origin C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEditor;

public class PlaceObjectOnOrigin : MonoBehaviour
{
    bool isModelSet = false;
    GameObject m_ObjectToPlace;
    GameObject gameObj;
    Vector3 originalScale;

    // Start is called before the first frame update
```

```
    private void Update()
    {
        if (isModelSet)
            return;
        gameObj = Instantiate(m_ObjectToPlace, new Vector3(0, 0, 0), new
Quaternion());
        originalScale = gameObj.transform.localScale;
        isModelSet = true;
    }

    public void SetObject(GameObject obj)
    {
        m_ObjectToPlace = obj;
        Debug.Log("Object Placed " + m_ObjectToPlace.name);
    }

    public void ChangeSize(float m)
    {
        Debug.Log("Called ChangeSize m = " + m);
        gameObj.transform.localScale = new Vector3(m * originalScale.x,
                                                   m * originalScale.y,
                                                   m * originalScale.z);
        //Undo.RegisterCreatedObjectUndo(gameObj, "Created instance");
    }
}
```

4) Scene Loader C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;
using UnityEngine.UI;

public class SceneLoaderScript : MonoBehaviour
{
    static int lastSceneIndex;
    static int currentSceneIndex;

    private void OnEnable()
    {
        SceneManager.sceneLoaded += OnSceneLoaded;
        SceneManager.sceneUnloaded += OnSceneUnload;
    }

    void OnSceneLoaded(Scene scene, LoadSceneMode mode)
    {
        currentSceneIndex = scene.buildIndex;
    }

    void OnSceneUnload(Scene scene)
    {
```

```
        lastSceneIndex = scene.buildIndex;
    }

    public void displayScene(int sceneIndex)
    {
        SceneManager.LoadScene (sceneIndex);
    }

    public void displayLastScene()
    {
        displayScene(lastSceneIndex);
    }
}
```

5) Model Info C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class ModelInfo : MonoBehaviour
{
    [TextArea(5, 20), SerializeField, Tooltip("Information About the Model")]
private string modelInfo;

    public string getModelInfo()
    {
        return modelInfo;
    }
}
```

6) Info Panel Manager C# Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using TMPro;

public class InfoPanelManager : MonoBehaviour
{
    public string displayText;

    public void ShowInfoPanel()
    {
        Transform infoPanel = GameObject.Find("InfoPanel").transform;
        Transform textBox = infoPanel.GetChild(1);
        Debug.Log(displayText);
        textBox.GetComponent<TMP_Text>().SetText(displayText);
        infoPanel.localScale = new Vector3(1, 1);
    }

    public void CloseInfoPanel()
    {
        GameObject.Find("InfoPanel").transform.localScale = new Vector3(0, 0);
    }
}
```

Output:

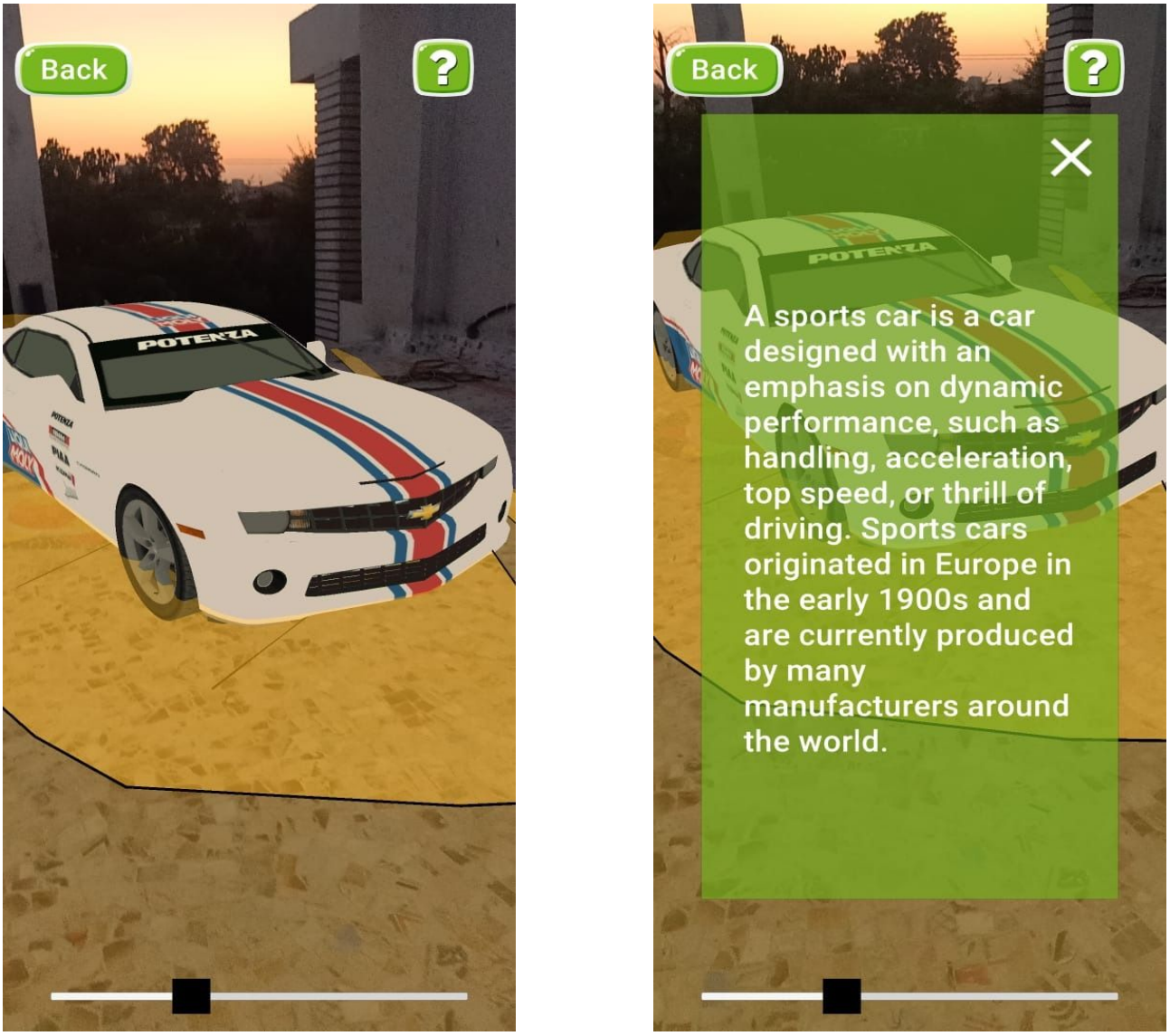


Figure: A Race car model in AR and some information about it.

