WEST UNIVERSITY OF TIMIŞOARA
FACULTY OF MATHEMATICS AND COMPUTER SCIENCE
BACHELOR: Computer Science in romanian

BACHELOR THESIS

SUPERVISOR:
Lect. Dr. Liviu Mafteiu-Scai

GRADUATE:
Sorin-Ionuţ Rosalim

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Development of an augmented reality app as an interactive tool

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Abstract

This paper presents a novel approach to the problem of augmenting the real world with digital content. We propose a new method to access digital content using QR codes. We present a proof of concept of our approach and discuss the potential of augmented reality as a tool for learning and discovering new things. This thesis theme is the development of an Android mobile application called RealityEnhance. The application aims to augment the real world with digital content through the user's smartphone. RealityEnhance gives its users the power to discover and interact with digital content.

Acesta lucrare prezintă o abordare inovatoare a problemei de a îmbogăți lumea reală cu conținut digital. Propunem o nouă metodă de acces la conținutul digital folosind coduri QR. Prezentăm o demonstrație practică a abordării noastre și discutăm potențialul realității augmentate ca instrument pentru învățare și descoperire de lucruri noi. Tema acestei teze este dezvoltarea unei aplicații mobile Android numite RealityEnhance. Aplicația își propune să completeze lumea reală cu conținut digital prin intermediul smartphone-ului utilizatorului. RealityEnhance oferă utilizatorilor puterea de a descoperi și interacționa cu conținutul digital.

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Chapter 1

Introduction

1.1 Why this topic?

Augmented Reality (AR) is the middle ground between the Real and the Virtual world. AR is an experience where designers use computer-generated input to augment parts of the user's physical world. Designers create inputs from sound to video, graphics to GPS overlays and more into digital content that responds in real-time to user environment changes. I chose the Augmented Reality topic because this field is very immersing. This field of immersive experiences allows people to join enhancing activities.

1.2 Why is this relevant?

Augmented reality is important because it can be implemented and used in any domain. This technology is commonly utilized in various applications such as aviation, military equipment, combat training, displaying information on car windshields and gaming on smartphones.

1.3 What is the novelty factor?

1.4 What are some general goals?

The goal is to develop a working mobile application that allows users to scan a QR code and use the smartphone's camera to visualize a 3D model of an object. They will be able to follow a guide and complete

1.5 What is my contribution?

My contribution is applying my knowledge and experience to develop a mobile application that uses an AR module for displaying and interacting with the digital content and a QR code scanner module for scanning the QR codes, loading the 3D models and displaying them with the (AR) module.

Chapter 2

Related Work

2.1 Related writings

2.1.1 Augmented Reality in Education: Transforming Learning Experiences in the Classroom

Introduction: In the realm of education, the integration of technology has revolutionized teaching and learning processes. This article explores the transformative potential of Augmented Reality (AR), and Quick Response (QR) codes in the context of education. Drawing inspiration from Monica Burns' book "Tasks Before Apps: Designing Rigorous Learning in a Tech-Rich Classroom," we delve into how AR and QR codes can enhance learning experiences and engage students in interactive educational content.

Augmented Reality: Immersive Learning at Your Fingertips Augmented Reality offers a unique opportunity to create immersive and interactive learning environments. By overlaying digital content onto real-world objects, AR provides students a dynamic and engaging platform for exploration. As Monica Burns highlights, AR can be likened to a "window to interactive learning" (Burns, 2017). Students can unlock a wealth of three-dimensional models, virtual objects, and multimedia resources through trigger images, such as posters or activity sheets. By scanning these triggers using smartphones or tablets, students are transported into a world where knowledge comes to life.

Integrating AR into the Classroom: Educators worldwide have embraced AR as a powerful tool for instructional design. Teachers can seamlessly integrate augmented reality into their lessons by leveraging AR apps and printing corresponding trigger images. For instance, using the Anatomy 4D app by DAQRI, students can explore the intricacies of the human body by scanning large posters of anatomical models. As Burns emphasizes, using AR captivates students' attention and provides a unique opportunity to interact with and deepen their understanding of content (Burns, 2017).

