CDR: Senior Design 2

Generative Projection Mapping System (GPMS)

Group 18

Francisco Soriano

Declan Carter

Victoria Moreno

Our team

Francisco Soriano

CPE – VLSI Track

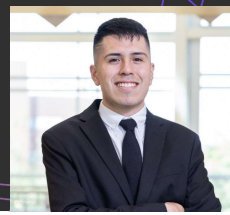
Declan Carter

CPE – Comprehensive Track

Victoria Moreno

CPE – Comprehensive Track

Table of contents




01.
Introduction

Motivations

Passion

Immersive Storytelling

- How can we combine this with Projection Mapping?

Inspiration

Disney projection mapping advancements

- How can we bring these capabilities to normal people?

Proposal

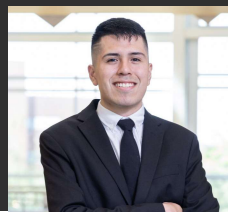
GPMS: A portable system using generative AI for themed projections on any surface/structure

Opportunity

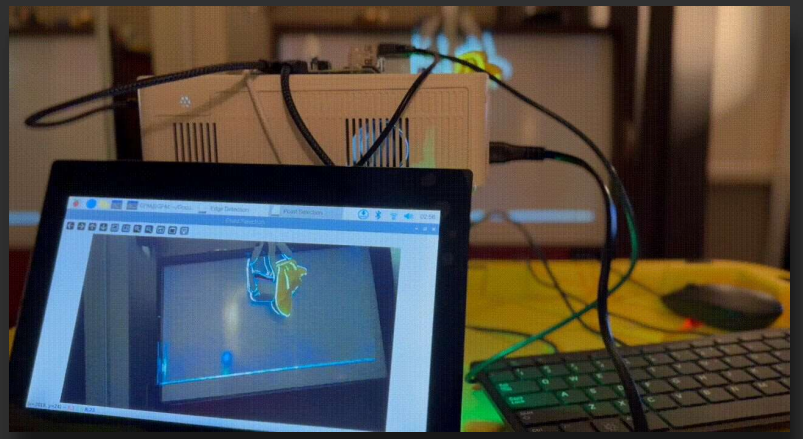
Pitch GPMS to local entertainment venues in Orlando, FL

- What does a use case look like?

Goal To make projection mapping using generative AI accessible to everyday consumers



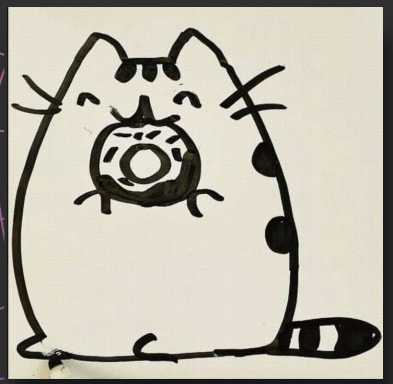
What is GPMS?

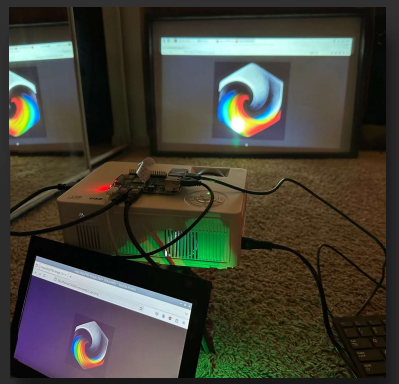


A device enabling a simple ***GUI*** to calibrate and generate unique images for structures

Device consists of:

- Raspberry Pi
- Touch Screen Display
- Projector
- Camera





Connected via ***API*** to a server running a ***generative AI*** stack

Basic Goals & Objectives

Projection

Project images onto structures using computer vision

Interaction

Touchscreen input + generative AI for image creation

Power

Configure sufficient power supply for GPMS

Structure Alignment

Generated image aligns with features on the structure

User Input Projection

Projector displays images aligned with user input

Reliable Power Supply

Reliable power supply via optimal Power Bank

Advanced Goals & Objectives

Increased Control

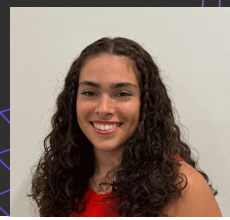
Empower users with greater control over the generated images based on input and preferences.

Image Outlines

Implement slider inputs for users to set edge detection thresholds, fine-tuning the outlines used to generate images.