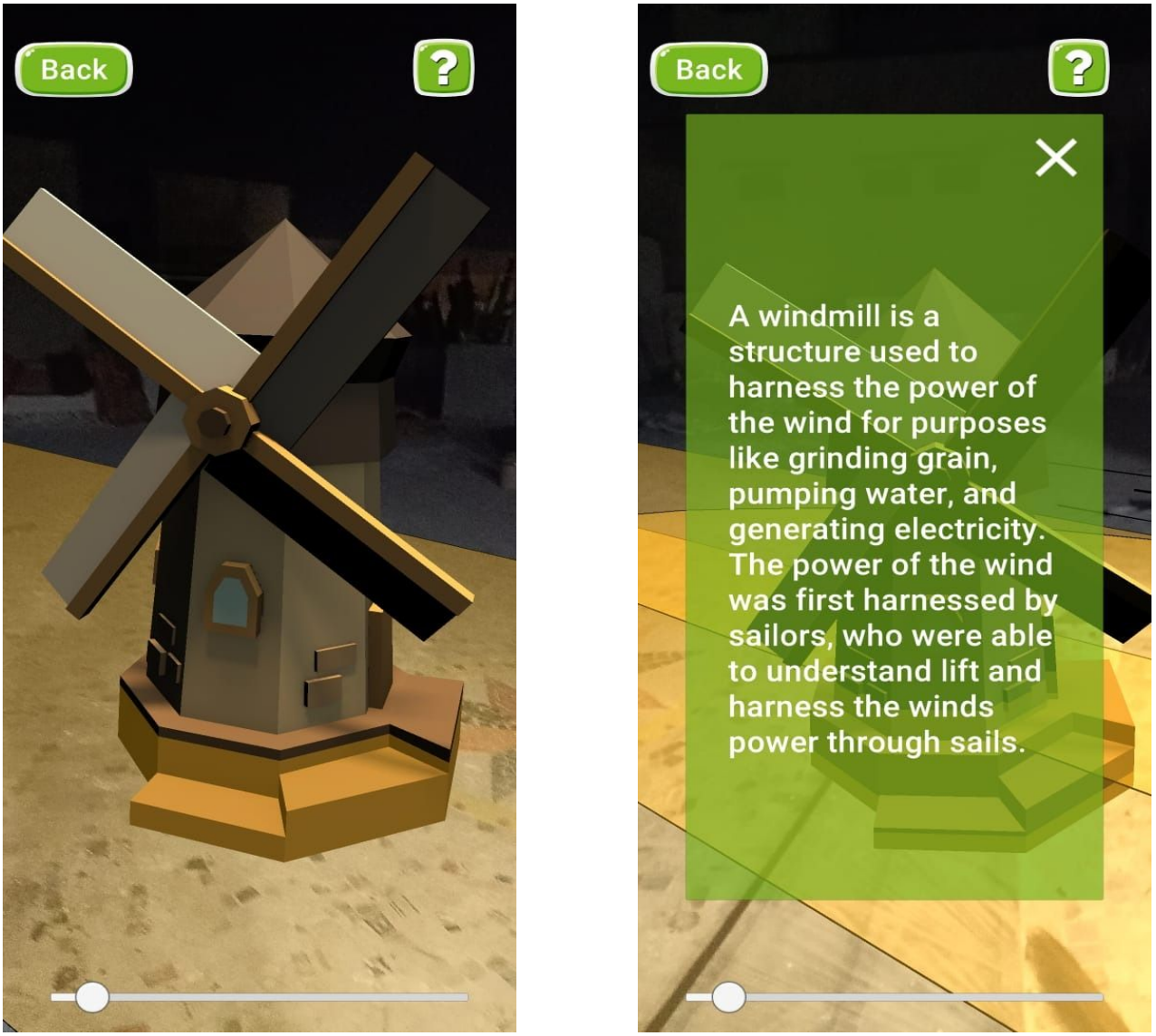


Figure: A Windmill model in AR and some information about it.

