Bilkent University

Department of Computer Engineering

Senior Design Project

craftual: a 3D model viewer and an asset management, presentation-based cloud platform

Analysis Report

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This report is submitted to the Department of Computer Engineering of Bilkent University in partial fulfillment of the requirements of the Senior Design Project course CS491/2.

Table of Content

1. Introduction

Presentations are an important part of work life that help people explain ideas, concepts and topics either for educational purposes or for other work related purposes. A survey conveyed with people working on different areas showed that 92% of the employees believed that presentation skills are critical for success at work. Yet 75% of adults are estimated to be affected by public speaking hindering their ability to be successful.[1] Aiming to help people affected by this condition we thought of ways to reduce their fear by boosting their confidence. The best tool to do this is to help people create a more unique and well-designed presentation. Research showed that 91% of people felt more confident during presentations when they were presenting with a well-designed slide deck.[2] The traditional presentation is made using Microsoft Powerpoint and consists of text and usually stock images. However, an estimated 79% of employees find these presentations boring and they claim that they often lose their concentration after the first 10 min. A novel approach that would increase the interest of people on these presentations is using 3D presentations in combination with AR technology. This technology could be used on the creative stage as well as the presentation of the final product. The interactive interface would allow the user to observe how small changes would affect the overall design of the product since all the components are in the appropriate ratios. Being able to easily see how minor or major changes influence the final product is a huge benefit regarding efficiency as it will prevent costly adjustments that were not foreseen. Easy remodelling and editing makes more accurate designs which means less cost and time invested. The 3D product presentation would offer a much more vivid depiction of the product that a 2D presentation could ever depict.

2. Current System

There are a few systems such as Jigspace and Brio that offer services similar to our proposed solution.[3,4] The main issue with these systems is that the users have to create all the 3D models themselves which could be time consuming and introduce unnecessary work. We intend to simplify the user experience by also introducing a marketplace where users can share their designs. Using this feature we expect to create an environment where everyone will be able to have access to various models and integrate them to their own projects.

3. Proposed System

3.1 Overview

craftual, is a 3D model viewer and an asset management, presentation cloud platform. With craftual users can visualise and inspect 3D models on mobile devices with Augmented Reality (AR) by intuitive hand gestures and navigations and can create presentations compatible with AR.
The aim of our project is to create a new and interactive tool to enable users to create unique presentations, which in turn will also increase the confidence of the presenters. The main difference between craftual and similar applications will be the online marketplace for 3D models. After a user has created a presentation of a 3D model, they can choose to either keep it private or make it available to the public. Using this feature, users will have access to already built models and can later integrate those models on their own presentations. First time users will be required to sign up for an account on craftual. During the sign up process the users will be required to provide some basic information such as name, surname, email and password. The users can also enter a username so that they can remain anonymous if they wish to do so. User data will be stored in a Cloud-Based database for security and reliability issues. Users will be able to upload a 3D model to their account. The supported 3D model formats include obj, fbx, usdz and gITF. The user will be able to create a step by step presentation by uploading various models to their project or by using keyframes to save specific positions or states of the model. After their presentation is complete the user will be able to share it based on a few available options. The user can choose to keep the presentation private and only share with a few other users, or they can choose to make it available to all the users of the application..

3.2 Functional Requirements

- Anyone with a valid email will be able to create a craftual account. Users can enter a username if they wish to remain anonymous.
- The application will have a short tutorial that will help the user get started on their projects.

3.2.1 Creating 3D Content

- craftual shall allow automatic generation of 3D models from CAD drawings
- craftual shall accept the following 3D model and animated 3D model input formats:
    - AutoDesk (OBJ, FBX)
    - Khronos Group (glTF)
    - Apple Pixar (USDZ)

3.2.2 Deployment of Software

- *craftual* shall allow the user to access from browser by supporting all of the below
    - Chrome
    - Firefox
    - Edge
    - Safari
- craftual mobile application shall be deployed to digital distribution platform listed all of the below:
    - Google Play
    - App Store

3.2.3 Ease of Use

- *craftual* shall have a user interface that can be learned by non-software literate users.
- Users can browse through a collection of models and presentations that have been shared by other users.
- Users can filter models based on categories, new or archived.
- Users can Archive a model shared by another creator to be viewed later.
- Users can access 3D models shared by other users.
- Users can create presentations using the 3D models they have available on their account. They can create keyframes to save a certain position or state of the model.

3.2.4 Zoom

- craftual shall allow the user to pinch finger tips together to zoom in.
- craftual shall allow the user to pull finger tips apart to zoom out.

3.2.5 Social

- Users can share their models and presentations with friends or all the users of craftual.
- Users can download the models and presentations from their account or ones that have been shared by other creators.
- Users can view the model and presentation they have access to, using a device with a camera that supports AR technology.
- Users can message other users.
- *craftual* shall support the user to comment, like and share the graphical assets that are publicly visible.

- *craftual* shall support the user to download the 3D model and animated 3D models in the all of the formats below
    - AutoDesk (OBJ, FBX)
    - Apple, Pixar (USDZ)
    - Khronos Group (glTF)

3.2.6 Interactions

- craftual shall allow the user to rotate 3D content.
- craftual shall allow the user to:
    - Rotate fingertips to rotate 3D content
    - Utilize a single finger sliding left/right/up/down to rotate 3D content
- craftual shall support the ability for the user to lock the 3D AR content view.

3.2.7 Asset Storage

- *craftual* shall allow the user to select content storage by supporting all of the below.
    - Local (on the smart device or desktop)
    - Cloud-Based

3.2.8 Field of View

- *craftual* shall support devices that provide 85 degree field of vision in both directions (vertical and horizontal) where AR content can be displayed.

3.2.9 On-board Storage

- *craftual* shall support devices that have a minimum on-board free memory storage of 256 MB.

3.2.10 On-board OS

- *craftual* shall support Apple devices with iOS 11.0 or later and an iOS device with an A9 or later processor.
- *craftual* shall support Android devices with Android 8.0 or later and Android devices with x86 or x86_64 based AVD processor.

3.2.11 Display

- *craftual* shall support mobile devices with a minimum resolution of 1920x1080.
- *craftual* shall support mobile devices with a minimum of 60Hz refresh rate.

3.3 Nonfunctional Requirements

3.3.1 Usability

- The application will be targeted to designers and general users alike so the application should be simple and easy to use. After a short tutorial every user should be able to use the full functionalities of our application.
- Craftual will be available for usage on the web and mobile version. The web app will be supported by the main browsers including Chrome, Firefox, Edge and Safari.The mobile application will be available on the App Store and Google Play.
- User can choose to cache their 3D models and presentations to their device so they can access it while offline as well.

3.3.2 Reliability

- Craftual shall reside in Cloud-Based systems for high availability
- User data and content will be stored in the Cloud-Based System to ensure data availability and consistency.
- Users will receive messages in real time.
- The payment made via our application should be safe and reach their target destination.

3.3.3 Security

3.3.3.1 User Authentication

- craftual shall store passwords of the user with a combination of hashing and salting.
- craftual shall provide 2-factor authentication.

3.3.3.2 Sanitizing and Validating User Input

- craftual shall sanitize the input from interactive form fields to prevent database injections and cross-site scripting (XSS) attacks.

3.3.3.3 Data Exposure

- craftual makes sure that any model that is shared privately, cannot be seen and modified by other users.
- craftual shall have an SSL Certificate (HTTPS) to ensure the protection of user-data.

3.3.4 Performance

- craftual shall provide an efficient loader for 3D contents.
- craftual shall provide responsive and low latency user-interface.
- craftual shall provide high performance rendering of the 3D models to offer real-time inspection to the user.

3.3.5 Scalability

- craftual shall handle multiple simultaneous uploads and downloads from multiple users by efficiently utilizing the network I/O.
- Even though the number of users logging into the system is excessive, the system takes care of these requests without getting into a bottleneck.

3.4 Pseudo Requirements

- React.js and React Native will be used to build the front end of the application.
- Visual Studio Code will be used to develop our application.
- The application will reside in a AWS Services
- NoSQL based system will be used as our database.
- ARCore and ARKit will be used to develop and present 3D models.
- Git and Github will be used to keep track of our project.
- Craftual be available for free to all users.
- Craftual mobile app will require an internet connection to load or download models and presentations.

3.5 System Models

3.5.1 Scenarios

USE CASE User Creates Presentation

Participating Actor:	User
Entry Conditions:	User is in dashboard and click on the “Create Presentation” button
Exit Conditions:	User finishes creating presentation and download it if he/she wants
Flow of Events:	1. User press “Crete Presentation” button 2. Users select modes from various options like uploading,browsing models to present. 3. User rearranges the model position, dimension, size etc. 4. User presses the “Finish Presentation” button.
Special Requirements:	None.

USE CASE User Browse Model

Participating Actor:	User
Entry Conditions:	User is on the main page and clicks the “Browse” or as a model selection when creating the presentation.
Exit Conditions:	User presses the “X” button on the top corner.
Flow of Events:	1. User press “Browse” button 2. User can see various models of other users . 3. User can see categories of models. Also he/she can filter or search models from the Browse section. 4. User can see the details of the model by clicking it. 5. Models can be archived from here. 6. Users can make comment on models
Special Requirements:	None.

USE CASE User Upload Model

Participating Actor:	User
Entry Conditions:	User is on the main page and clicks on the “Upload Model” button or as a model selection when creating the presentation.
Exit Conditions:	User uploads the model successfully.
Flow of Events:	1. User presses the “Upload Model” button. 2. Users can upload their model into our system by dragging and dropping the model to the upload frame. 3. User enters the description and type of the model. Then, he/she makes it public or private. 4. User presses the “Save” button.
Special Requirements:	Model type must match the types in our system.

