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

## BACHELOR THESIS

**SUPERVISOR:**  
Lect. Dr. Liviu Mafteiu-Scai

**GRADUATE:**  
Sorin-Ionuț Rosalim

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2023

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# Development of augmented reality app as an interactive tool

**SUPERVISOR:**  
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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. The field of immersive experiences allows people to join an enhancing activity.

### **1.2 Why is this relevant?**

Augmented reality is important because it can be applied in any domain. It is widely used in aircraft, military devices, and combat training to head-up car displays and smartphone games.

### **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 and use the camera of the smartphone to visualize a 3D model of an object, follow a guide, and complete assembling that objects in the real world.

### **1.5 What is my contribution?**

My contribution is applying my knowledge and experience to develop a mobile application that uses an AR module to scan a QR code and load a 3D model and a guide into the user's smartphone.



# **Chapter 2**

## **Application description**

### **2.1 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 Romanian. The users will be able to import any model in the application using the QR code.

### **2.2 Description**

## 2.3 Diagrams

### 2.3.1 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.

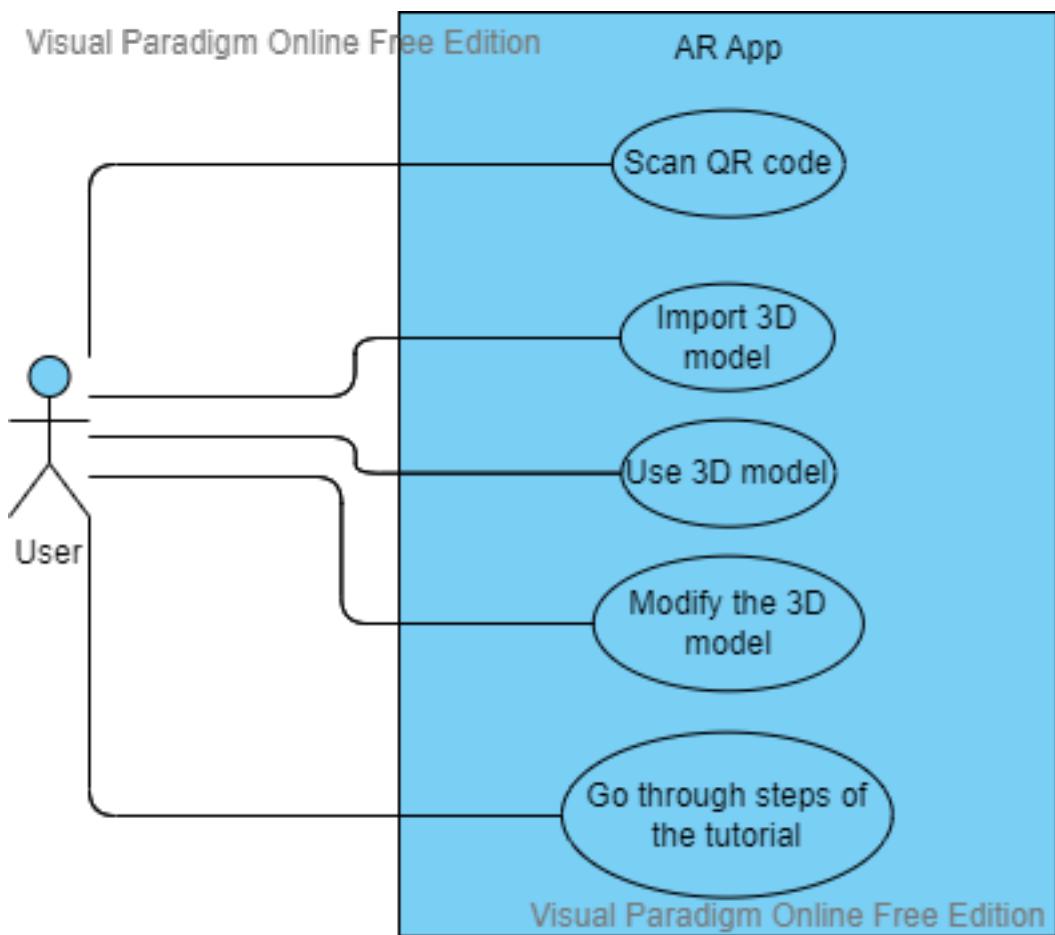


Figure 2.1: Initial use case

### 2.3.2 Sequence diagram

TEXT TO BE ADDED

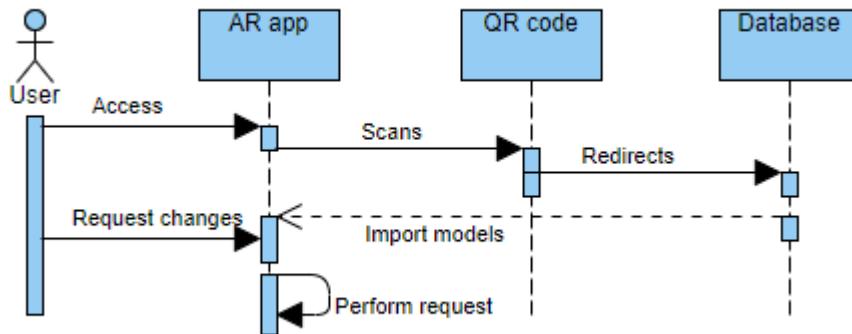


Figure 2.2: Sequence diagram

## 2.4 Features

- 2.4.1 Import model
- 2.4.2 See model in AR
- 2.4.3 See guide
- 2.4.4 See list of models
- 2.4.5 Delete model
- 2.4.6 Load model from library
- 2.4.7 Create a scene