QR Codes: Unleashing Digital Resources Alongside AR, QR codes have become an efficient way to connect physical and digital resources. By scanning these codes using mobile devices, students gain instant access to a wealth of online content. With a simple scan, QR codes can link students to websites, videos, interactive quizzes, and other digital resources, expanding their learning beyond the confines of traditional materials.

Harnessing the Power of QR Codes: QR codes have become a versatile tool in the classroom, empowering teachers to deliver digital content seamlessly. Educators can create QR codes to supplement lessons, provide additional resources, or foster independent research. Students can embark on self-directed learning journeys by incorporating QR codes into lesson plans, exploring personalized content, and engaging in collaborative projects. The ease of use and immediate access to digital resources make QR codes invaluable in modern classrooms. Synergistic Integration: AR and QR Codes Unite The combination of AR and QR codes unlock educational possibilities. Teachers can create synergistic learning experiences that blend the physical and digital realms by thoughtfully integrating both technologies. For example, students can scan a QR code to access background information or supplementary materials related to an AR experience, deepening their understanding and connecting with real-world applications.

Conclusion: Integrating Augmented Reality and QR codes in education holds tremendous potential for transforming learning experiences. Educators can foster engagement, deepen understanding, and inspire lifelong learners by immersing students in interactive virtual worlds and providing access to vast digital resources. As we embrace Monica Burns' notion of "tasks before apps," we must approach these technologies with clear pedagogical objectives (Burns, 2017). By strategically integrating AR and QR codes, we can create meaningful and impactful learning experiences that prepare students for success in a technology-driven world. Reference: Burns, M. (2017). Tasks Before Apps: Designing Rigorous Learning in a Tech-Rich Classroom. ASCD.

2.2 Related apps

2.2.1 Snapchat AR

In augmented reality (AR) applications, Snapchat AR stands out as a platform that revolutionises how we create, explore, and play. By harnessing the power of their AR Bar and a plethora of special Lenses, Snapchat AR enables users worldwide to scan their surroundings and discover valuable information. With just a tap on the Camera screen, the AR Bar unfurls, revealing myriad options, including the ability to create and edit unique Lenses. What sets Snapchat AR apart is its commitment to accessibility. The introduction of the Web Lens Builder and Lens Studio tools has democratised the creation of AR Lenses, making it easier for aspiring creators to bring their visions to life. Moreover, Snapchat has embraced the incorporation of real-world physics and real-time data integrations, elevating the realism and immersion of their AR experiences to new heights. Snapchat AR boasts a wide range of special Lenses, each offering a distinct and captivating visual experience. From playful animations to informative overlays, the creative possibilities are endless. Integrating real-world physics and real-time data ensures that the AR elements seamlessly interact with the user's environment, forging a more authentic and immersive encounter. Despite its notable contributions, Snapchat AR does have its limitations. A consistent internet connection is imperative to fully enjoy the AR features, which may prove challenging in certain circumstances. Additionally, while Snapchat AR offers a compelling experience, it needs to improve in terms of functionality when compared to more specialised AR applications.