USE CASE User Make Comment

Participating Actor:	User
Entry Conditions:	User clicks any model from the browse section and then goes to the comment section.
Exit Conditions:	User presses the “Make Comment” button.
Flow of Events:	1. User presses any model to see details. 2. User writes his comment on the text field. 3. User can also see other comments. 4. User presses the “Make Comment” button.
Special Requirements:	The model to be commented on must be public.

USE CASE User Download Model

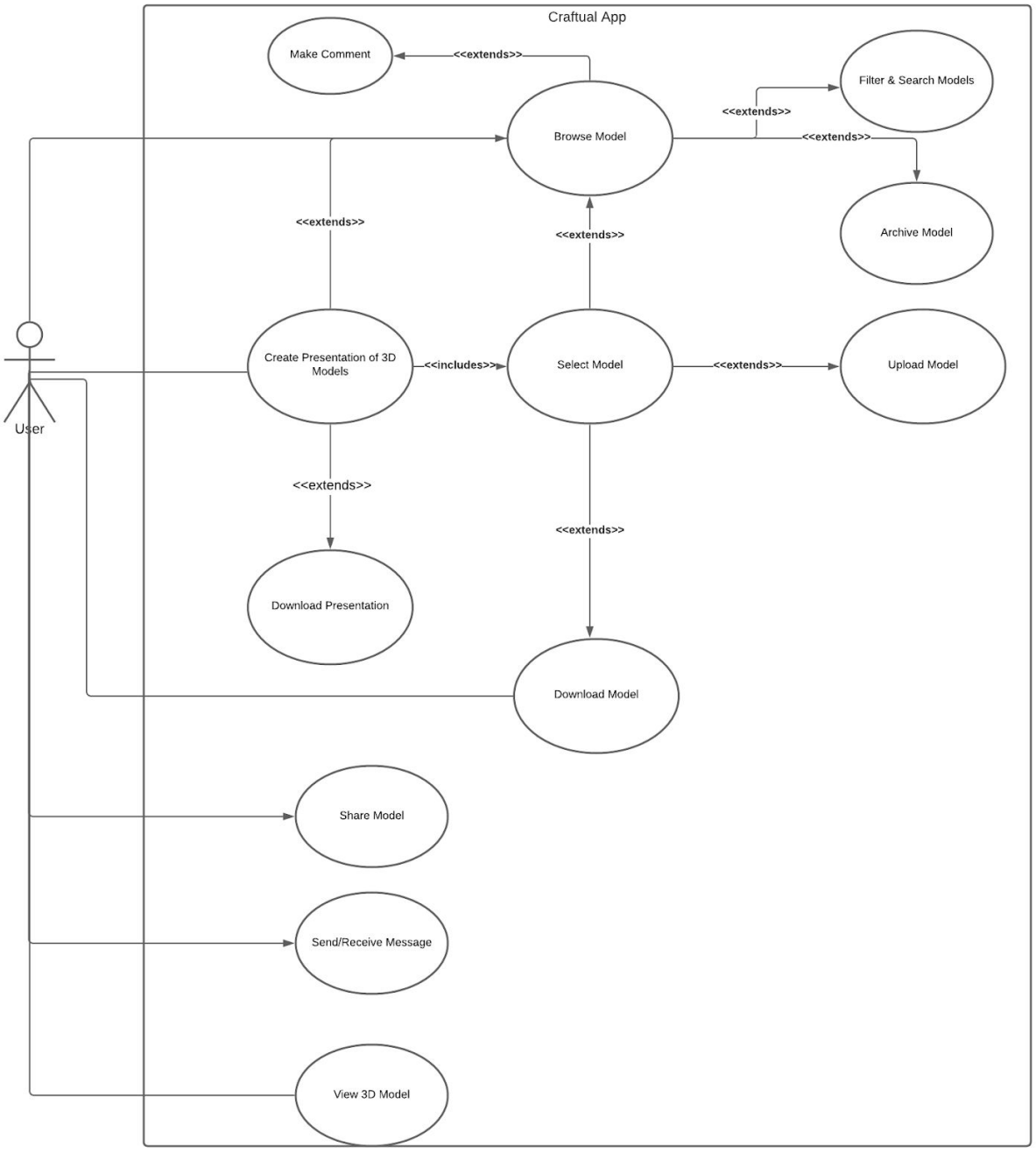
Participating Actor:	User
Entry Conditions:	User clicks any model either from browsing or from their own models
Exit Conditions:	User presses the “Finish” button.
Flow of Events:	1. User presses any model to see details. 2. User clicks on “Download Button” 3. User selects a format to be downloaded. 4. User chooses a location to download the model. 5. User presses the “Finish” button.
Special Requirements:	None

USE CASE User Archives Model

Participating Actor:	User
Entry Conditions:	User clicks any model and presses the “Archive Model” button.
Exit Conditions:	User archives the model successfully.
Flow of Events:	User finds a model to archive. Models can be found by browsing, searching or looking at categories.

	User clicks the model to see details. User presses the “Archive Model” button.
Special Requirements:	None.