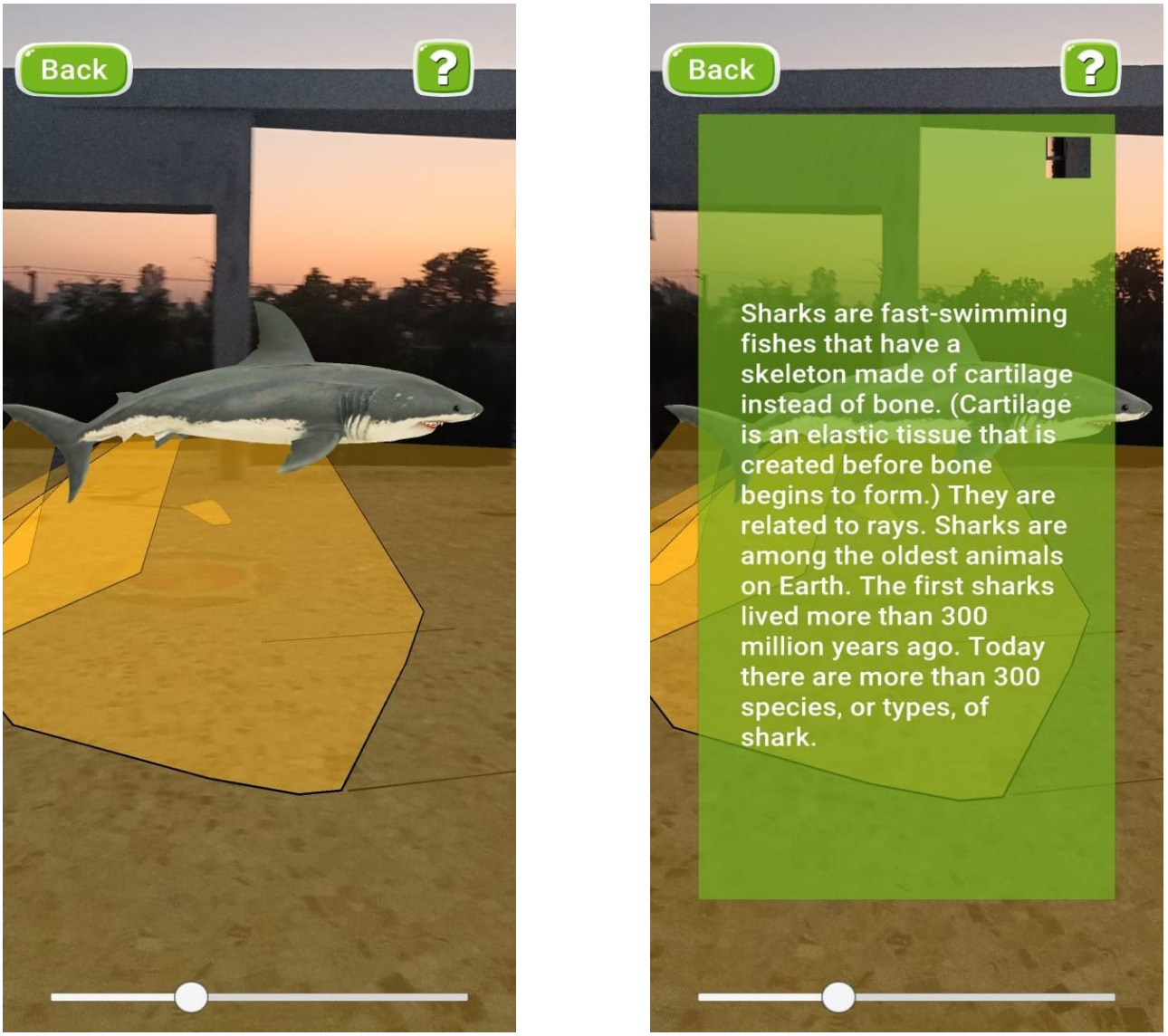


Figure: A Windmill model in AR and some information about it.

Application User Interface:

Figure: Home screen of the application

Figure: User Interface of the Buildings category

Figure: User Interface of Animals Category

Figure: User Interface of the Cars category

Future Work

We have developed a reliable application for teachers with the focus on the making learning experience of children and students facing attention disorders.The materials features provided in this project are in constraints of time and finances.The Scope of this project can be further enhanced for various target groups.In future we can also include many other 3D models belonging to different fields like chemical structures of different chemical compounds, plants. This will provide a better understanding of these complex structures . and thereby the application of our product will widen. Our application can further be expanded where users can provide any 2D image which can be converted into Augmented reality model with some constraints.

Conclusion

On the basis of the evaluation tests we performed on different Interface models(both pre existing and self developed), we can safely conclude that the pre existing models are not friendly for kids especially the mentally impaired and differently abled ones. The developed models are better not only for the disabled people but also time saving for the general kids as it redefines the whole learning process and most importantly everything is inside the smartphone and can be accessed very easily. The UI designed by us is very simple yet very interactive and thus holds good all the HCI principles.

Inferences about the already existing models

- The user interface design of the application is not satisfactory.
- The interface design of the application is not suitable for the use of kids.

Improvements suggested on the existing interfaces

- Our UI is made as simple as possible. It is designed keeping in mind the 5 E's of usability – efficient, effective, engaging, error tolerant and easy to learn. Among the small pool of people in which we tested this model, all the users were satisfied and found the game very easy to use.
- Developing a system using unity application can be beneficial as viewing through the application, images give a 3 – Dimensional feeling which is easier to perceive.

All of the information shall be stored in the same page and sorted in basic directions. To achieve this, we shall be using unity to develop the application. This shall make the system much interact

References

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- Britannica used for putting information about the models in the application: https://www.britannica.com
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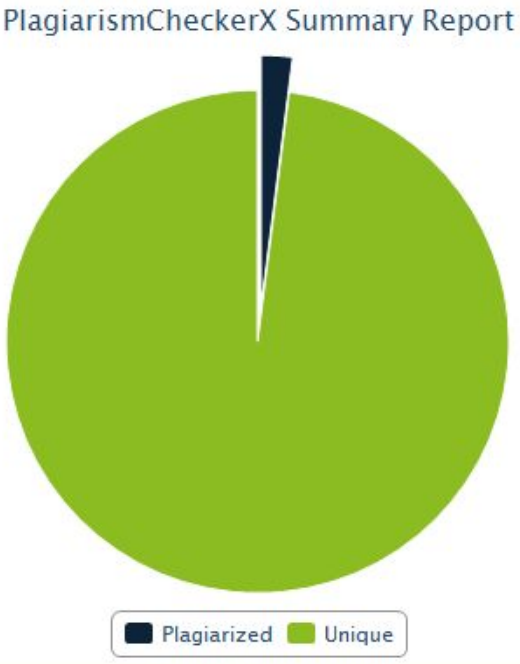

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Augmented Reality Based Learning Application School of Computing Science & Engineering Human Computer Interaction-CSE4015 Slot - A2+TA2 B.Tech CSE Review - 1 Submitted by Abhisar Shukla - 18BCE0110 Anshul Tripathi - 18BCE0148 Yashaswi Shivank - 18BCE0162 Table of Content Index 2 Acknowledgement 2 Abstract 3 Introduction 3 Design Survey 5 Existing Designs 11 New Design and Development 13 Evaluation Plan of the Interface 14 App Outputs 20 Conclusion 25 References & Tools 25 Acknowledgement We would like to give our special thanks with full gratitude to our course professor Proj.

