

# AR Museum

May 12, 2024

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# Introduction

In the world, you would visit a regular old museum to retrieve your intended historic information. Now, you use our mobile AR Museum application. It incorporates commonly held artifacts in museums but in an augmented reality environment with your phone as the vital ingredient.

As you open it up, you begin to scan registered unique patterns, the backbone of projecting these models. These registered unique patterns are hardcoded to their respective objects to project onto the environment. There in the application adds a non-AR model view room where you can see all the objects as you would expect on the screen. Each comes with an information-dense description describing what we aim to be “fun facts and historical relevance.” However in our prototype version of the application, it includes tester captions as a way to show that the functionality of text is there.

Adopted in the modern-day setting of an elementary school classroom, the teacher will provide a pre-written worksheet for the students to gradually learn more about playing around with our application and swiping through the information deemed essential to fill the worksheet.

# Software Functions

**PRIORITY 1A:** The system shall have a database to store the 3D model with its descriptions and valid QR code.

**PRIORITY 1B:** The system shall be able to detect QR codes.

**PRIORITY 1C:** The system shall display nice rendered 3D models.

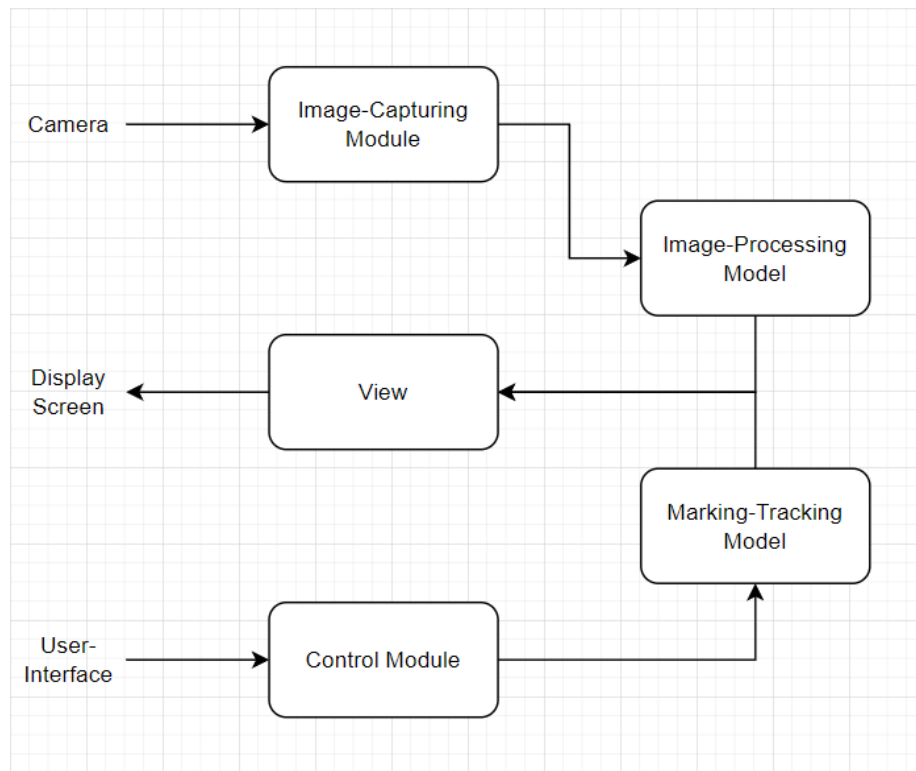
**PRIORITY 2A:** The system shall allow the users to play with the model that includes resizing and rotating the model.

**PRIORITY 3A:** The system shall have a friendly user interface (UI).

**PRIORITY 3B:** The system shall provide more details when displaying the 3D model.

# Architecture

## Model-View-Controller (MVC)



**Image-Capturing Module:** allows the camera to record the size and shape of the unique pattern while sending its dimensions to the system

**Image-Processing Module:** interprets the details of the unique pattern allowing the app to render digital content within the space above the pattern

**Control Module:** enables the user to interact with the model and manipulate settings via touch screen

**Marking-Tracking Module:** handles information regarding the currently loaded model and its relative position to the real world and the object it is placed upon.

**View Module:** displays the museum object in AR-view

# Implementation

## Implementation Technologies

- Unity (our game engine), Visual Studio Code (our integrated development environment), C# (our programming language)
- Vuforia Engine (extension and library): help us manage image database and it is the foundation of our image recognition and tracking system
- Blender: help us to build 3D models and create animations
- ARKit (our software development kit): help us to compile the application on an iOS platform device

## Implementation Tasks

### The control module

- Image preload: include the pattern that should be recognized into the project
  - perform grayscale processing on the image to turn it into black and white
  - extract the visually distinct features in the image (feature points) from the black and white image
  - using Vuforia Engine to compress and manage these image feature data
- Image process
  - when the application is running, the application will real-time monitor and compare between the features points on the camera and our database
- Model tracking and displacement
  - the application detects feature points
  - uses PnP algorithms solve for the camera pose using a set of 3D points (corresponding to feature points in the reference image)
  - compute the corresponding 2D image coordinates (from the camera feed)

### Image capturing and processing

- AR mode
  - we added some responses to the 3D models when the user clicks them (it might be a cool animation or even a song...)
  - we added collision to the models, then we used a script to collect user input (touch screen) and manage different responses
- Model display mode
  - we have a script to control the model rotation, responding to how the user scrolls the screen

## Consistency

- The main changes in requirements happen at the QR codes and the resizing model feature. In our finished product, we shifted to a unique pattern requirement where a unique pattern would be laid in the physical environment ready to be scanned. The resizing model feature proved to be too tumultuous so we were prudent on that.