Image Styles

Add options for users to specify image style, such as animated or realistic, to guide the generation process.



Stretch Goals & Objectives

Structure

Emphasize specific structural elements

Calibration

Automatic calibration for ease of use

Power

Advanced Power Supply Unit (PSU)

Area Selection

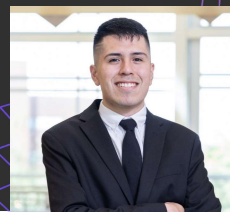
Enable users to select specific portions of the input image they want to focus on.

Device to Structure

Automatic device calibration to structure

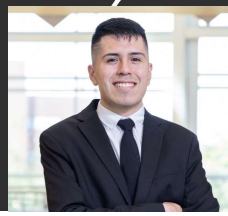
PSU PCB

Custom PCB with buck-down regulator for voltage/current control



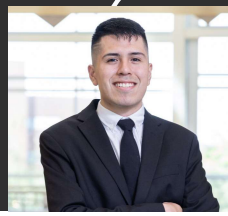
Project Specifications

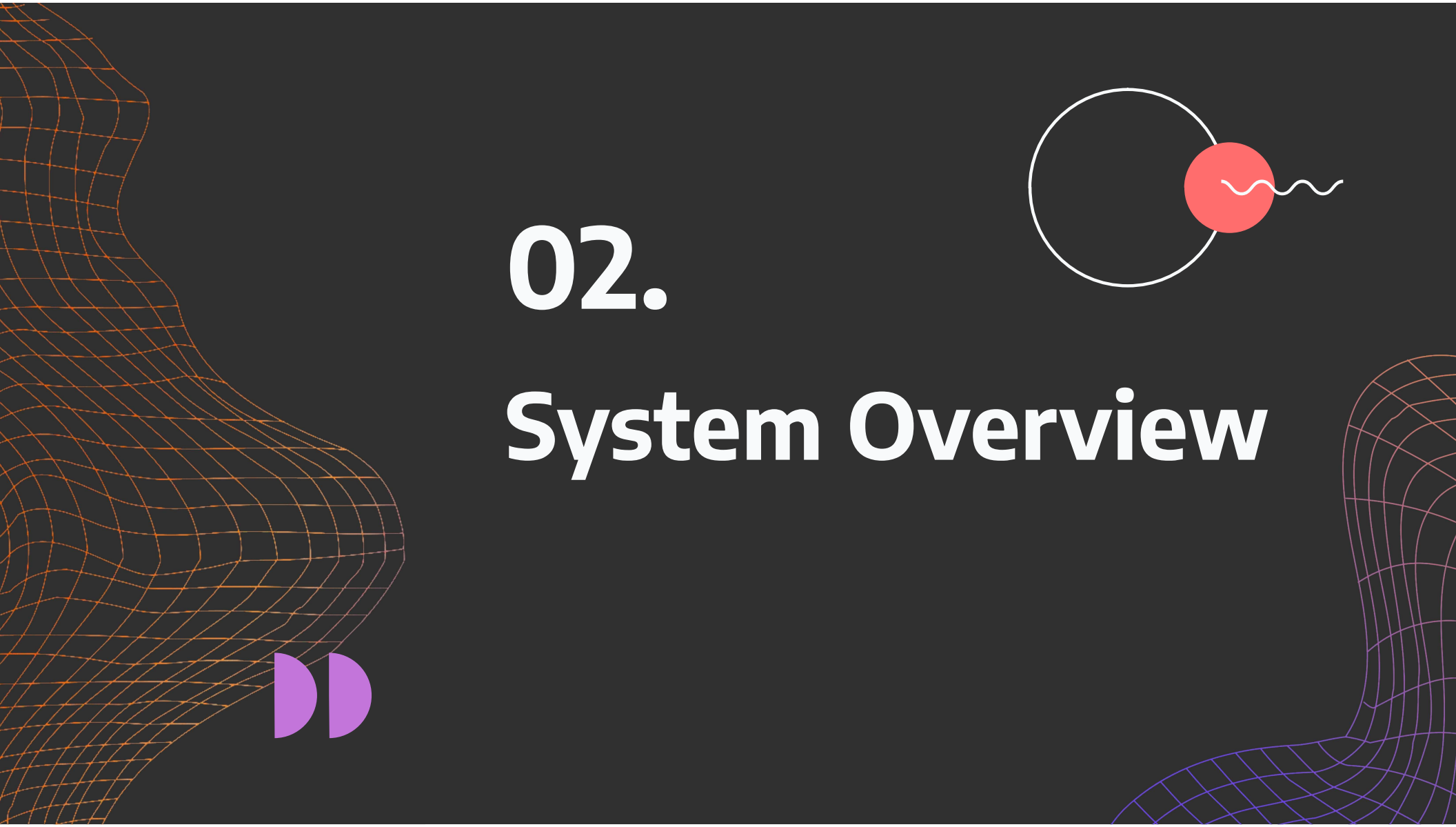
Category	Target
Size	12 in x 12 in x 5 in
Weight	~10 pounds
Battery Life	~1 hour
Recover Time	< 1 minute / image
Elapsed Time	< 2 minutes
Alignment Accuracy	> 90%
AI Generation Time	< 1.5 minute / image