2.2.2 Pokemon Go

In mobile gaming, Pokemon Go has become a global sensation by leveraging the power of augmented reality. The game's AR+ mode takes the concept of augmented reality to new heights by seamlessly merging the Pokemon universe with the player's real-world surroundings. Through this innovative approach, Pokemon come alive and appear anchored to the user's environment, providing exciting opportunities for capturing perfect photos and executing skilful throws. In AR+ mode, Pokemon Go brings an added layer of realism to the gameplay experience. Players can approach, walk toward, or even move around these digital creatures by fixing Pokemon to specific points in the real world. The Pokemon in AR+ mode possess an uncanny awareness of the player's proximity and movement, requiring strategic and cautious approaches to maximise successful encounters. In contrast, the AR mode in Pokemon Go detaches Pokemon from the real-world environment, lacking the anchor points and awareness of the player's location and movement found in AR+ mode. The enhanced AR features in Pokemon offer players a captivating and dynamic experience. As they explore their surroundings, Pokemon seemingly inhabit their world, creating magical moments for excellent throws and captivating photos. The fusion of augmented reality with the beloved Pokemon franchise has captivated millions of players worldwide, fostering an engaging and interactive gameplay experience. Like Snapchat AR, Pokemon Go relies on a consistent internet connection to enable the AR features. This requirement may pose challenges in situations where a stable connection is unavailable. Additionally, while Pokemon Go's AR+ mode excels in delivering a unique Pokemon experience, it may need to catch up when compared to dedicated AR applications that offer a broader range of functionalities.

2.2.3 ARFICIO

While undertaking my bachelor's thesis, I discovered an intriguing app called ARFICIO. Although ARFICIO shares some similarities with the goals I aim to achieve, it operates on a partially free model and offers different features. It is worth noting that utilising ARFICIO requires a permanent internet connection. ARFICIO provides users a partially free usage experience, making it accessible to a broader audience. However, in my research, I have observed that ARFICIO may have certain limitations regarding features compared to the specific objectives I seek to fulfil. Nevertheless, it serves as an essential point of reference and inspiration for my endeavours in augmented reality. To obtain more comprehensive documentation on ARFICIO and other AR apps, I recommend conducting further research by referring to articles, reviews, and the official websites of these applications. Incorporating these apps into your bachelor thesis showcases the impact and diversity of augmented reality applications. Snapchat AR revolutionises creative expression and immersion, Pokemon Go captivates gamers with its AR+ mode, and ARFICIO inspires your research journey. By examining these apps and their strengths and limitations, you gain valuable insights into the current landscape of augmented reality and pave the way for your innovative contributions in the field.

Chapter 3

Application description

3.1 Description

3.2 Diagrams

3.2.1 Use cases

Each user that has a smartphone capable to run the AR moduls should be able to use the app. If the user has models already imported he/she can use the app without any connection to the internet. If the user wants to import a new model he/she will need to have an internet connection. The user will be able to import a model using the QR code. The user will be able to see the model in AR mode. The user will be able to see the guide of the model. The user will be able to see the list of all the models that he/she has imported. The user will be able to delete a model from the list of models. The user will be able to see the list of all the models that he/she has imported. The user will be able to delete a model from the list of models.