3.5.2 Use Case Model



3.5.3 Object and Class Model

3.5.3.1 Login Package

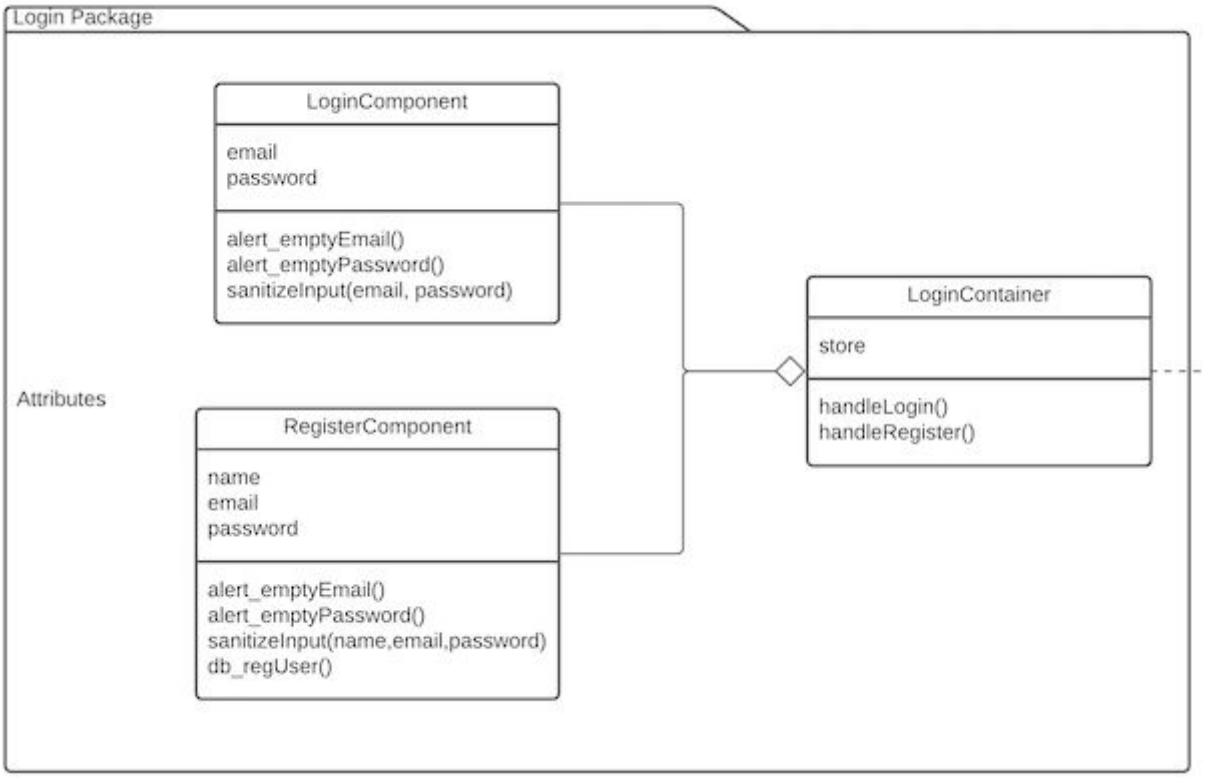


Figure 4. Login Package

3.5.3.2 Settings Package

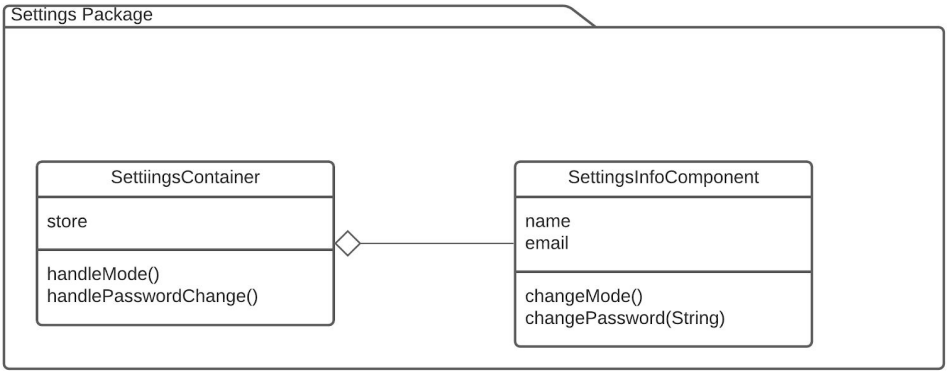


Figure 5. Settings Package

3.5.3.3 Explore and Profile Package

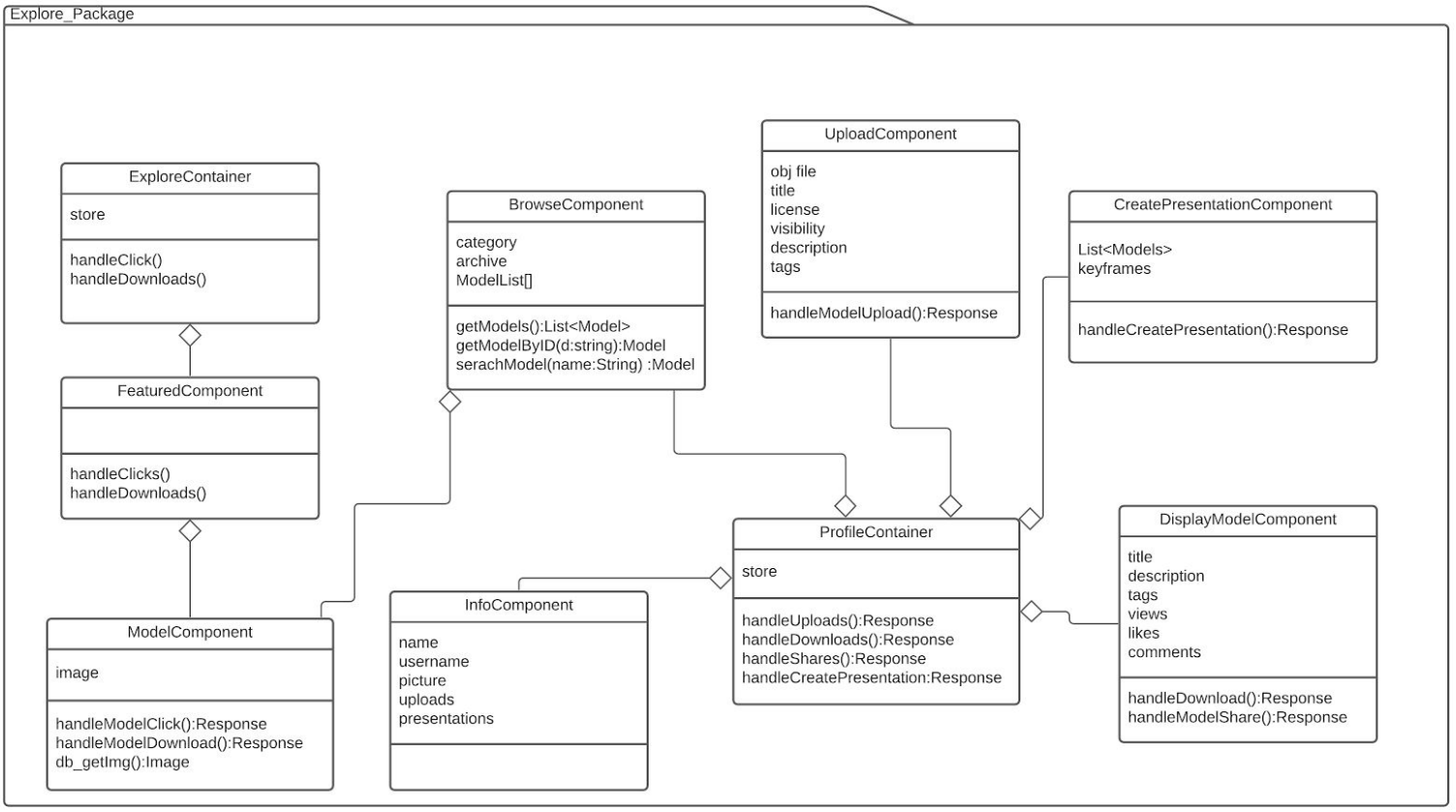
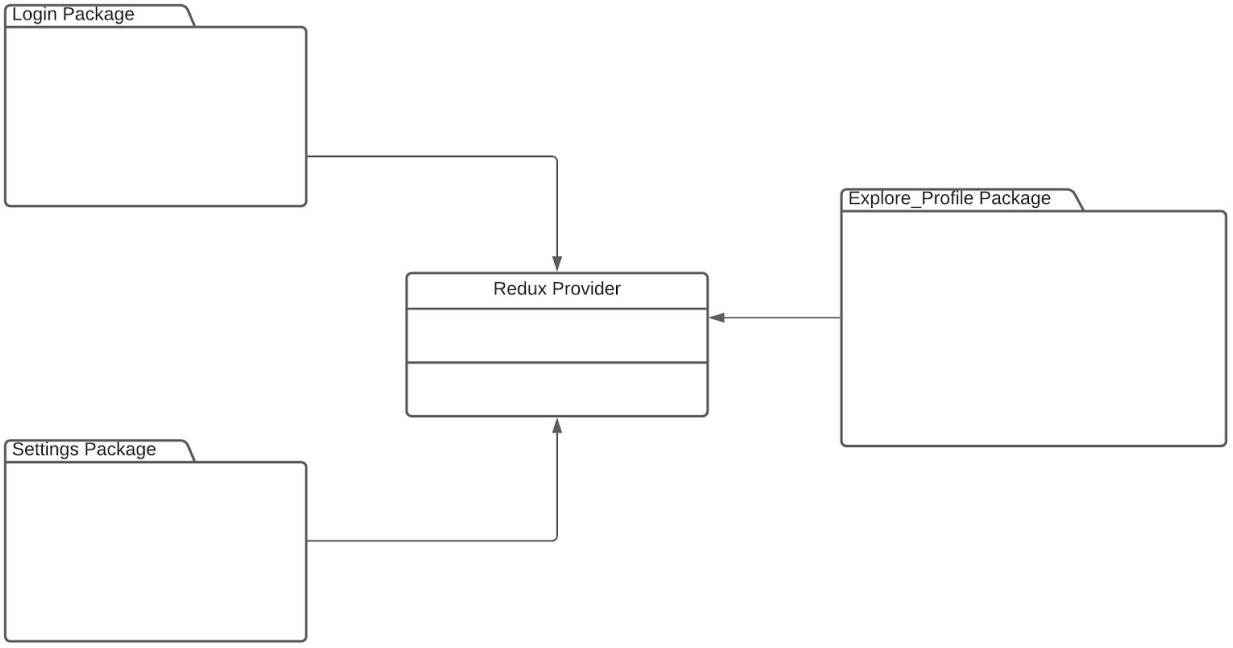