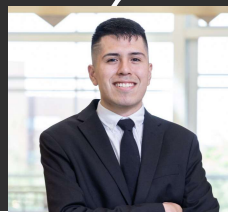
Project Specifications

Category	Target
Size	12 in x 12 in x 5 in
Weight	~10 pounds
Battery Life	~1 hour
Recover Time	< 10 seconds
Elapsed Time	< 5 minutes
Alignment Accuracy	< 8 mm
AI Generation Time	< 1.5 minute / image

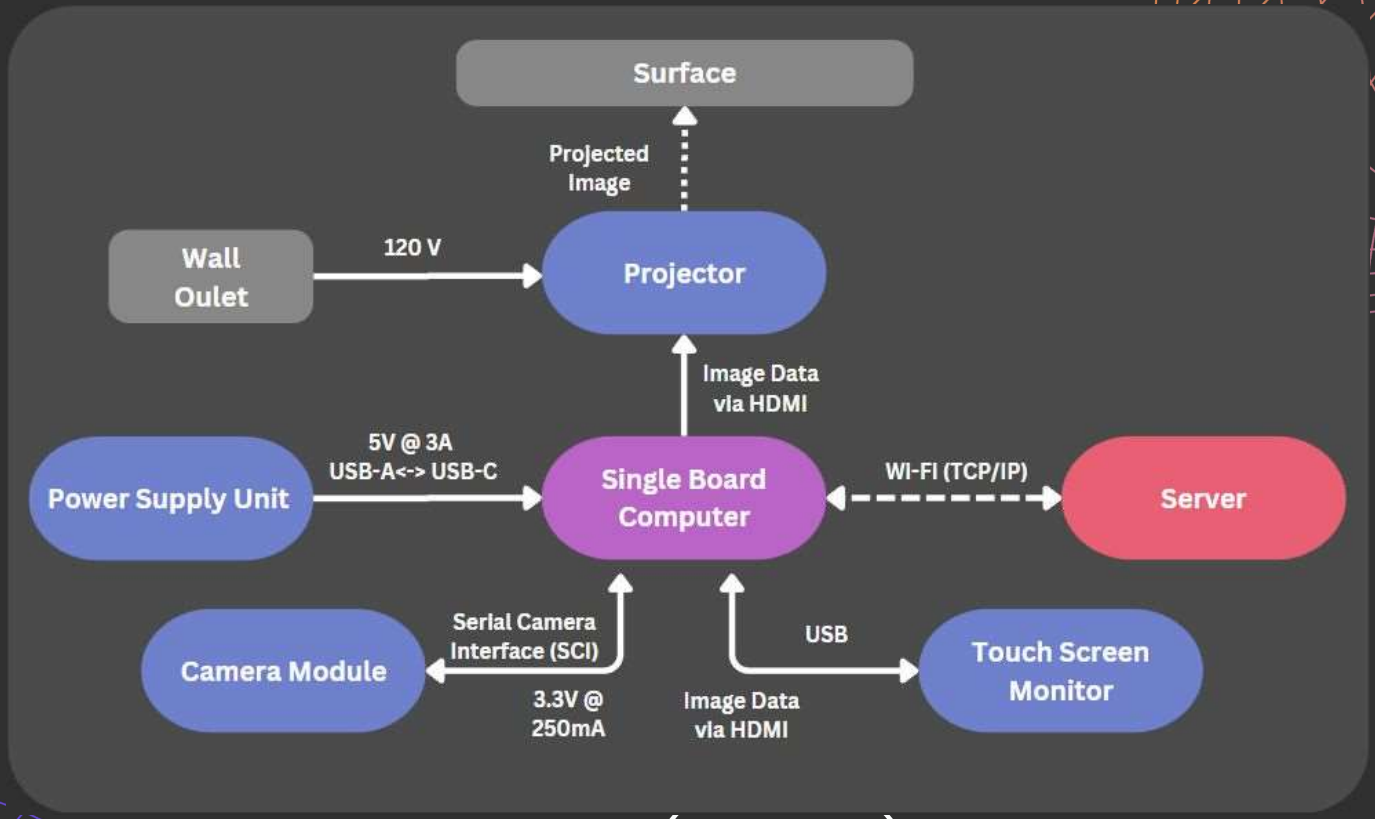


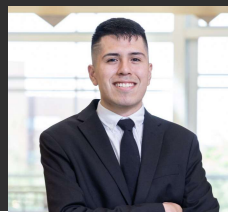

02.
System Overview

Visual Product Representation



Hardware Block Diagram - Overview

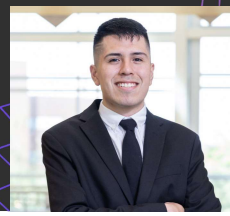




Significant Decisions - Computing Options

	Single Board Computer (SBC)	MCU	Development Board
Display	High Fidelity		Simple
Peripherals	X	X	X
Operating System	X		
Ease of Integration	Simple	Complex	Moderate
Price	$60	~$1 - $10	$10 - $30

Raspberry Pi 5



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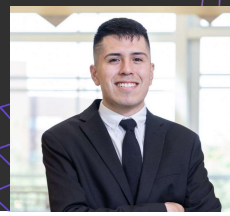
Selection justification – simple to use

Raspberry Pi 5



Significant Decisions - PSU for SBC

	PCB with Regulator	Power Charger/ Bank
Stability	Potential for inconsistent/insufficient power supply	Stable/consistent power supply
Safety	Thermal Runaway	Built in protection
Time to Obtain	~ 2 weeks	Next Day