Joshwa Devadas who gave us the golden opportunity to do this wonderful project on the topic Augmented reality Based Learning App, which also led us in conducting research through which we got to know about so many new concepts in the course of CSE4015 Human Computer Interaction. We are thankful to them. We would like to express my gratitude towards members of Vellore Institute of Technology for their kind cooperation and encouragement which helped me in completion of this project. Abstract This ongoing Covid crisis has greatly impacted the education culture of our country. A new online learning culture has rapidly grown among our teachers and students. Learning experience has been restricted to 2D learning only.

It has become much more difficult for teachers to keep their students engaged and maintain interest in subjects among students.This has come out as a major problem especially among small childrens. Students having attention disorders face similar problems. The aim of this project is to design an AR Learning app for teachers aimed at promoting fun based learning. Currently teaching is taking a monotonous track where teachers either teach through a book or presentation both of which are 2-D image based printed educational modes in which understanding and retaining concepts is quite difficult.

To tackle this situation, we shall be using augmented reality to make this process much interactive and friendly. Augmented Reality (AR) refers to displaying virtual images over real-world objects. Seeing models in Augmented Reality helps the children to engage in a fun way using the virtual world. Motivation behind our plan to design AR learning comes from the idea. This project aims to make learning fun for children and making it easy for the children to remember various things using Augmented Reality and 3D models with which they can interact with in a fun way.

This also increases children's memory capacity as they can relate the words to the 3D model and seeing it before their eyes makes it easy for them to remember it for a longer time period. Our application can be further developed to provide a better representation of complex chemical models and games which can highly enhance analytical and problem solving skills of students.They can be highly helpful for children having Attention Disorders. Research shows that online games help children with attention disorder. The following was the result of the professor at Nottingham University.

This not only relates to models whereby children have to remember aspects in order to solve the game, memorize critical sequences, or track narrative elements.It also supports fast Strategic Thinking & Problem-Solving. Children should think fast in most of the 2D games. Also they have to think ahead of the current situation to solve the puzzle and complete levels. This helps children increase their thinking ability and develop their logic, it also helps in increasing their accuracy and thinking outside the box.

REQUIREMENT ANALYSIS: Target User Community Primary stakeholders aka our end users (any person with stable hands) are : Kids (5-13): the game helps in improving fast strategic thinking and problem solving and 3-D demonstration is very useful for educational purposes. Teenagers (14-20): really helpful for them to view the 3-D structures of important models like chemical

structures. Adults/office going people (21-50): Artists can use it to visualize their designs in 3-D.In medical field,demos can be used to view micro structures in detail.Civil Engineers can use it to view the building's structure at every floor without even going there inreality.

Elderly (50+): Games are really helpful for them to improve their attention disorders which fade with age. Required User Actions/Skills: Users need to have the application installed in their mobile phone. Users need to have a smartphone that has Augmented Reality (AR) supported cameras. Most of the modern smartphones have this capability. Users should have knowledge of how to navigate the interface of the application. Tutorials can make this step easier for users who have problems navigating the interface of the application. Most of the users like a simple and easy to use user interface. User interface design and planning should be done before implementing.

User surveys can help shape the user interface design decisions. Users also may not appreciate technical possibilities (or impossibilities). User feedback from time to time through the app. Example Use of Application: It can be used in primary schools to enhance the learning experience of the students. Students will be able to learn and remember things taught if they get to see it in 3D. With AR they will be able to see it right in front of them, this can make the learning experience epic and more memorable. Teenagers can use the app to visualize models of chemical compounds, geometric structures or biological diagrams.