## System Availability

- [https://drive.google.com/file/d/11P\\_mT2KYsmiKXplocyJAHNJO7swB3bt4/view?usp=drive\\_link](https://drive.google.com/file/d/11P_mT2KYsmiKXplocyJAHNJO7swB3bt4/view?usp=drive_link)
- <https://drive.google.com/file/d/18sn60oe99c7ny3Q1K7v66AWwyj7l0LzR/view?usp=sharing>
- Unity file(first link) and demo(second link)

## Project Management

Date:	Topic:	Specific Descriptions:	Group Members Participated:
2/12/2024	Meeting	Architectural design	Ji Guo, Lucas Gomes, Jacob Autus, Daniel Sagbini
2/14/2024	Meeting	Discuss about the final outcome base on SRS	Ji Guo, Lucas Gomes, Jacob Autus, Daniel Sagbini
2/19/2024	Meeting	Narrow down the implementation part	Ji Guo, Lucas Gomes, Jacob Autus, Daniel Sagbini
3/06/2024	Use case diagram	Created the use case diagram for the whole project to outline potential uses	Daniel Sagbini
3/06/2024	Architectural Diagram	Creating the diagram for architecture design	Jacob Autus
3/06/2024	Mock-up	Creating the mock-up	Lucas Gomes
3/07/2024	AR_MUSEUM 1.0.0	AR feature is now supported, but can only recognize one pattern	Ji Guo
3/09/2024	AR_MUSEUM 1.0.1~1.0.2	Fixed bugs	Ji Guo
3/14/2024	AR_MUSEUM 1.0.3	Display mode and description panels have been implemented	Ji Guo
3/25/2024	AR_MUSEUM 1.0.4	Display mode now support rotate models in X direction	Ji Guo
4/03/2024	AR_MUSEUM 1.0.5	corrected description toggle display logic, optimized switch model button display effect	Ji Guo
4/04/2024	AR_MUSEUM 1.0.6	Now can scan and detect multiple patterns	Ji Guo
4/06/2024	AR_MUSEUM 1.0.7	added previous model select for display mode, fixed sometimes the model switch disappear problem	Ji Guo
4/08/2024	AR_MUSEUM 1.0.8	finalize the preload model database, all models are available in the display mode	Ji Guo
4/10/2024	AR_MUSEUM 1.0.9	AR interaction prototype is completed. The model can play a song if the user clicks on it	Ji Guo
4/15/2025	AR_MUSEUM 1.1.0	First animations included	Ji Guo, Lucas Gomes
4/20/2024	AR_MUSEUM 1.1.1	More animations, AR interaction is completed, the model can switch animation if the user click on it	Ji Guo, Lucas Gomes
5/1/2024	AR_MUSEUM 1.1.2	Tutorial is complete	Ji Guo, Jacob Autus
5/5/2024	Demo film & survey	Ask random selected stakeholders to try our product and share their thoughts	Jacob Autus
5/5/2024	Application of our application	Created a worksheet to test out and examine the potential use cases with elementary school students	Daniel Sagbini

Since the work was started early, most problems we encountered mainly focused on the AR feature since we have zero experience with that.

The first issue was with the AR and UI. Since AR, unlike the usual Unity project that gives you total control of what the user will view, we had some trouble displaying our UI(in-game content) with a real-world element. Then, we resolved it by setting an empty space to only contain the UI and mixing the AR camera with the in-game camera.

Another difficulty we encountered was using Blender in Unity. Again, we had zero experience, so we struggled a lot when trying to import or create animations. But we made it through.

Then, there is the resizing model feature. We eliminated it completely simply because we could not find a proper way to display it. I can actually imagine doing it, but our group doesn't have the 3D art skills that are compatible.

Lastly, and personally, the greatest difficulty is the time. I had so many ideas besides the SRS that can take this application to the next level, but we don't have the time to actually test or even try to implement it.

## Conclusion

To reflect upon this work would not require much but thanking the benefit of starting early. The project team led on strong and most of the important initial code was implemented and debugged early in the life cycle. The instrumental aspects of the product were taken care of right from the start and the rest of the time was used to revamp and streamline the user experience and in some ways fancify the application design.

A part of the fun in bringing this project to life was the use case. Originally, drafting several plots of how the real world could fit into what we've built, we landed on the classroom setting to really captivate the essence of our project's story. This learning environment would allow the students and teachers to both engage with new technology that puts forth educational enrichment while improving access to information for all schools in use of our application. The added worksheet that is suited for the application will further stretch curiosity in the student and curriculum in the classroom.



# References

## Free 3D Models

### ● 西业解: 萨姆技能动作

- <https://www.aplaybox.com/details/model/DHZG8o25OCT5>

### ● seth the yutyranus: ARK archaeopteryx

- <https://sketchfab.com/3d-models/ark-archaeopteryx-cae0cdf2206c4e869b15032f06d6b46f>

### ● brakovish333: Vergil Chair

- <https://www.aplaybox.com/u/962253927>

## Image

- <https://twitter.com/happydog47/media>