Ease of Integration	Complex	Simple
Cost	$50 per iteration	$74.99

RoyPow PD
Power Station

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Safety	Thermal Runaway	Built in protection
Time to Obtain	~ 2 weeks	Next Day
Ease of Integration	Complex	Simple
Cost	$50 per iteration	$74.99

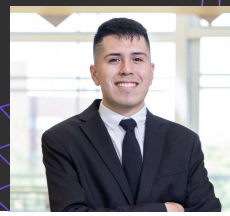
Selection justification – more efficient/safe

RoyPow PD Power Station

Significant Decisions - Wireless Com.

	Bluetooth	Wi-Fi
Image Handling Throughput	Low Bandwidth	Higher Bandwidth
Client Server Model Integration	Not Optimal	Optimal
Overall Ease of Integration	No	Yes

Wi-Fi



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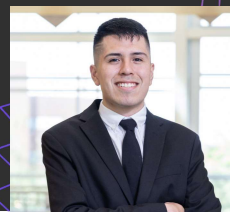
Wi-Fi

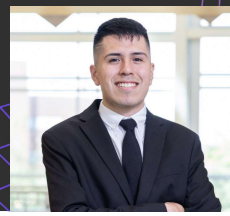
Selection justification – most practical integration



Significant Decisions - Touchscreen

	Resistive Touch	Capacitive Touch	Infrared Touch
Touch Technology	Pressure sensitive	Responds to electrical conductivity	Uses infrared light
Multi-touch Support	No multi-touch support	Excellent multi-touch support	Good multi-touch support
Visibility	Reduced Clarity	Clear	Clear
Cost	Less Expensive	More Expensive	Most Expensive