Some chemical compound diagrams can be hard to understand because most of the organic compounds are 3D. Viewing in AR can help understand the overall structure of the compound more effortlessly. Similarly geometric structures and biological diagrams can be easily understood if viewed interactively in AR. 3. More 3D models can be added to the application for visualizing it in AR. 3.1 This might be useful in cases when users want to visualize their models in AR. Acceptance Criteria: User interface should be easy enough to be understood by users of all demographics.

Application should be able to load the models in a reasonable amount of time across all supported devices. Application should give useful error messages on crash or any other unexpected behaviour from the user. Task Analysis: Aim of task analysis is to determine the actions taken by the user when using the application. Also the order in which they should do these tasks to accomplish the root task. Also the knowledge necessary for the users to efficiently operate the applications. Textual HTA for using the applications: Hierarchy description: 0. Open Application 1. Register 1.1 Login 1.1.1 Find the desired activity to perform 1.1.1.1

Select the desired option 1.1.1.1.1 Games 1.1.1.1.2 Puzzles 1.1.1.1.3 Alphabets 1.1.1.1.4 3D Models 1.1.1.1.4.1 Plants 1.1.1.1.4.2 Animals 1.1.1.1.4.3 Objects 1.1.1.1.4.4 Buildings 1.1.1.1.1.1 Select the desired model 1.1.1.2 Search the specific activity from the top bar 1.2 Enter the required details Plans: Plan 0: do 1, register. Plan 1: try 1.1 to login, if fails 1.2 enter the required details. Plan 1.2: do 1.1.1, find the desired activity. Plan 1.1.1: do 1.1.1.1 select the option or 1.1.1.2 search for the activity. Plan 1.1.1.1: do anyone of 1.1.1.1.1 games or 1.1.1.1.2 puzzles or 1.1.1.1.3 alphabets or 1.1.1.1.4 3D models Plan 1.1.1.1.1: do 1.1.1.1.1.1 select the desired model. Plan 1.1.1.1.2: do 1.1.1.1.1.1

select the desired model. Plan 1.1.1.1.3: do 1.1.1.1.1.1 select the desired model. Plan 1.1.1.1.4: do 1.1.1.1.4.1 select plants or 1.1.1.1.4.2 select animals or 1.1.1.1.4.3 select objects or 1.1.1.1.4.4 select buildings. Plan 1.1.1.1.4.1 till 1.1.1.1.4.4: do 1.1.1.1.1.1 select the desired model. Survey Form Responses The survey conducted gave us crucial information regarding the people's view with respect to the field of our project. Almost 70% of the people responded that learning with image visualisation is important for grasping the concept behind any topic.

About 72% of the people in our survey accepted that learning is not necessarily done through books but the experience along with it is what gives an edge to a person over others learning through conventional strategies. As many as 80% people think that 3D models are more informative and would help in understanding concepts and enhancing analytical skills. More than half of the people in the survey are willing to pay for the services provided by us which includes learning concepts through augmented reality which will help in visualizing concepts for children in a 3D model so that they could easily grasp the information. Coming to the expectation of the potential customers, accuracy of the model generated through AR with proper visualisation. Also, people expect the software should also work in low brightness which will be a bit challenging. 42.9% of the voters demand the UI to be user friendly as the application developed is to be used by people in all age groups so that no one is facing any difficulty in accessing the maximum services provided by it.

These things will be our top priority in the development process. Although many people are satisfied by the current ppt/ textual based learning but this is not the general case, many children face difficulties in the early stages due to any medical or hereditary issues. These children will be our main target and we will try our best to give them a best learning experience so that they can compete with the other normal children.

Storyboard Modules involved in the app: These modules have been implemented in the current version of the project: Loading models in the Augmented Reality scene. This module uses Unity ARFoundation package to interface with native AR libraries, ARCore for Android and ARKit for IOS. AR scene is created by using ARSession and ARSessionOrigin. A list menu of pre-installed models in application. The models have been categorised into three parts named as Animals, Buildings and Vehicles. Each of these models are further categorised in order to be more informative about them.

When a specific model is selected, the camera opens and the model is displayed Plane Detection and Raycasting. Plane detection helps in detecting horizontal and vertical planes in the real world. After the plane is detected then using raycasting, ray is emitted from the device camera into the scene and point of collision with location and rotation is used to instantiate the model on the plane. If the plane is not detected then the model will not be instantiated. Loading models across scenes. Models are selected and loaded from one scene to another. Models get destroyed once the camera is closed to save memory on the device.