## 2.5 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

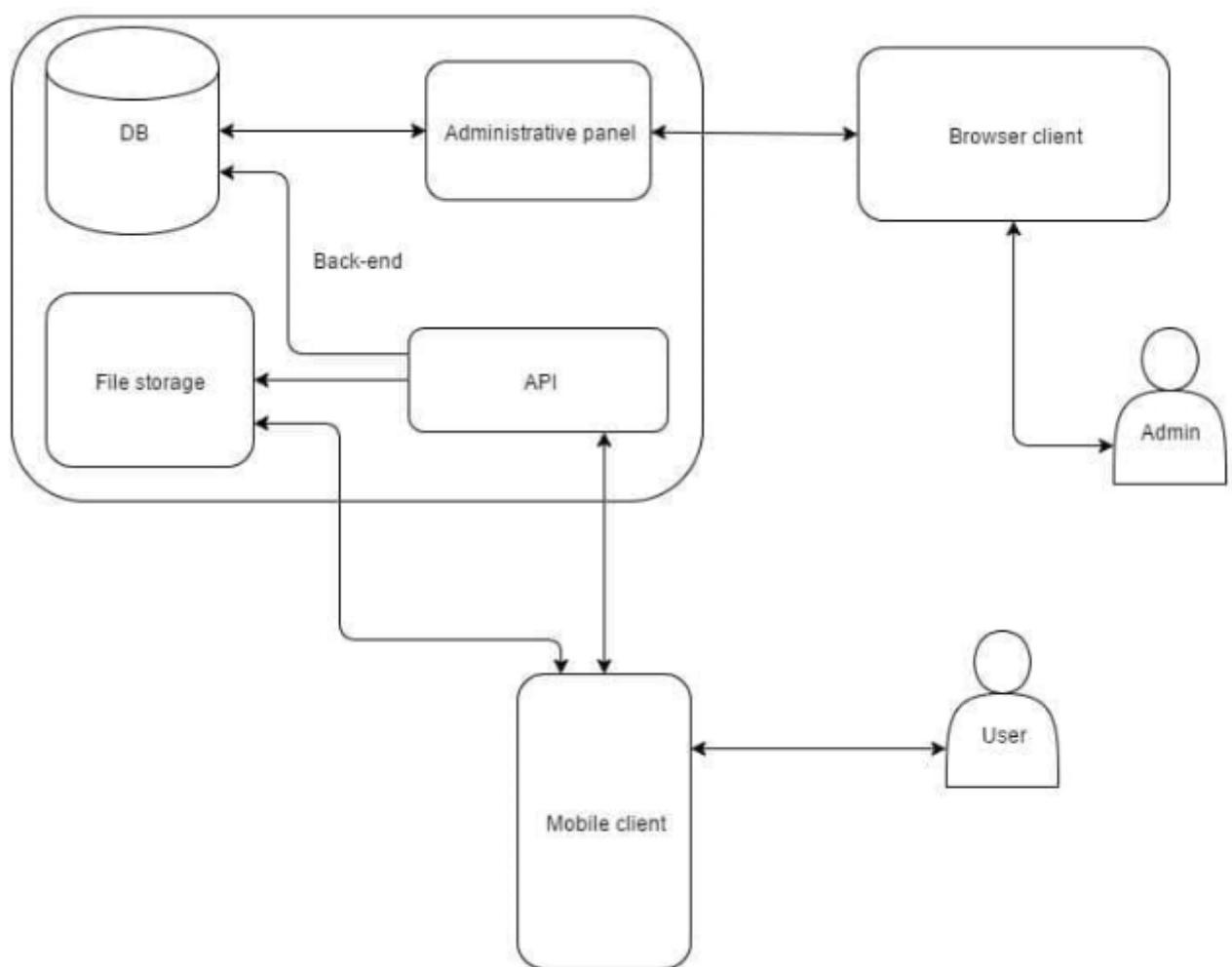


Figure 2.3: Architecture

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

## **2.6 Implementation**

### **2.7 Testing**

### **2.8 Deployment**

### **2.9 Maintenance**



# **Chapter 3**

## **User Manual**

### **3.1 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.