Figure 6. Explore and Profile Package

3.5.3.4 Complete Diagram



3.5.4 Dynamic Models

3.5.4.1 Flowchart Diagrams

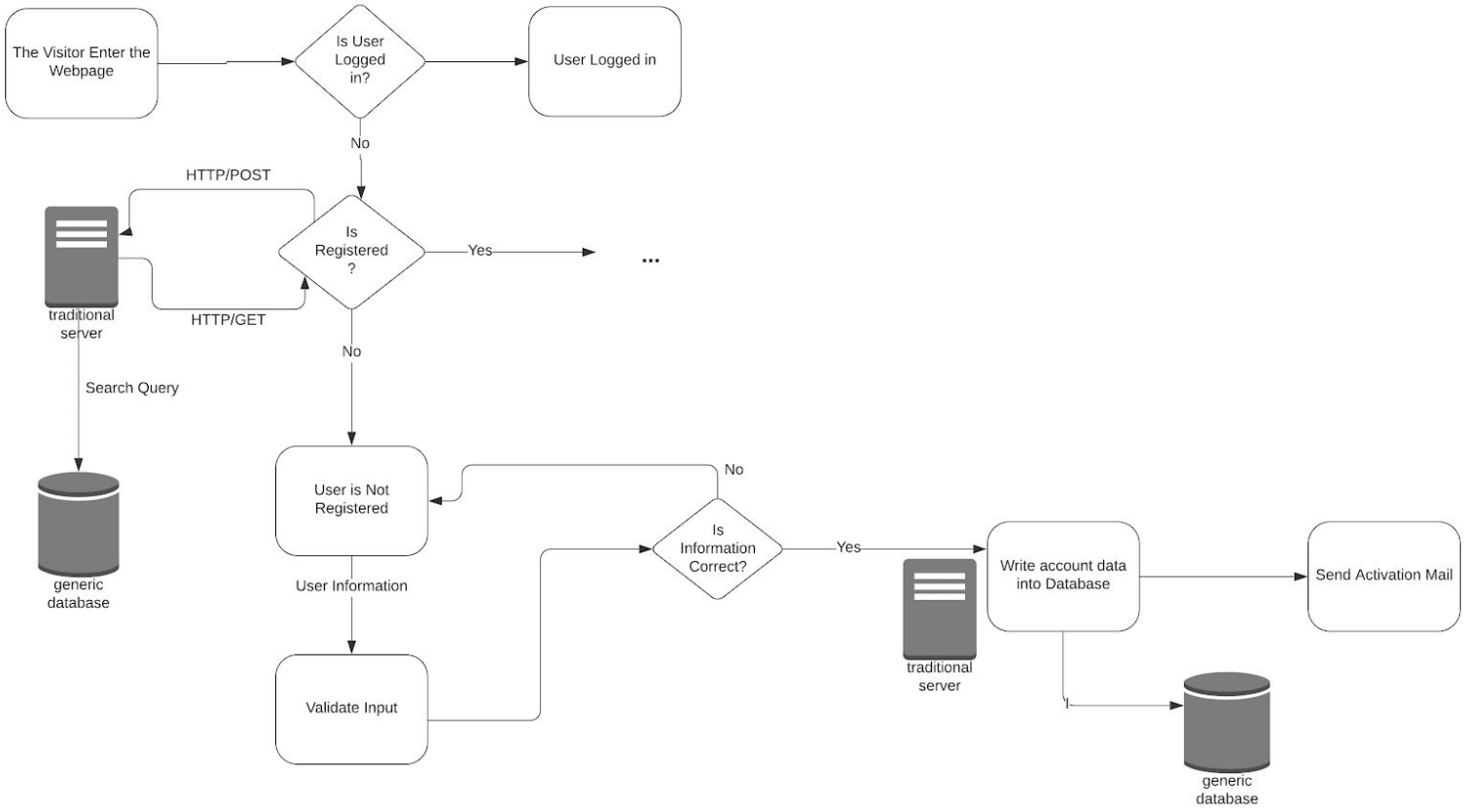


Figure 1. User Registration

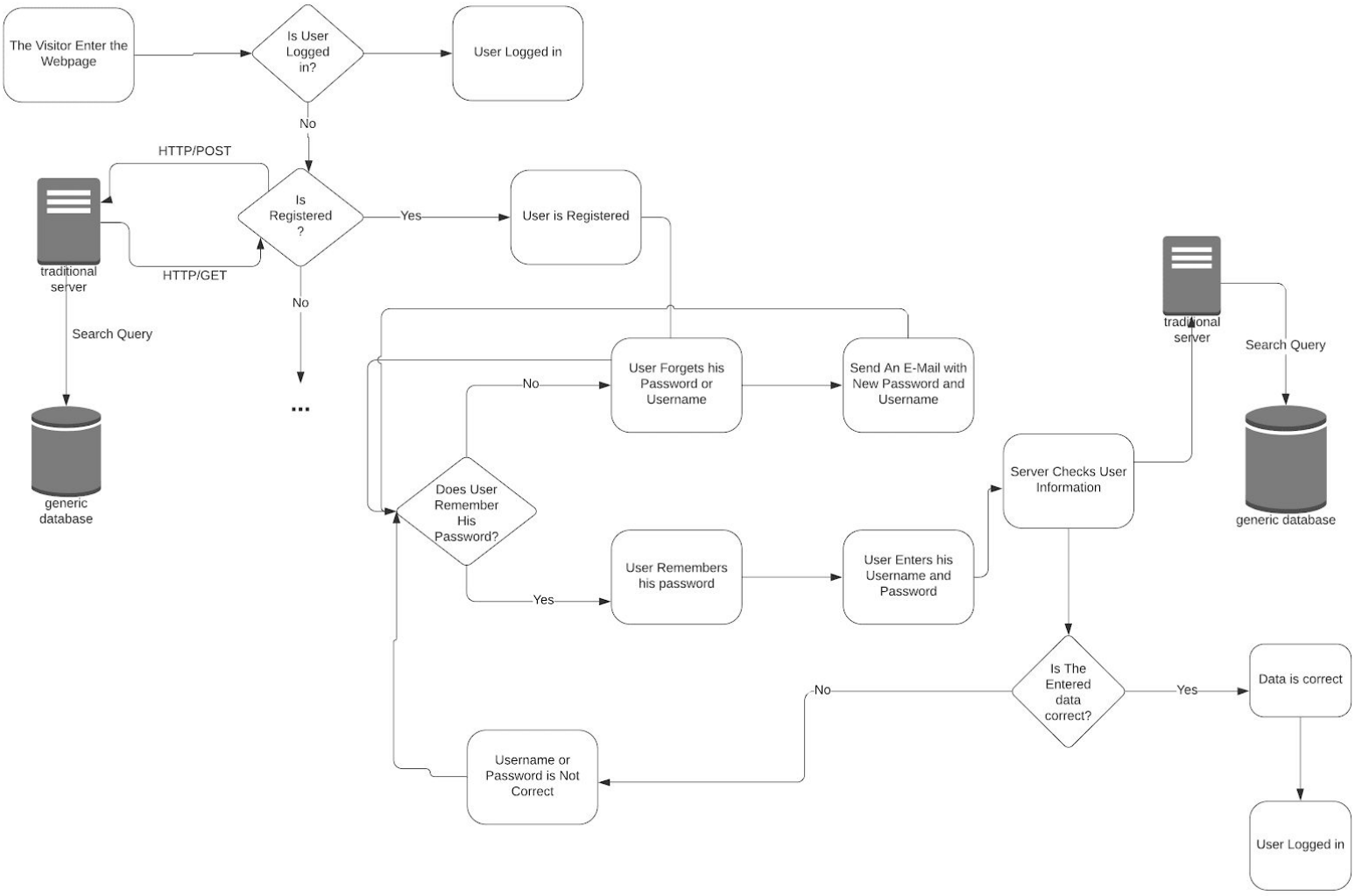


Figure 2. User Login

3.5.4.2 Sequence Diagrams

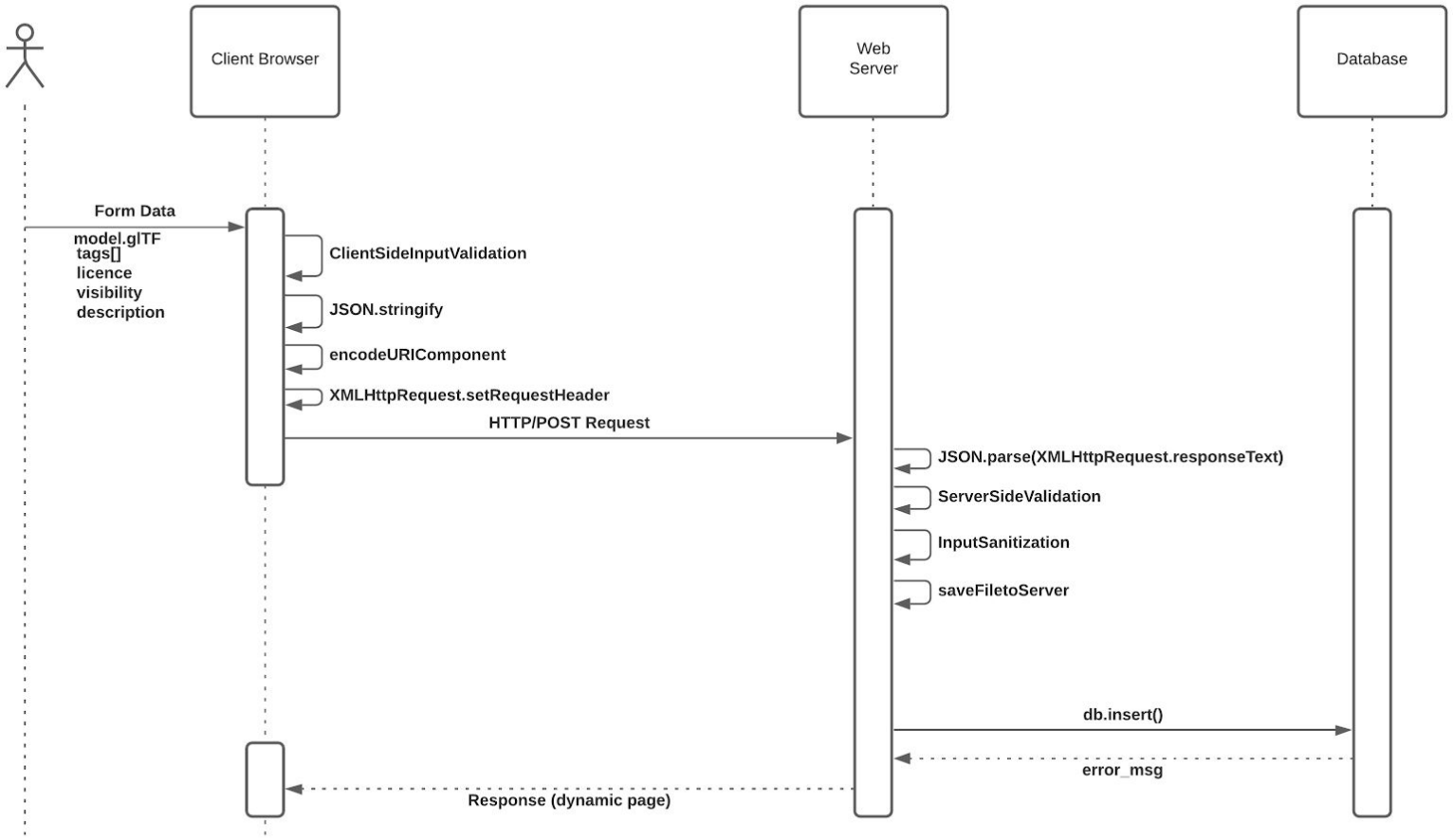


Figure 6. Upload Model Sequence Diagram

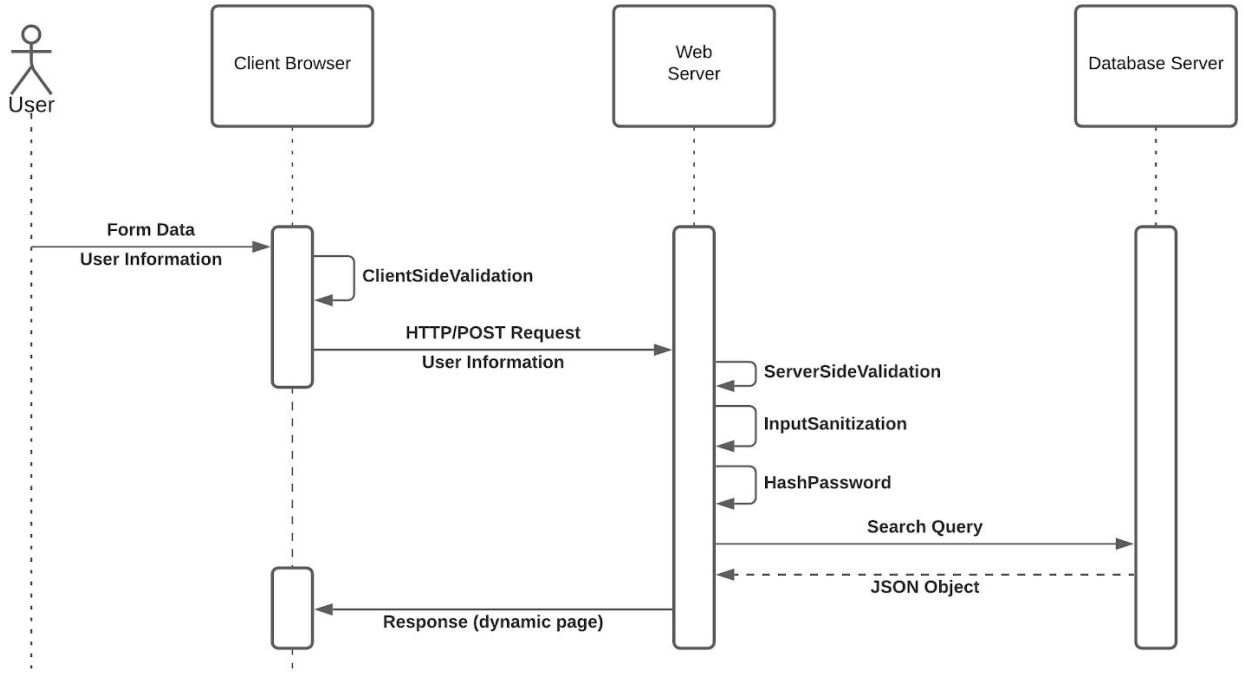


Figure 7. User Login Sequence Diagram

3.5.5 User Interface - Navigational Paths and Screen Mock-ups

3.5.5.1 Landing Page

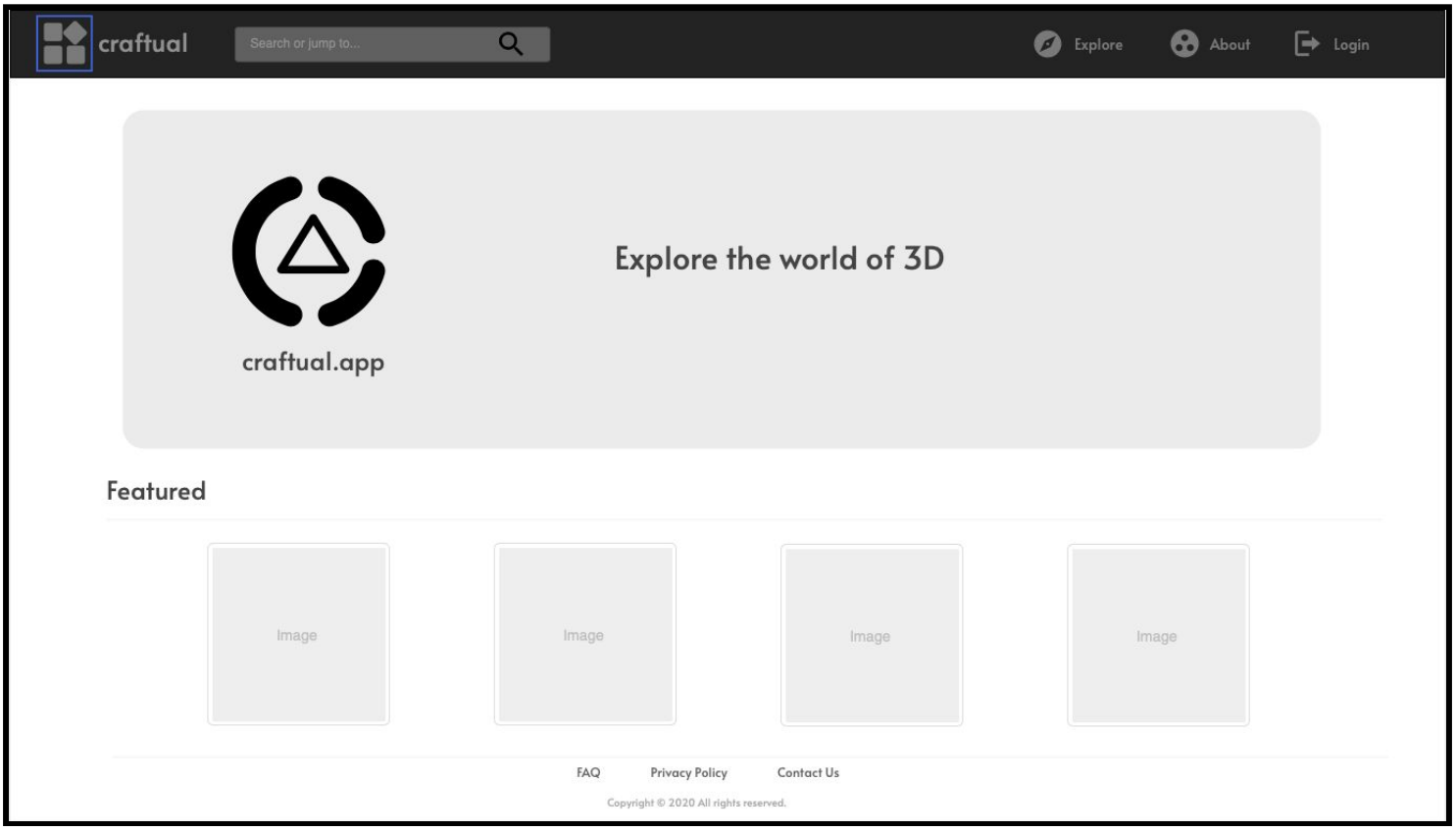


Figure 8. Landing Page

3.5.5.2 Browse Page

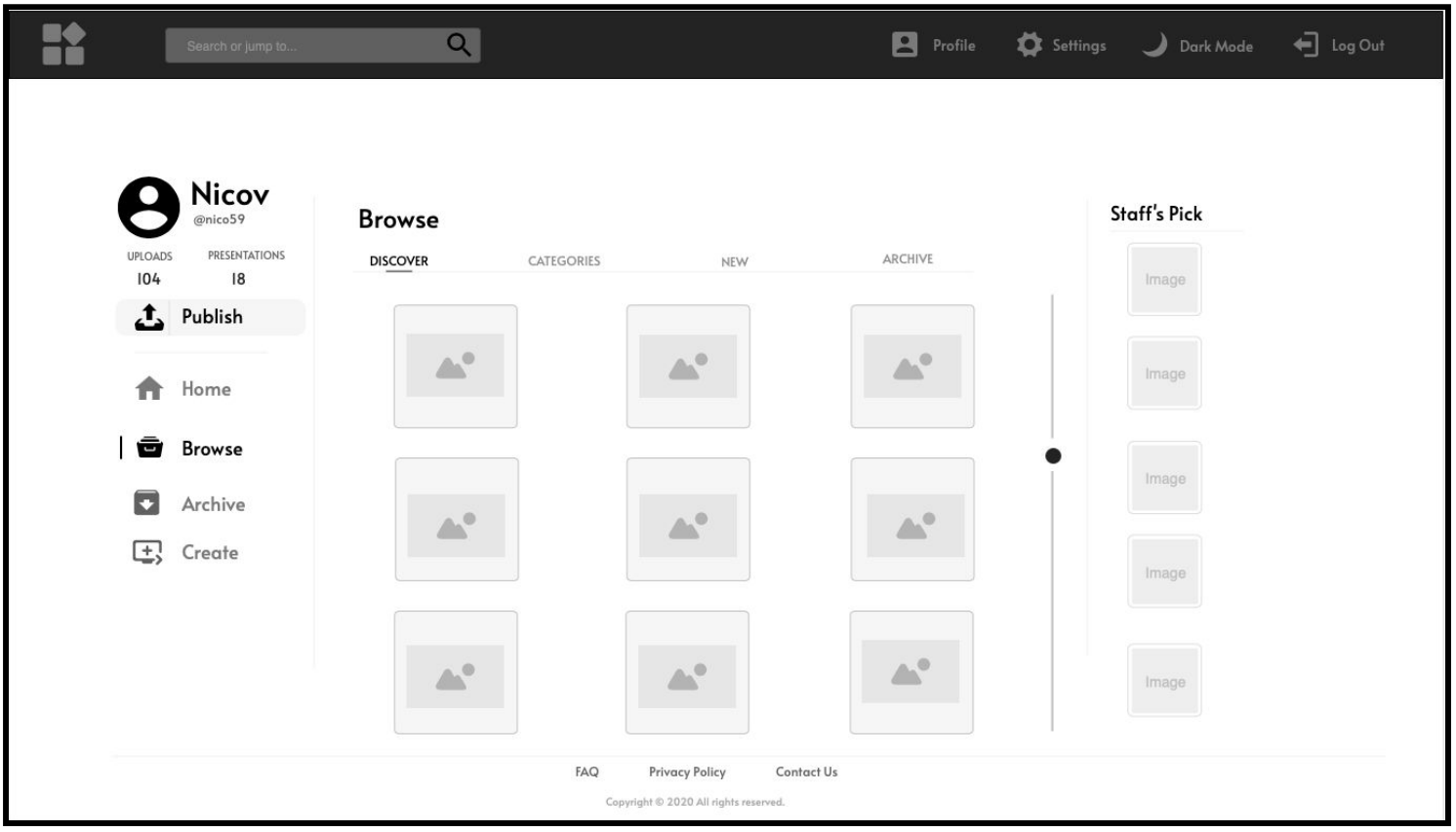


Figure 9. Browse Page

3.5.5.3 Model Viewer Page

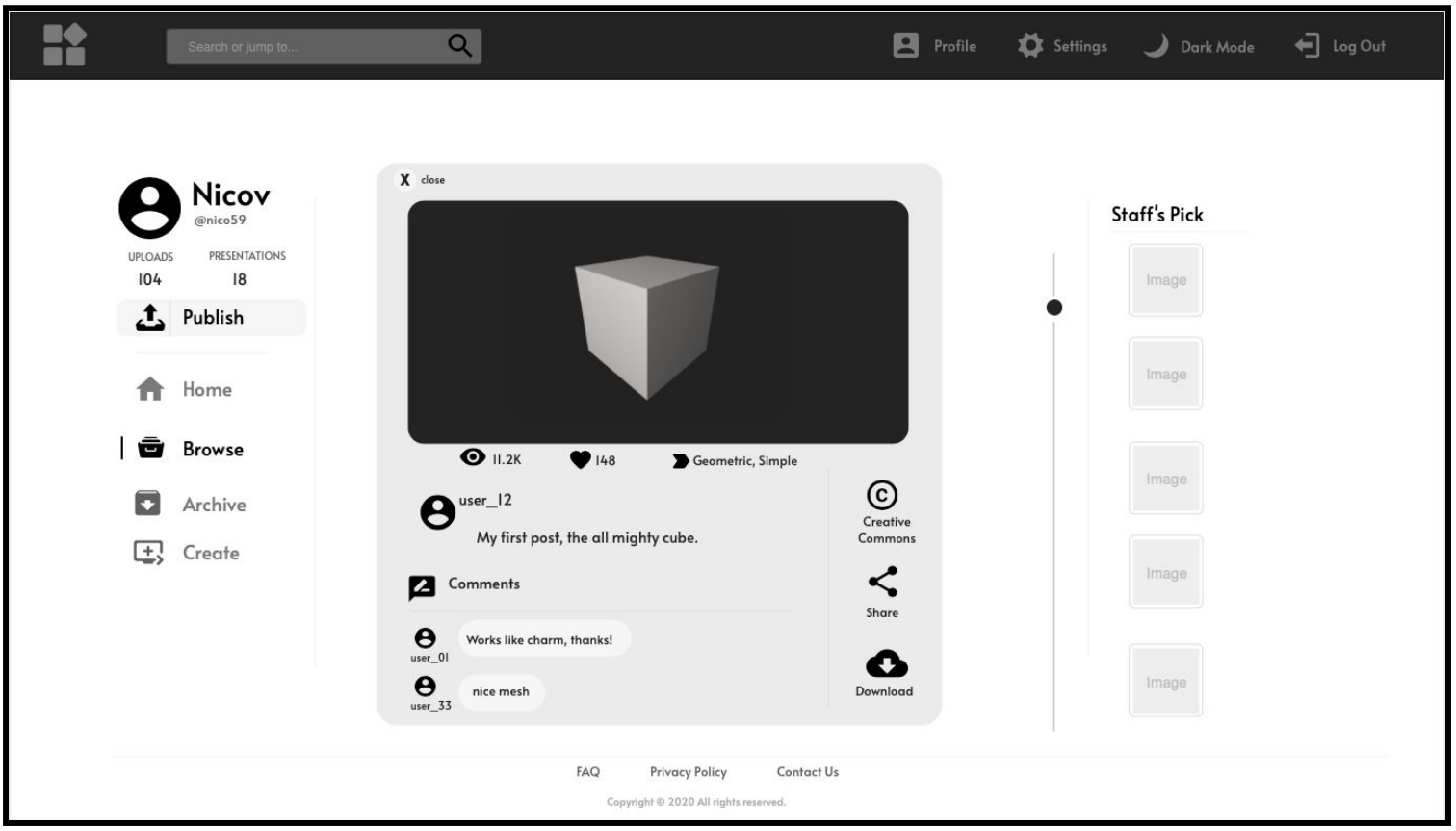


Figure 10. Model Viewer Page

3.5.5.4 Upload Model Page

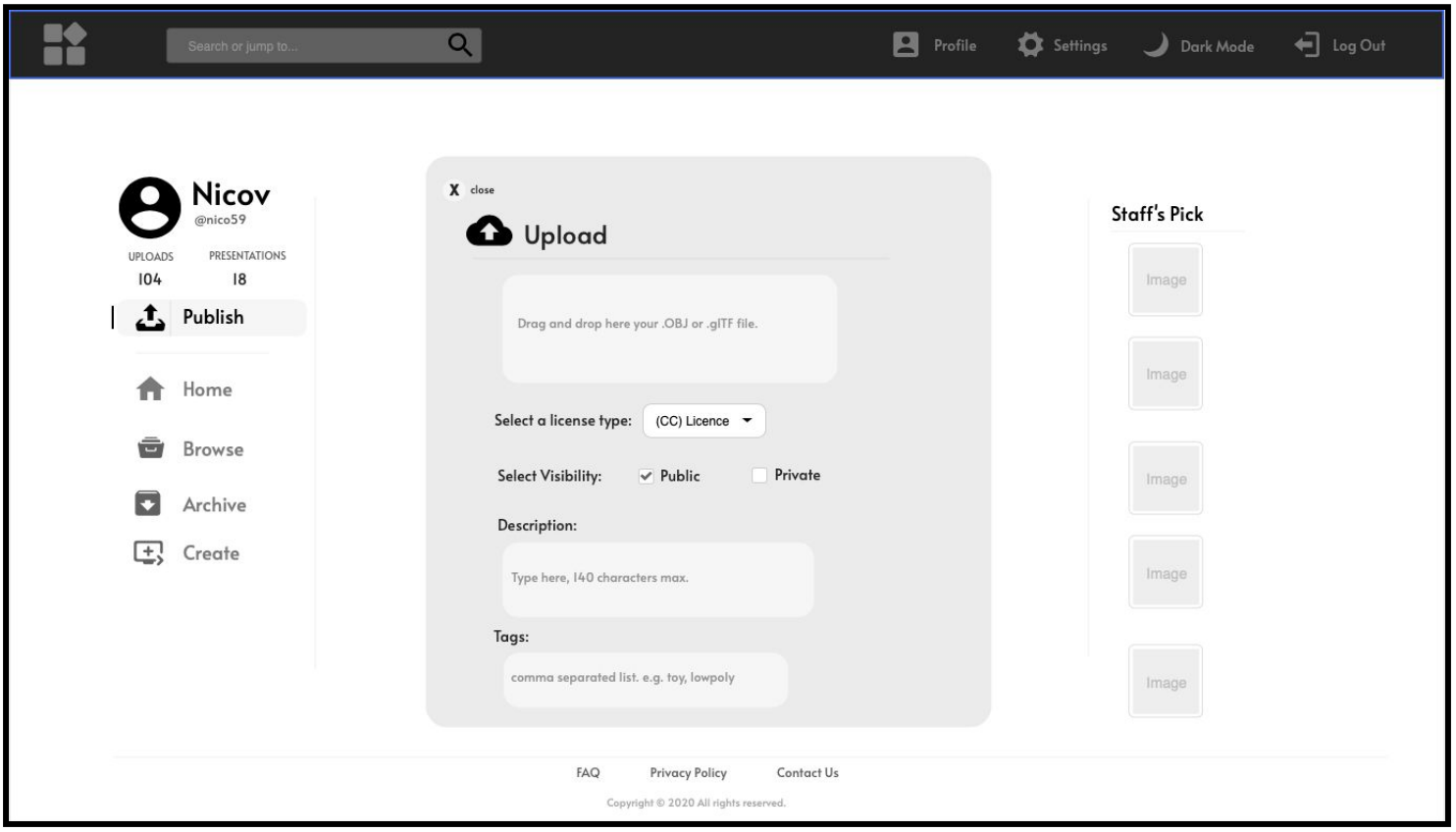


Figure 11. Upload Page

3.5.6 Database E/R Diagram

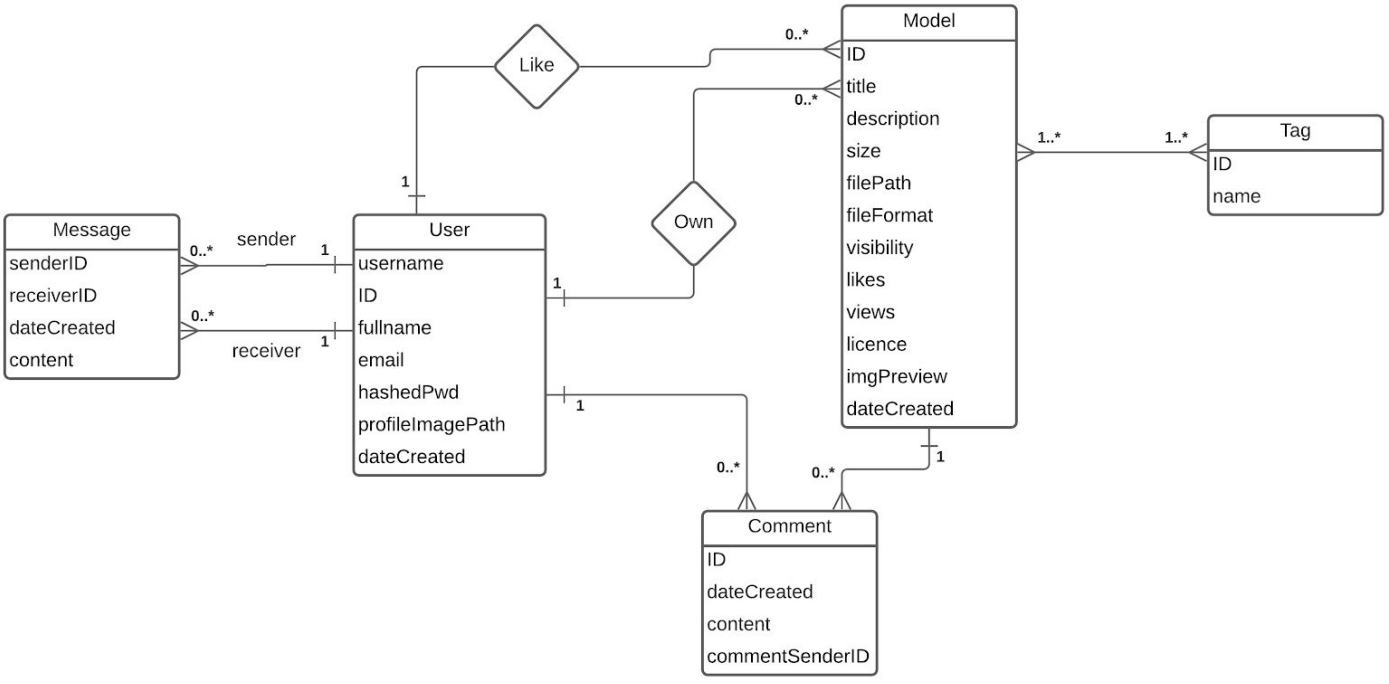


Figure 3. Entity-Relationship Diagram

4. Other Analysis Elements

4.1. Consideration of Various Factors in Engineering Design

This section discusses the potential factors that are considered during design decisions. How these decisions may change the performance, user experience and social impact of the project are argued in their respective sections.

4.1.1 Public Health

There aren't any major public health concerns that our product may cause directly. Compared to other augmented reality apps, it requires minimal mobility on the users part. We can say that generally it is very safe for public use. However, certain aspects of the product, by their very nature, might lead to indirect health concerns such as the psychological effects of using an interactive online social platform or the possibility of the visuals from the devices causing epilepsy seizures. The effect of social media on public's psychological health is a big issue nowadays, but the platform we provide will be mainly about the products and not the users. This will encourage feedback on the products and also limits users' potential to abuse the platform.