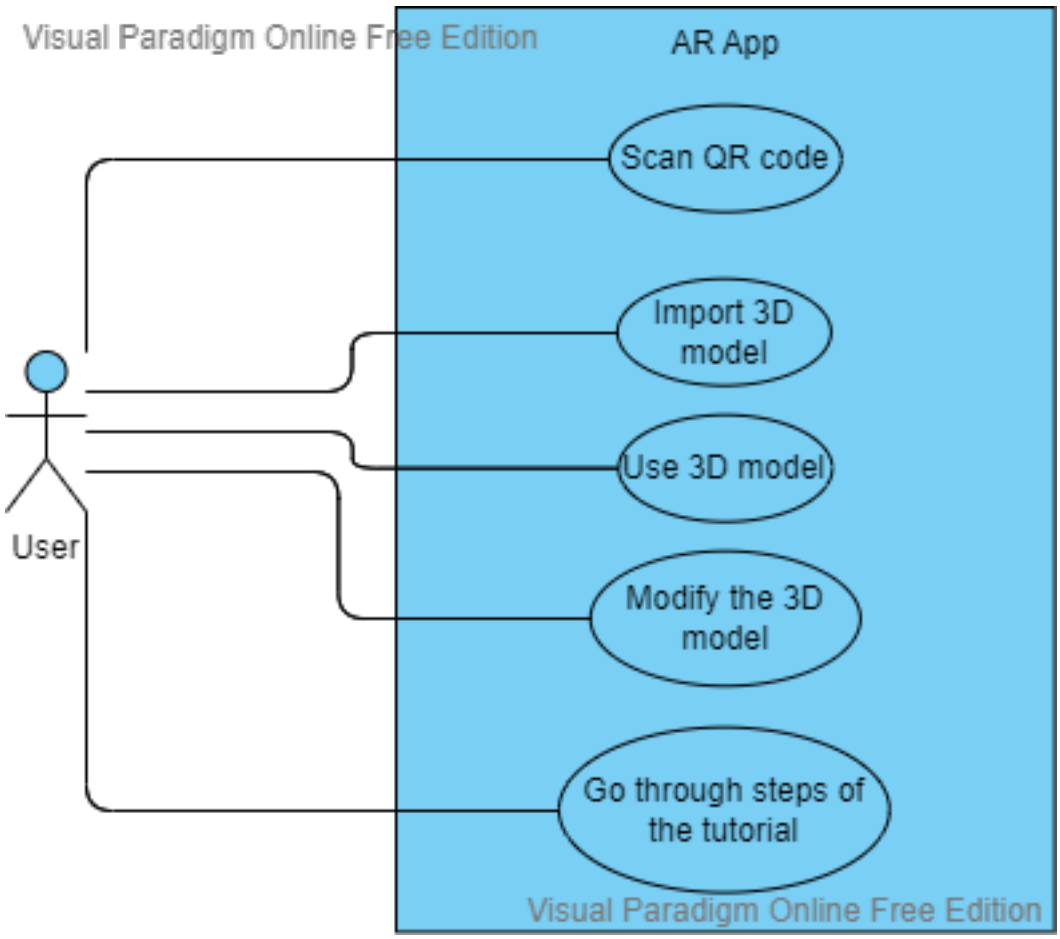

Figure 3.1: Initial use case

3.2.2 Sequence diagram

TEXT TO BE ADDED

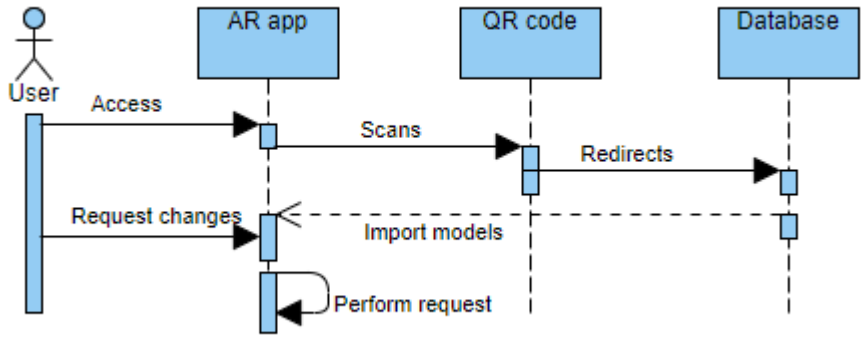

Figure 3.2: Sequence diagram

3.3 Features

3.3.1 Import model

3.3.2 See model in AR

3.3.3 See guide

3.3.4 See list of models

3.3.5 Delete model

3.3.6 Load model from library

3.3.7 Create a scene

3.4 Architecture

The application will be developed using the Android Studio IDE. The application will be developed using the Java programming language. The application will use the Google ARCore framework. The application will use the Firebase cloud database to store the models. The application will use the QR code reader to import the models. The application will use the Google Vision API to recognize the QR code.