### 3.1.1 App start page

The first thing any user will see when they launch 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.

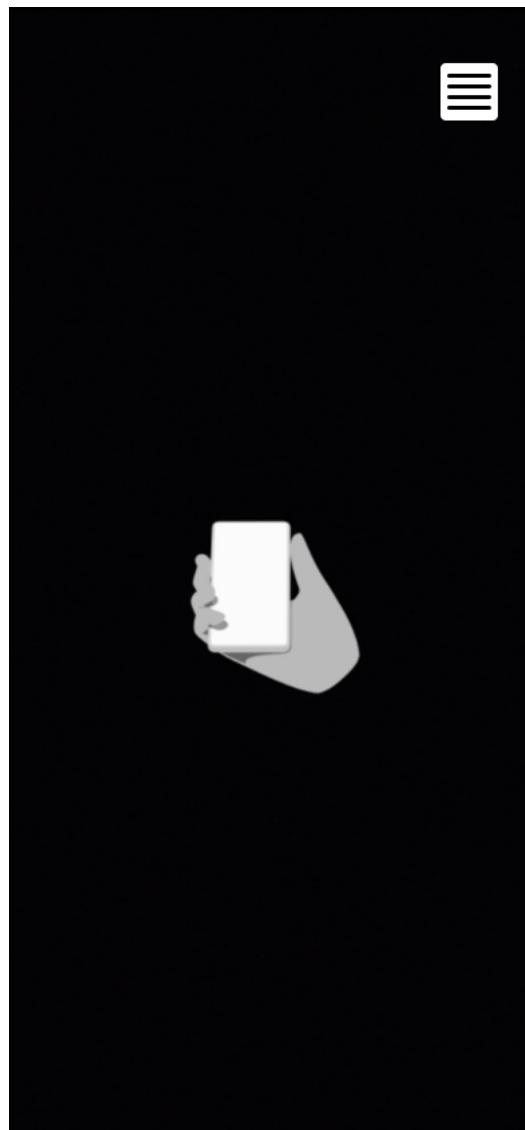


Figure 3.1: Loading page

### 3.1.2 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.

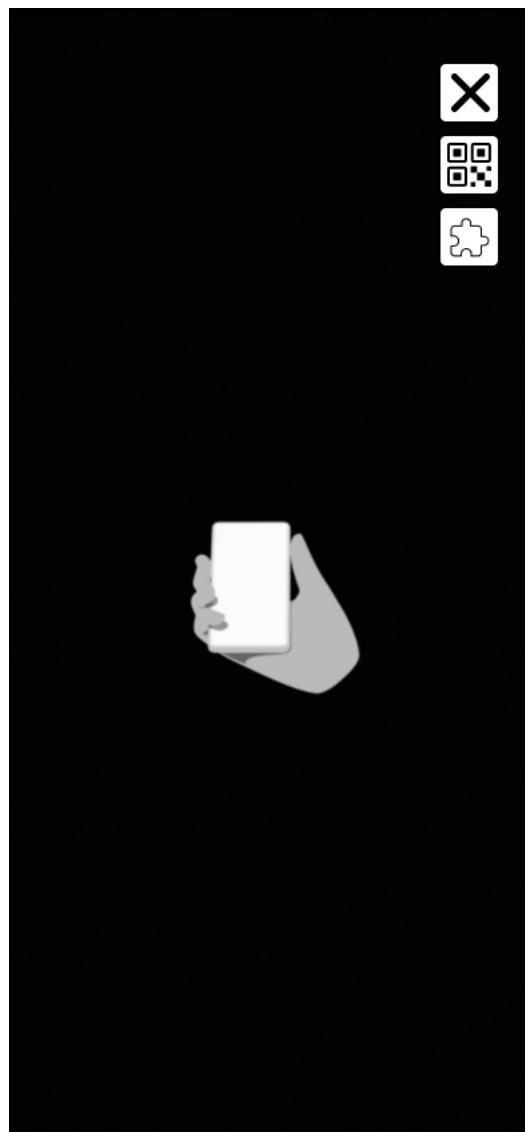


Figure 3.2: Burger button menu

### 3.1.3 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 3.3: QR scanner interface

### 3.1.4 QR validation

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.