Secondly, the probability of any health problems that may occur in response to the visual content of the application is very low. With that being said, examples of this can still be found all over the world. In 1997, several hundred children were admitted to hospitals after a cartoon was aired on national television. "The visual content of that specific episode contained a flickering pattern that generated convulsions, headache, nausea, general malaise, eye irritation with blurred vision, and seizures. Most of these children had experienced photosensitive epilepsy (PSE), a form of stimulus-induced epilepsy that has an incidence of up to 10% of all new cases of epilepsy detected in the 7-19 years old range."[5]. It would be possible to induce such seizures through visuals in AR. However, the frequencies which have the potential to trigger PSE are recorded to be very low and the number of people that can be affected by it is very restricted. Nevertheless, it is a relatively unknown health issue that deserves thinking about.

4.1.2 Economic Factors

Craftual could have a big financial impact on users. It brings together many different practices that benefit from 3D modelling such as marketing, architecture or even entertainment. Its purpose is to provide users with a platform to advertise their products and get feedback on them. It is free to download and has both free and paid products. It can serve as a way to start for beginners and find quality work from professionals for their respective line of work so it has something for everyone. It can provide the users with whole new opportunities by breaching the distance between creators and employers . As a result, all users of our applications will see financial improvement whether in the form of finding new customers or new investing opportunities or simply feedback to improve their products.

4.1.3 Social & Cultural Factors

There aren't any social factors that can affect the workings or functionalities of our project. The aim of our design is simply to provide users from all over the world with a platform to share their models. It is oblivious to nationality, age, gender or social status. In a more general assessment of the matter, we might say that privacy of the user's credentials and sensitive information is an issue. However, as is the case with all applications that record personal information. We will follow the general regulations to assure safety of any sensitive information.

4.1.4 Environmental Factors