- **Android Version 7.0+** - to use the application on the phone
- **Android Studio** - IDE for Android development
- **Firebase** - Cloud DataBase for where the models will be retrieved

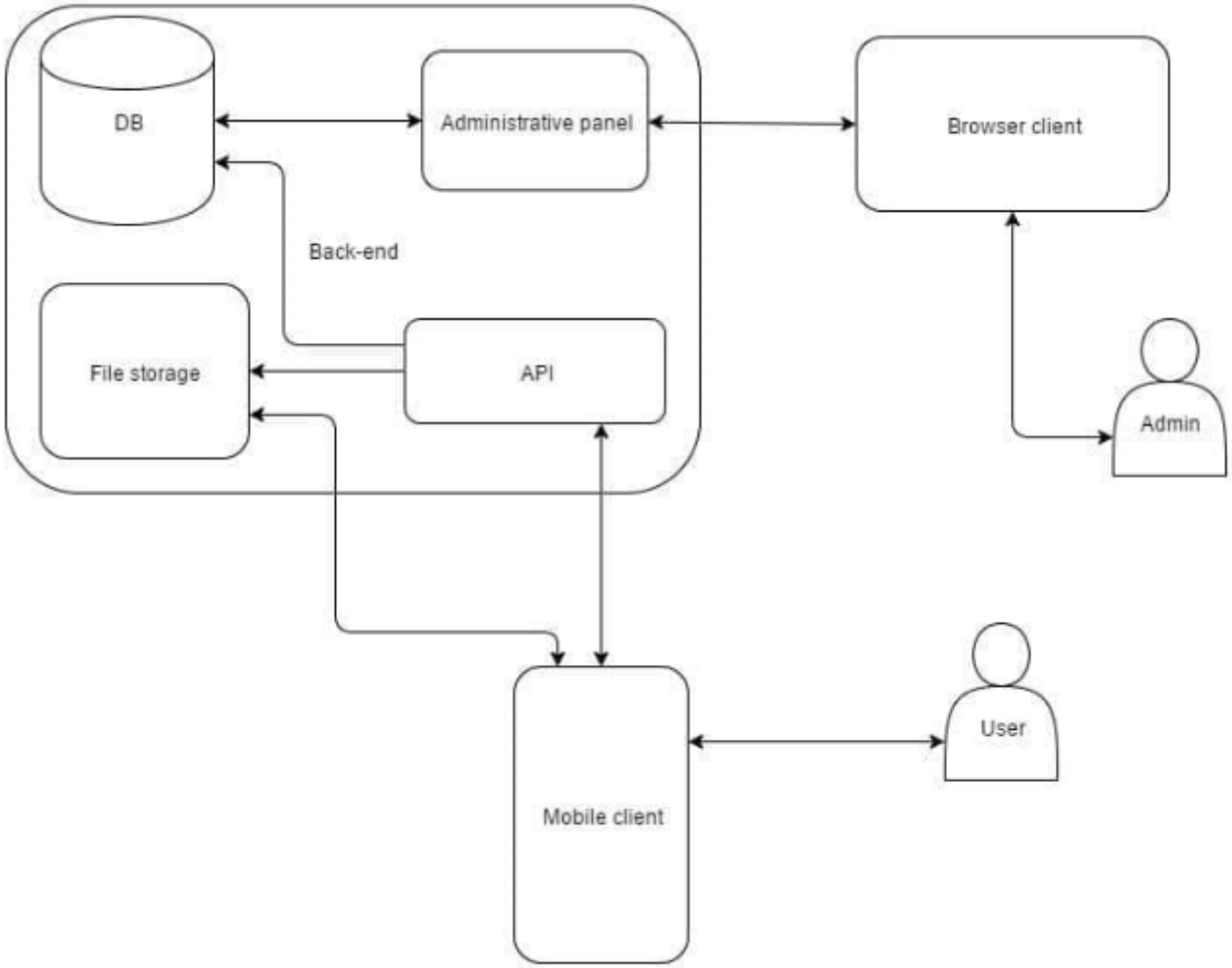

Figure 3.3: Architecture

- **Java** - Programming language
- **Google ARCore** - AR framework

3.5 Implementation

3.6 Testing

3.7 Deployment

3.8 Maintenance

Chapter 4

User Manual

4.1 Requirements

The application can be used in different area of application. The main requirement is to have a smartphone with a camera and a QR code reader. The application is available for Android and iOS. The application is available for free on the Google Play Store and the Apple App Store. The application is available in English and Romnian. The users will be able to import any model in the application using the QR code.