GeeekPi 10.1 Inch Capacitive Touchscreen



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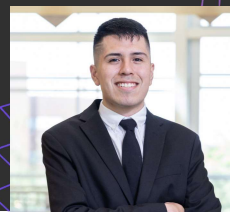
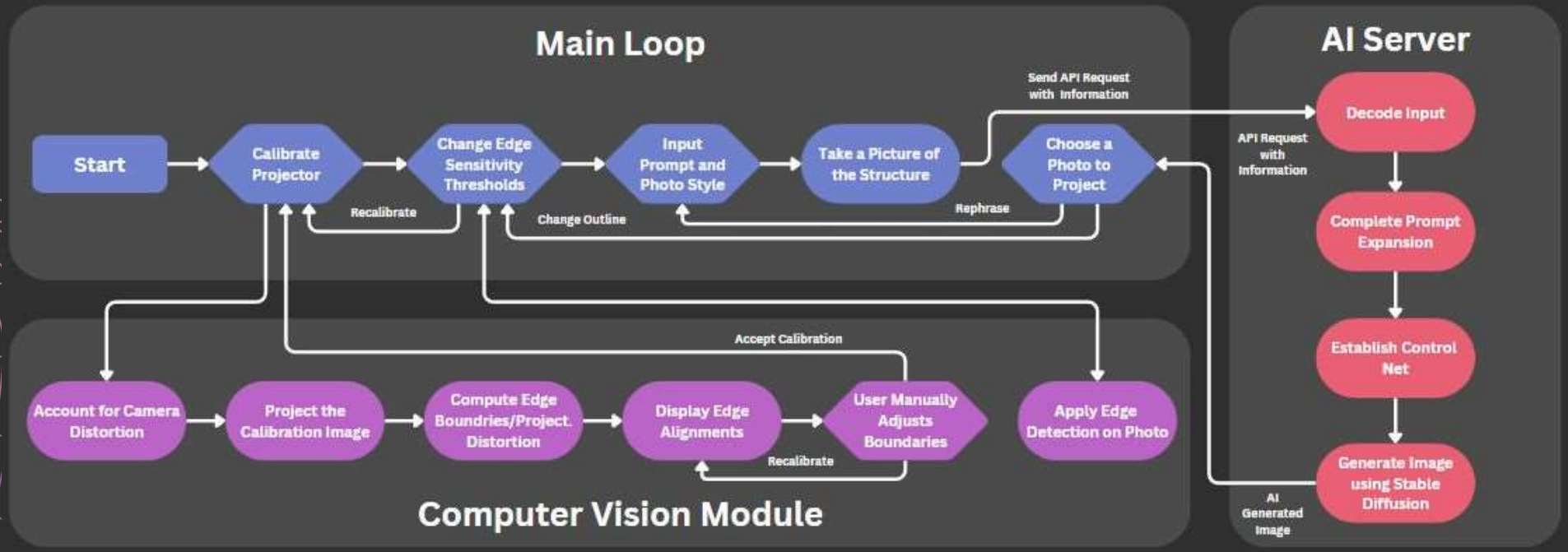
Cost	Less Expensive	More Expensive	Most Expensive

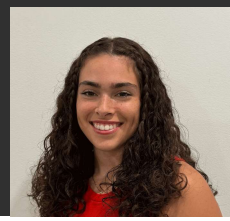
Selection justification – most suitable/optimal for UI