When designing an app like Craftual, the environment plays a big role in how it will perform since it uses augmented reality. All aspects of the background environment must be taken into consideration since the models will differ in color, size, place, and shape and it will greatly affect the UI and, by extension, the quality of user experience. Interfaces of augmented reality applications aren't necessarily tied to concrete screens, they are interactive. Therefore it is important to define what kind of objects the user will interact with and on what kind of frames. Our application does not have tight environment constraints, however, it does require a flat visible surface to avoid problems.

The table below provides levels of significance for the aforementioned factors that range from 1-10. The levels are based on the likelihood of the concerns happening and their impact on the applications performance or the user's experience. Certain factors like Public Safety are not

included as our project is in no way connected to public safety and therefore its level is virtually zero.

	Level	Effect
Public Health	3	May lead to psychological or physical problems
Economics	7	Bigger customer profiles, increased income
Social & Cultural	5	Information privacy
Environmental	8	Performance of the app

4.2. Risks and Alternatives

4.2.1 Protection of Private Data

Our project has some privacy issues to consider. Users will be able to put their model products for sale which will require safe payment methods and protection of the information used in the process. Same goes for any presentations made by the user as they may contain critical information about a company's inner workings.

Furthermore, augmented reality projects are uniquely vulnerable to certain types of data leaks that web based applications rarely face, due to their usage of input and output devices. Even simple face-filtering apps like the ones available in SnapChat technically have access to your face's biometric information. Conventional web pages cannot access the camera or other native resources outside the browser unless explicitly authorized by the user. Unfortunately, the AR browser's access rights can be hijacked by malicious webpages to gain this access without involving the user [6]. In order to minimize the risk of such leaks, the user should be frequently asked for verification so that malicious software cannot have unauthorized access to sensitive information. This may cause birth problems, however, our application will require only a flat surface to be visible to the camera and will not gather any significant information about the surroundings. Main privacy concern of our project is safe storage of the users' information that they provided