4.2 Graphical overview of RealityEnhance

We will now go through some of the application's graphical user interfaces. This should give a summary of the fundamental flows present in the program and accommodate the user with regard to the interface.

4.2.1 App start page

The fisrt thing any user will see when they lounch the app on their phone is the loading page. This page is a simple loading screen that will be displayed while the app is loading. In the loading phase the app will check if the user is able to run the app on their phone and if the phone has the necessary sensors to run the app. If the user is able to run the app, the app will load the main page. If the user is not able to run the app, the app will display a message that the user is not able to run the app on their phone.

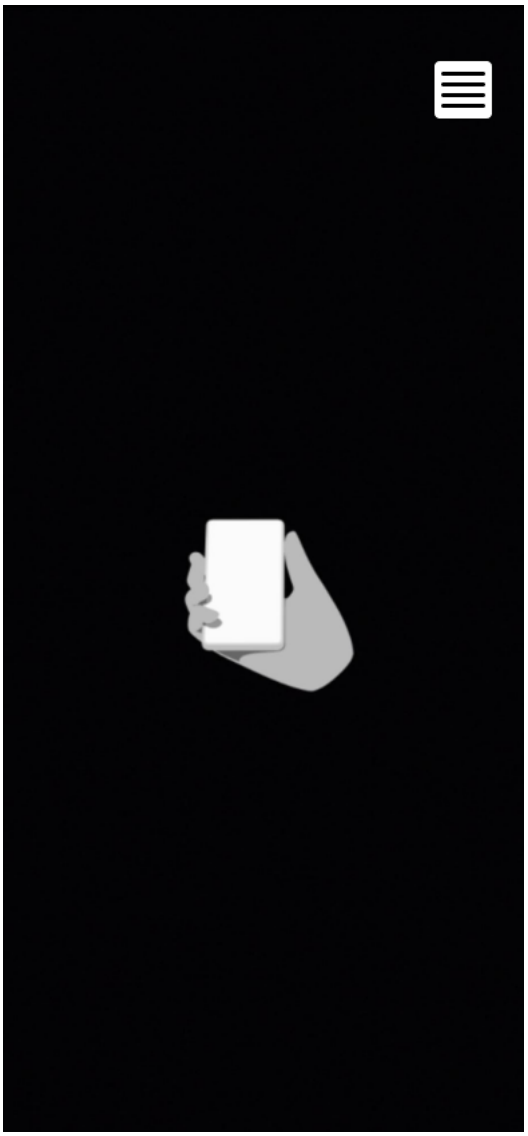

Figure 4.1: Loading page

4.2.2 App burger button

The burger button is a button that is present on every page of the app. It is used to open the side menu. The side menu is used to navigate through the app. In the burger button we have access to the following options: QR scanner, Library, and EXIT. The QR scanner is used to scan a QR code and load a 3D model and a guide into the user's smartphone. The Library is used to display all the 3D models that the user has scanned. The EXIT button is used to exit the app.