Resizing the model in real time The model displayed in Augmented Reality can be resized by using a slider. It can go from 0.5x the size of the instanced model to 2x the size of the instanced model. Rotating the model in real time to view it from multiple points Instanced models can be rotated to view from multiple points by simply swiping across the screen of the device. Info about the model

Touching the ‘info’ icon on the Augmented Reality screen will open a little card with the information about the model. It will also provide links to useful websites.

Process flow of the proposed application: Code: Model Loader C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; using UnityEngine.SceneManagement; public class ModelLoaderScript : MonoBehaviour { //bool sceneLoaded = false; static PlaceObjectOnOrigin debugPlacer; static PlaceObjectOnPlane placer; static GameObject modelToPlace; [HideInInspector] public int lastSceneIndex; [Tooltip("(DEBUGGING)Turn it on if only normal camera is enabled in ARScreen scene.")] public bool debug = false; private void Awake() { DontDestroyOnLoad(this); } private void OnEnable() { SceneManager.sceneLoaded += OnSceneLoaded; SceneManager.sceneUnloaded += OnSceneUnload; Debug.Log("Wake Up"); } private void OnSceneLoaded(Scene scene, LoadSceneMode mode) { //sceneLoaded = true; if (scene.name == "ARScreen") { GameObject.Find("EventSystem").GetComponent<InfoPanelManager>().displayText = modelToPlace.GetComponent<ModelInfo>().getModelInfo(); if (debug) { debugPlacer = GameObject.FindGameObjectWithTag("DebugCamera").GetComponent<PlaceObjectOnOrigin>(); debugPlacer.SetObject(modelToPlace); } else { placer = GameObject.FindGameObjectWithTag("MainCamera").GetComponent<PlaceObjectOnPlane>(); placer.SetObject(modelToPlace); } } Debug.Log("Loaded " + scene.name); } private void OnSceneUnload(Scene scene) { //sceneLoaded = false; lastSceneIndex = scene.buildIndex; Debug.Log("Unloaded " + scene.name); } public void LoadModel(GameObject model) { GameObject.Find("SceneLoadManager").GetComponent<SceneLoaderScript>().displayScene(4); modelToPlace = model; Debug.Log("Got Model: " + modelToPlace.name); } } Place Object on Plane C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; using UnityEditor; using UnityEngine.XR.ARFoundation; using UnityEngine.XR.ARSubsystems; using UnityEngine.SceneManagement; public class PlaceObjectOnPlane : MonoBehaviour { [SerializeField] ARRaycastManager m_RaycastManager; static List<ARRaycastHit> s_Hits = new List<ARRaycastHit>(); bool isModelSet = false; bool isModelPlaced = false; GameObject m_ObjectToPlace; GameObject gameObj; Vector3 originalScale; private Vector2 fingerDown; private Vector2 fingerUp; public bool detectSwipeOnlyAfterRelease = false; public float SWIPE_THRESHOLD = 20f; Quaternion rotate; Quaternion current; private void OnEnable() { SceneManager.sceneUnloaded += OnSceneUnload; } private void OnSceneUnload(Scene scene) { isModelPlaced = false; isModelSet = false; } // Update is called once per frame void Update() { if (!isModelSet) return; if (Input.touchCount > 0) { if(!isModelPlaced) { Touch touch = Input.GetTouch(0); if (touch.phase == TouchPhase.Began) { if (m_RaycastManager.Raycast(touch.position, s_Hits, TrackableType.PlaneWithinPolygon)) { Pose hitPose = s_Hits[0].pose; float distance = s_Hits[0].distance; GameObject model = m_ObjectToPlace.transform.GetChild(0).gameObject; if (distance < 3f) model.transform.localScale = new Vector3(distance / 2, distance / 2, distance / 2); gameObj = Instantiate(m_ObjectToPlace, hitPose.position, hitPose.rotation); originalScale = gameObj.transform.localScale; isModelPlaced = true; } } } foreach (Touch touch in Input.touches) { if (touch.phase == TouchPhase.Began) { fingerUp = touch.position; fingerDown = touch.position; } //Detects Swipe while finger is still moving if (touch.phase == TouchPhase.Moved) { if (!detectSwipeOnlyAfterRelease) { fingerDown = touch.position; checkSwipe(); } } //Detects swipe after finger is released if (touch.phase == TouchPhase.Ended) { fingerDown = touch.position; checkSwipe(); } } } void checkSwipe() { //Check if Horizontal swipe if (horizontalValMove() > SWIPE_THRESHOLD) { //Debug.Log("Horizontal"); if (fingerDown.x - fingerUp.x > 0)//Right swipe { OnSwipeRight(); } else if (fingerDown.x - fingerUp.x