when signing up. To overcome any potential leaks, all information will be encoded and can only be accessed by the correct encryption key.

4.2.2 Input and Output Definitions

Defining the input and outputs well generally provides a more user-friendly interface and sets the bounds clearly for what a user can or cannot do. It is important for good AR design that the specifics for a user's ability to manipulate the models be precise so that it is less error-prone when faced with an abundance of unique inputs and outputs. The outputs of the app will involve 3D models, possibly with adjustable height, width, color and orientation. A crucial part of the design process is choosing what type of input is best suited for each individual element a user can interact with. There are a wide range of possible inputs that are available on mobile devices such as swiping, rotating, tapping and dragging. Selection of what input to use for any functionality will have a considerable effect on the user experience and the application's performance since one of the main aspects of our project is to create presentations that will require easy-to-use UI. If problems arise on different mobile devices, we will change all inputs to fundamental inputs that all mobile devices have. This may present user experience issues.

4.2.3 Server Complications

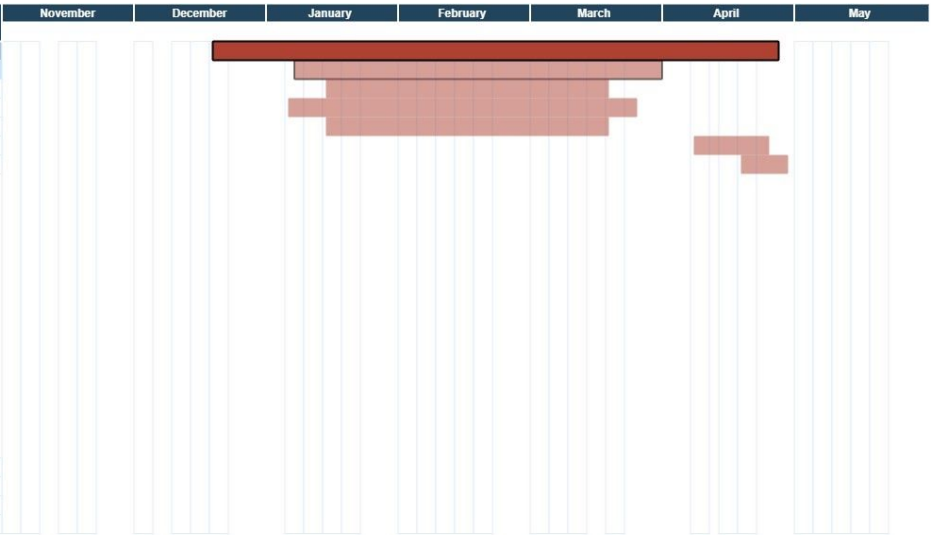
Our project heavily relies on information storage and retrieval from Cloud. Main concerns regarding this aspect are speed and cost. When manipulating models or presentations, speed of data transfer should be fast enough that the application feels interactive." Businesses can instead access extra processing through pay-as-you-go models from public cloud providers. However, the on-demand and scalable nature of cloud computing services make it sometimes difficult to define and predict quantities and costs." [7]. Cost issues are harder to predict as Cloud-based systems' requirements for space is dynamic but does not require substantial hardware investments. In order to keep the cloud computations as efficient and cheap as possible, good financial analysis should be implemented. Should the cost be too high, certain features in the application may be paid or more income could be gathered by giving advertisements.

The below table shows the effects of the risks mentioned previously, their likelihood and their respective alternative solutions.