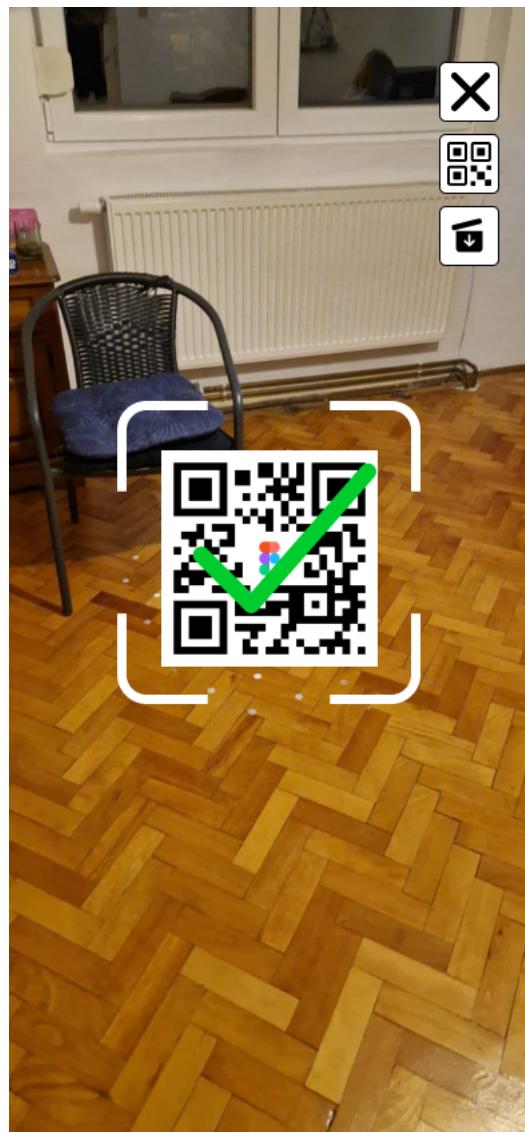


Figure 3.4: QR code is valid

### 3.1.5 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 3.5: AR vision interface

### 3.1.6 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 dragging 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 bottle cap(rotating clock-wised) or closing a bottle 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 3.6: Adding a model