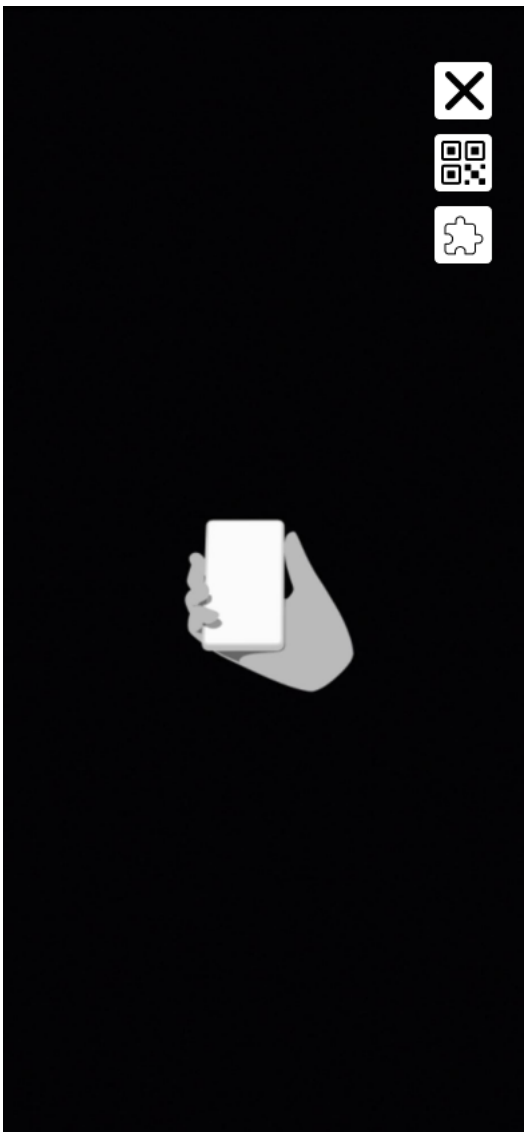

Figure 4.2: Burger button menu

4.2.3 QR scanner

In this mode, on the user's screen will be displayed a camera view. The user will have to scan a QR code. The QR code will contain a link to a 3D model and a guide. The app will download the 3D model and the guide and will display them on the user's screen. The model loaded from the QR code will be ready to use without the need to enter the Library menu. The guide will be displayed on the user's screen and the user will have to follow the guide to assemble the 3D model.

Figure 4.3: QR scanner interface

4.2.4 QR valdiation

If the QR code is valid, the app will display a message that the QR code is valid and will load the 3D model and the guide. If the QR code is not valid, the app will display a message that the QR code is not valid.

Figure 4.4: QR code is valid

4.2.5 AR vision

After a model is loaded, the AR moduls will use the phone's camera to find out what is around the user. It will make a 3D model of the environment and will place the 3D model on top of the environment. The user will have a guide of the app is understanding the surroundings (a mesh of the planes will be displayed on the screen).

Figure 4.5: AR vision interface

4.2.6 Adding a model

After the app has a basic understanding of the surroundings and a model loaded, the user can click on the screen to add an object to the scene. This object will be placed on the screen and the user will be able to move it around the screen. The user will be able to move the object around the screen by press-and-hold the object and moving phone around or draging the object with his/her finger across the screen. The user will be able to rotate the object by rotating the model using two fingers (like opening a bottlle cap(rotating clock-wised) or closing a bottlle cap(rotating counter-clock-wised)). The user will be able to scale the object by pinching the screen. The user is not bound to use just a single object. The user can add multiple objects to the scene and move them around the screen. The user will be able to add another object by clicking on the screen in a place where an object is not present.

Figure 4.6: Adding a model

4.2.7 Removing a model

The user will be able to remove the object by clicking and holding on the object and then clicking on the remove button. The user will be able to remove multiple objects at the same time by clicking on the reset all button.

Figure 4.7: Removing a model

4.2.8 Library

When the user clicks on the Library button in the burger menu, the app will display the Library interface. The Library interface will display all the 3D models that the user has scanned. The user will be able to select a model and load it into the AR vision mode. In the Library interface, the user can search for a model and add a model to the Library. The user can also delete a model from the Library.

Figure 4.8: Library interface

4.2.9 Using multiple models at the same time

The user will be able to use multiple models at the same time. The user will be able to add multiple models to the scene and move them around the screen. The user will be able to add another model by clicking on the screen in a place where an object is not present. The guide for assembling or building a model will be displayed on the screen when in the scene is present just one object.

Figure 4.9: Using multiple models

4.3 Proof of concept

4.4 Domains of application

4.4.1 Interior designing

4.4.2 Outdoor designing

4.4.3 3D printing

4.4.4 Architecture

4.4.5 Pedagogical instrument

Chapter 5

Conclusion

In the concluding chapter, we will summarize the main results of the thesis and we will present future work.

5.1 Summary

5.2 Future work

In this section we will present the future work that will be done to improve the application.

Bibliography