< 0)//Left swipe { OnSwipeLeft(); } fingerUp = fingerDown; } } float horizontalValMove() { return

Mathf.Abs(fingerDown.x - fingerUp.x); } void OnSwipeLeft() { rotate = Quaternion.Euler(0, Mathf.PI*horizontalValMove(), 0); current = gameObj.transform.localRotation; gameObj.transform.localRotation = Quaternion.Slerp(current, current * rotate, Time.deltaTime); } void OnSwipeRight() { rotate = Quaternion.Euler(0, -Mathf.PI*horizontalValMove(), 0); current = gameObj.transform.localRotation; gameObj.transform.localRotation = Quaternion.Slerp(current, current * rotate, Time.deltaTime); } public void SetObject(GameObject obj) { isModelSet = true; m_ObjectToPlace = obj; Debug.Log("Object Placed " + m_ObjectToPlace.name); } public void ChangeSize(float m) { Debug.Log("Called ChangeSize m = " + m); gameObj.transform.localScale = new Vector3(m * originalScale.x, m * originalScale.y, m * originalScale.z); //Undo.RegisterCreatedObjectUndo(gameObj, "Created instance"); } } 3)Place Object on Origin C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; using UnityEditor; public class PlaceObjectOnOrigin : MonoBehaviour { bool isModelSet = false; GameObject m_ObjectToPlace; GameObject gameObj; Vector3 originalScale; // Start is called before the first frame update private void Update() { if (isModelSet) return; gameObj = Instantiate(m_ObjectToPlace, new Vector3(0, 0, 0), new Quaternion()); originalScale = gameObj.transform.localScale; isModelSet = true; } public void SetObject(GameObject obj) { m_ObjectToPlace = obj; Debug.Log("Object Placed " + m_ObjectToPlace.name); } public void ChangeSize(float m) { Debug.Log("Called ChangeSize m = " + m); gameObj.transform.localScale = new Vector3(m * originalScale.x, m * originalScale.y, m * originalScale.z); //Undo.RegisterCreatedObjectUndo(gameObj, "Created instance"); } } 4) Scene Loader C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; using UnityEngine.SceneManagement; using UnityEngine.UI; public class SceneLoaderScript : MonoBehaviour { static int lastSceneIndex; static int currentSceneIndex; private void OnEnable() { SceneManager.sceneLoaded += OnSceneLoaded; SceneManager.sceneUnloaded += OnSceneUnload; } void OnSceneLoaded(Scene scene, LoadSceneMode mode) { currentSceneIndex = scene.buildIndex; } void OnSceneUnload(Scene scene) { lastSceneIndex = scene.buildIndex; } public void displayScene(int sceneIndex) { SceneManager.LoadScene (sceneIndex); } public void displayLastScene() { displayScene(lastSceneIndex); } } 5) Model Info C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; public class ModelInfo : MonoBehaviour { [TextArea(5, 20), SerializeField, Tooltip("Information About the Model")] private string modelInfo; public string getModelInfo() { return modelInfo; } } 6) Info Panel Manager C# Script using System.Collections; using System.Collections.Generic; using UnityEngine; using TMPro; public class InfoPanelManager : MonoBehaviour { public string displayText; public void ShowInfoPanel() { Transform infoPanel = GameObject.Find("InfoPanel").transform; Transform textBox = infoPanel.GetChild(1); Debug.Log(displayText); textBox.GetComponent<TMP_Text>().SetText(displayText); infoPanel.localScale = new Vector3(1, 1); } public void CloseInfoPanel() { GameObject.Find("InfoPanel").transform.localScale = new Vector3(0, 0); } } Output: Figure: A Race car model in AR and some information about it. Figure: A Windmill model in AR and some information about it. Figure: A Windmill model in AR and some information about it.

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Improvements suggested on the existing interfaces Our UI is made as simple as possible. It is designed keeping in mind the 5 E's of usability – efficient, effective, engaging, error tolerant and easy to learn. Among the small pool of people in which we tested this model, all the users were satisfied and found the game very easy to use. Developing a system using unity application can be beneficial as viewing through the application, images give a 3 – Dimensional feeling which is easier to perceive. All of the information shall be stored in the same page and sorted in basic directions.

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