	Likelihood	Effect	Alternative Plan
Privacy	low	may lead to financial fraud, theft.	Store encoded data, require encryption key for access.
I/O	low	may affect functionality and user experience.	use basic i/o common to all mobile devices.
Server cost/speed	medium	poor user experience, inability to meet demands	financial analysis, additional income from advertising

4.3. Project Plan

	Task Name	Duration	Start	ETA
1	Documentation	200	12.04.12	30.04.2021
2	Front-End Development	104	01.12.2020	05.03.2021
3	Back-End Development	50	15.01.2020	05.03.2020
4	Mobile Application Development	109	01.12.2020	20.03.2020
5	Database Implementation	50	15.01.2021	05.03.2020
6	Beta Launch of the Project	15	05.04.2020	20.04.2021
7	Project Launch	11	20.04.2021	01.05.2021



WP	Work Package Title	Leader	Members Involved
WP 1	Documentation	Endri Suknaj	All Members
WP 2	Front-End Development	Çağrı Orhan	All Members
WP 3	Back-End Development	Deniz Doğanay	All Members

WP 4	Mobile Application Development	Doruk Altan	All Members
WP 5	Database Implementation	Sencer Umut Balkan	Çağrı Orhan, Deniz Doğanay, Doruk Altan
WP 6	Beta Launch of Project	Endri Suknaj	All Members
WP 7	Project Launch	Sencer Umut Balkan	All Members

4.3.1. Documentation Package

WP 1: Documentation
Duration: 200 Days (**Start Date:** 12.10.2020 **End Date:** 30.04.2021)
Leader: Endri Suknaj **Members Involved:** Çağrı Orhan, Deniz Doğanay, Doruk Altan, Sencer Umut Balkan
Objectives: Delivering well organized reports in order to have structured and planned development.
Tasks: **Task 1.1** Project Specifications: Includes brief description and the initial requirements of the project. **Task 1.2** Analysis Report: Includes a detailed analysis of the project. **Task 1.3** High-Level Design Report: Includes translation of the analysis model into system design model, and decomposition of the system into modules and components. **Task 1.4** Low-Level Design Report: The high-level design produced at the end of CS 491 course is refined into the detailed low-level design document. **Task 1.5** Final Report: The final architecture and design of our system as well as the final status of the project is presented in this report.

Deliverables: **Deliverable 1.1** Project Specifications **Deliverable 1.2** Analysis Report **Deliverable 1.3** High-Level Design Report **Deliverable 1.4** Low-Level Design Report **Deliverable 1.5** Final Report

4.3.2. Front-End Development Package

WP 2: Front-End Development
Duration: 104 Days (**Start Date:** 01.12.2020 **End Date:** 05.03.2021)
Leader: Çağrı Orhan **Members Involved:** Endri Suknaj, Deniz Doğanay, Doruk Altan, Sencer Umut Balkan
Objectives: Design and implementation of a user-friendly user interface.
Tasks: **Task 2.1** Design: Designing the interface by using mock ups and making changes if necessary. **Task 2.2** Implementation: Development of an easy to use user interface while providing best possible user experience.
Deliverables: **Deliverable 2.1** Functioning user interface

4.3.3. Back-End Development Package

WP 3: Back-End Development
Duration: 50 Days (**Start Date:** 15.01.2021 **End Date:** 5.03.2021)

Leader: Deniz Doğanay **Members Involved:** Endri Suknaj, Çağrı Orhan, Doruk Altan, Sencer Umut Balkan
Objectives: Implementation of all classes using the class diagram. This Work Package includes all algorithms and back-end systems.
Tasks: **Task 3.1** Database connection: Implementation of communication with the database including searching for models, updating or deleting them. **Task 3.2** Authentication and authorization: Implementation of verification and confirmation of users. **Task 3.3** Messaging: Implementation of messaging between users. **Task 3.4** Notification: Implementation of notifications sent to users upon related activity such as received comments, likes and messages.
Deliverables: **Deliverable 3.1** Source code

4.3.4. Mobile Application Development Package

WP 4: Mobile Application Development
Duration: 109 Days (**Start Date:** 01.12.2020 **End Date:** 20.03.2021)
Leader: Doruk Altan **Members Involved:** Endri Suknaj, Çağrı Orhan, Deniz Doğanay, Sencer Umut Balkan
Objectives: Development of the cross-platform mobile application and integration with AR solutions.
Tasks: **Task 4.1** Researching UI: Research application similar to ours and study their UI and Ux **Task 4.2** Design UI: Design a simply and easy to use UI for our mobile app **Task 4.3** Implement UI: Finish the implementation of our UI elements

Deliverables: **Deliverable 4.1** UI Designs and Mock Ups **Deliverable 4.2** Fully tested and working mobile interface

4.3.5. Database Implementation Package

WP 5: Database Implementation
Duration: 50 Days (**Start Date:** 15.01.2021 **End Date:** 05.03.2021)
Leader: Sencer Umut Balkan **Members Involved:** Çağrı Orhan, Deniz Doğanay, Doruk Altan
Objectives: Building a database for storage and accessing models and personal information of users.
Tasks: **Task 5.1** Conceptual database design: Creating data models and determining entities, attributes and relationships. **Task 5.2** Normalization: Applying normalization rules to remove any redundancy and making necessary adjustments.
Deliverables: **Deliverable 5.1** ER Diagram

4.3.6. Beta Launch of Project Package

WP 6: Beta Launch of Project

Duration: 15 Days (**Start Date:** 05.04.2021 **End Date:** 20.04.2021)
Leader: Endri Suknaj **Members Involved:** Çağrı Orhan, Deniz Doğanay, Doruk Altan, Sencer Umut Balkan
Objectives: Identifying and fixing bugs and inconsistencies between platforms.
Tasks: **Task 6.1** Cross-platform testing: Ensuring consistency of user interface and user experience on different platforms. **Task 6.2** Beta Launch: Identification of possible bugs after cross-platform testing, as well as fixing the bugs.
Deliverables: **Deliverable 6.1** Final product ready for release

4.3.7. Project Launch Package

WP 7: Project Launch
Duration: 11 Days (**Start Date:** 20.04.2021 **End Date:** 01.05.2021)
Leader: Sencer Umut Balkan **Members Involved:** Endri Suknaj, Çağrı Orhan, Deniz Doğanay, Doruk Altan
Objectives: Releasing the final product on different platforms.
Tasks: **Task 7.1** Organizing Github Repository: Merging all the branches into master and removing unnecessary files.
Deliverables: **Deliverable 7.1** Final product **Deliverable 7.2** Website **Deliverable 7.3** Source code

4.4. Ensuring Proper Teamwork

In order to ensure every member is involved and taking part in every aspect of the project, we have decided to use tools that can monitor our progress as a team, as well as individual progress of each team member. Tools that we are planning to use are as follows:

4.4.1 Github

Using Github, we will be able to monitor the contribution of each team member and the overall progress of the project. We will divide work to be done, which is necessary for proper teamwork and relevant workload distribution, with features provided by Github.

4.4.2 Discord

We have created a Discord server mainly in order to keep track of communication between team members, as well as highlight tasks and deadlines. We will also be able to carry out group meetings and post completed tasks in the form of reports to our Discord server, which helps keeping track of progress as well.

4.4.3 Zoom

Zoom will be used in place of real-life meetings. With features such as screen sharing and video conferencing, we predict that using Zoom will not put us at a disadvantage rather than gathering in person. We will schedule meetings at times when every team member is available, in order to have every team member’s idea about the topic that will be discussed in that particular meeting. Zoom and Discord may be used interchangeably for meeting purposes.

4.5. Ethics and Professional Responsibilities

craftual will contain models that are created by individuals which may be classified as Intellectual Property. In order to prevent any issue related to violation of Intellectual Property, craftual will allow users to mark their models accessible by the public or not. If a user classifies their model as private and does not want to share it publicly, craftual will not allow other users to access that particular

model. Likewise, if a user wants to share their model anonymously, craftual will not allow other users to access information of that particular model's creator.

Other than user name and e-mail address, users can not access any personal information related to another user. Interaction with other users will be restricted to liking, saving and using other users' models, provided that the particular model is shared publicly.

craftual will not allow any non-appropriate model to be seen by users, by confirming that the model does not contain any provocative, insulting or offensive features.

4.6. Planning for New Knowledge and Learning Strategies

While developing craftual, we will have to acquire new knowledge and get experience on several different issues related to application design and development.

Firstly, we will have to learn web development, which relies heavily on front-end development. The nature of craftual makes it a must to offer an easy to use user interface and the best user experience, as much as possible.

Also, we will need to learn how to use Android and iOS development kits and tools, in order to provide a mobile application as well. Moreover, we will have to acquire knowledge about how to deploy and maintain mobile applications in those operating systems and their related application stores, Google Play Store and App Store, respectively.

Furthermore, we will have to use the knowledge that we have gained in our CS-319, Object-Oriented Software Engineering course about software development process and related methodologies, while learning more about them and continuously planning ahead.

Developing an augmented reality application is no small enterprise. As mentioned above, we had to familiarize ourselves with many new concepts and skills such as 3D modelling, graphical design and usage of AR SDKs. As a group, we have found that the best resources to learn such skills are available online. There is an abundance of articles and research regarding AR development and/or Cloud-based systems as they are both increasing in popularity very rapidly. However, actually getting into it and writing code can be very slow and frustrating with only the theoretical knowledge gathered from written resources. One of the most beneficial materials for understanding the inner

workings of such systems and how to implement them would be video guides that visually illustrate it. There are many such videos on YouTube that are very instructive that helped solidify our knowledge about the subject.

5. Glossary

- **Android:** Open source Linux-based mobile operating system developed by Google.
- **App:** Mobile application
- **AR:** Augmented Reality
- **iOS:**Proprietary mobile operating system developed by Apple runs on iPhone and iPad.
- **REST:** Representational state transfer, that the server does not store transient states regarding requests and responds all requests in stateless manner
- **In-memory cache:** A key-value store that stores a variety of data non-persistently in memory and serves it as needed.
- **Document (NoSQL) database:** Non-relational database management systems that stores records (documents) independently of any scheme.
- **MongoDB:** an open source document database developed by 10gen, Inc.
- **Memcached:** an open source in-memory solution.

6. References

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