### 3.1.7 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.

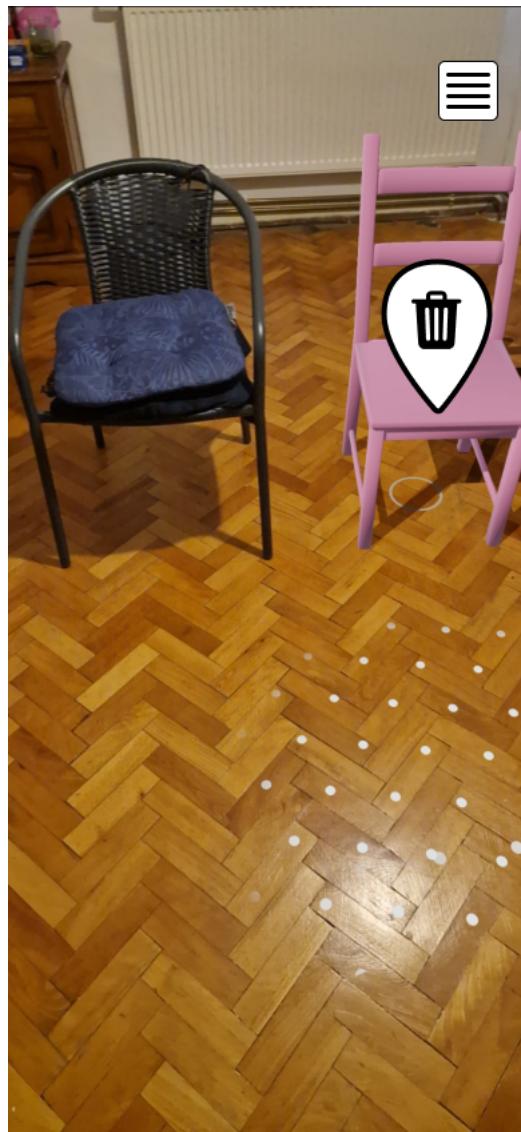


Figure 3.7: Removing a model





### 3.1.8 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.

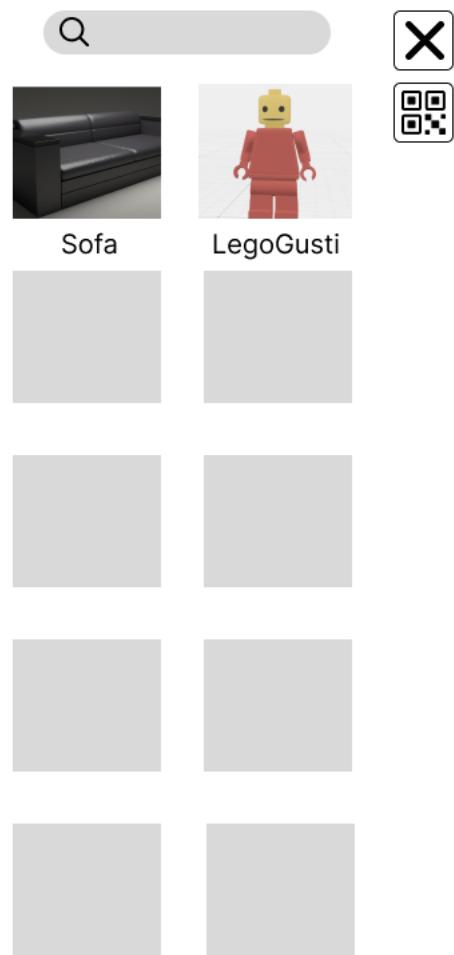


Figure 3.8: Library interface

### 3.1.9 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 3.9: Using multiple models

### **3.2 Proof of concept**

### **3.3 Domains of application**

**3.3.1 Interior designing**

**3.3.2 Outdoor designing**

**3.3.3 3D printing**

**3.3.4 Architecture**

**3.3.5 Pedagogical instrument**



# Chapter 4

## Related Work

### 4.1 Related writings

Deeper Learning With QR Codes and Augmented Reality: A Scannable Solution for Your Classroom

### 4.2 Related apps

#### 4.2.1 Snapchat AR

Snap AR enables creators around the world to revolutionize the way we create, explore, and play. The AR Bar has special Lenses and helps you scan the world for useful info! Tap the Camera screen to open the AR Bar. The AR Bar has the following options: Create: Choose from a selection of special Lenses you can edit and change!

Snapchat has continued to democratize the process of creating AR Lenses with their Web Lens Builder and Lens Studio tools. With the addition of real-world physics and real-time data integrations, they've improved the realism of their AR to offer a more immersive experience.

Pros:

Wide range of special Lenses to choose from Real-world physics and real-time data integrations improve the realism of AR Web Lens Builder and Lens Studio tools make it easy for creators to make their own Lenses Cons:

May require a permanent internet connection Limited functionality compared to other AR apps

#### 4.2.2 Pokemon Go

LINK: Pokemon Go AR mode AR+ mode is an enhanced version of Pokémon GO's augmented reality feature in which Pokémons appear anchored to your real-world environment right in front of you. You can walk right up to a Pokémon for a chance at an Excellent Throw bonus or the perfect photo opportunity. Pokémons are aware of your movement, so proceed with caution. Move toward a Pokémon too fast and you'll scare it away...but approach slowly, and you'll have a better chance at catching it.

AR+ mode displays Pokémons fixed to a point in your real-world environment. Pokémons appear on the ground in front of you. You can walk toward or around the Pokémons. Pokémons have awareness of how close you are and how fast you are moving toward them.

AR MODE: Pokémons are not fixed to your real-world environment in AR mode. Pokémons do not have awareness of the Trainer's location or movement.

Pros:

Enhanced AR feature with fixed point of Pokémons in real-world. Pokémons have awareness of player's location and movement. Excellent Throw bonus and photo opportunity for players.

Cons:  
May require a permanent internet connection. Limited functionality compared to other AR apps.

### 4.2.3 ARFICIO

This app is similar with what I'm trying to do but is partially free and doesn't have the same features as I want to have. I believe that you need to have a permanent connection to the internet.

Pros:

Partially free.

Cons:  
Limited features compared to what I am trying to do. Permanent internet connection may be required.

LINK: ARFICIO pricing  
Note: To find more documentation on ARFICIO and other AR apps, you may want to search for articles and reviews online or visit the official website of the app.

# **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