GeeekPi 10.1 Inch Capacitive Touchscreen

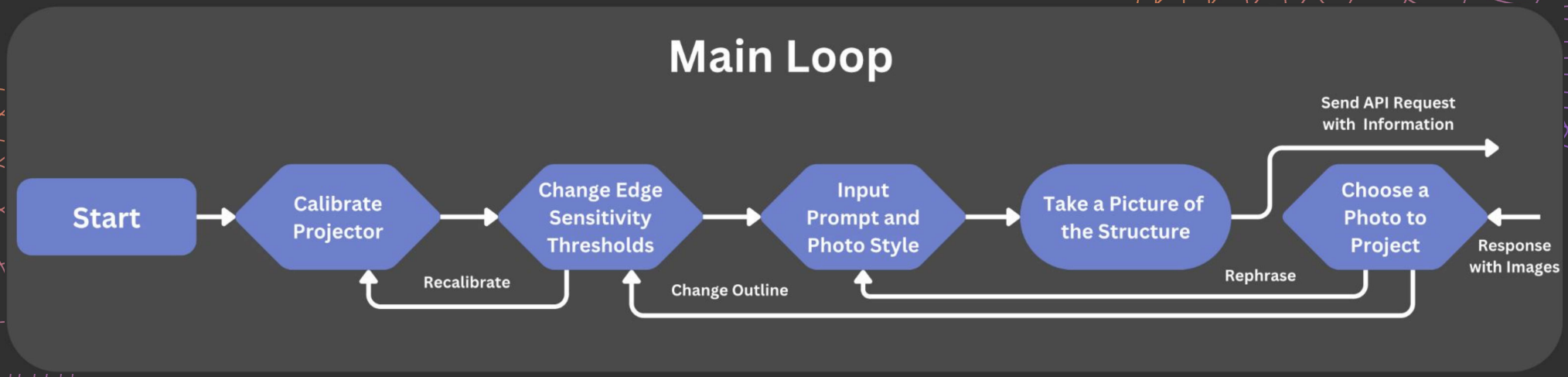


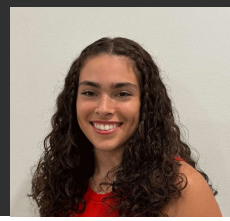
Software Block Diagram - Overview



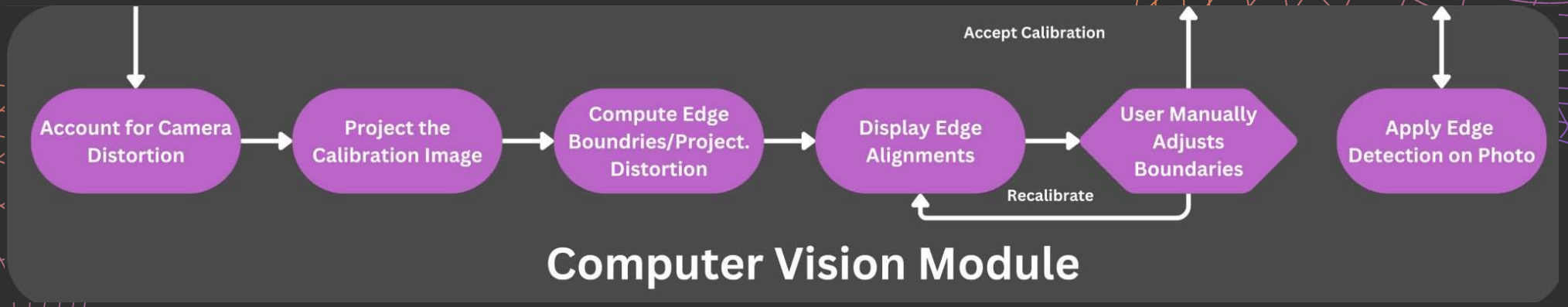


Software Block Diagram - Application





Software Block Diagram - Computer Vision

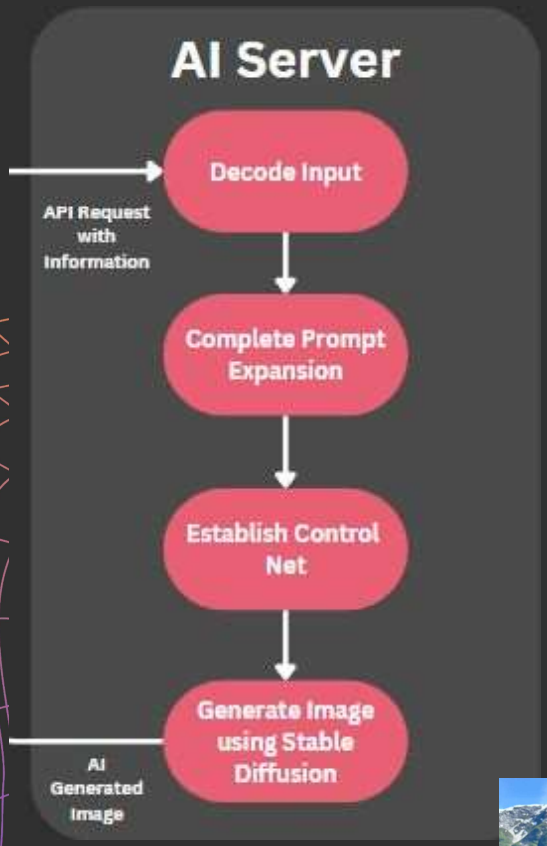


Software Block Diagram - Generative AI Server

Open a designated port on the machine to accept POST requests to the Python server

- ***Input***: Incoming prompt and image capture
- ***Output***: Outgoing selection of AI images

Utilize Stable Diffusion w/ Control Nets



Significant Decisions

	QT	Electron	Flutter
Programming Language	C++	JavaScript (HTML/CSS)	Dart
OpenCV Integration	Easy (built-in support)	Moderate (requires additional libraries)	Moderate (requires additional libraries)
Performance	High	Good	High
Ease of Use	Moderate to complex	Easy (for web developers)	Moderate

QT

Significant Decisions

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Programming Language	C++	JavaScript (HTML/CSS)	Dart
OpenCV Integration	Easy (built-in support)	Moderate (requires additional libraries)	Moderate (requires additional libraries)
Performance	High	Good	High
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QT

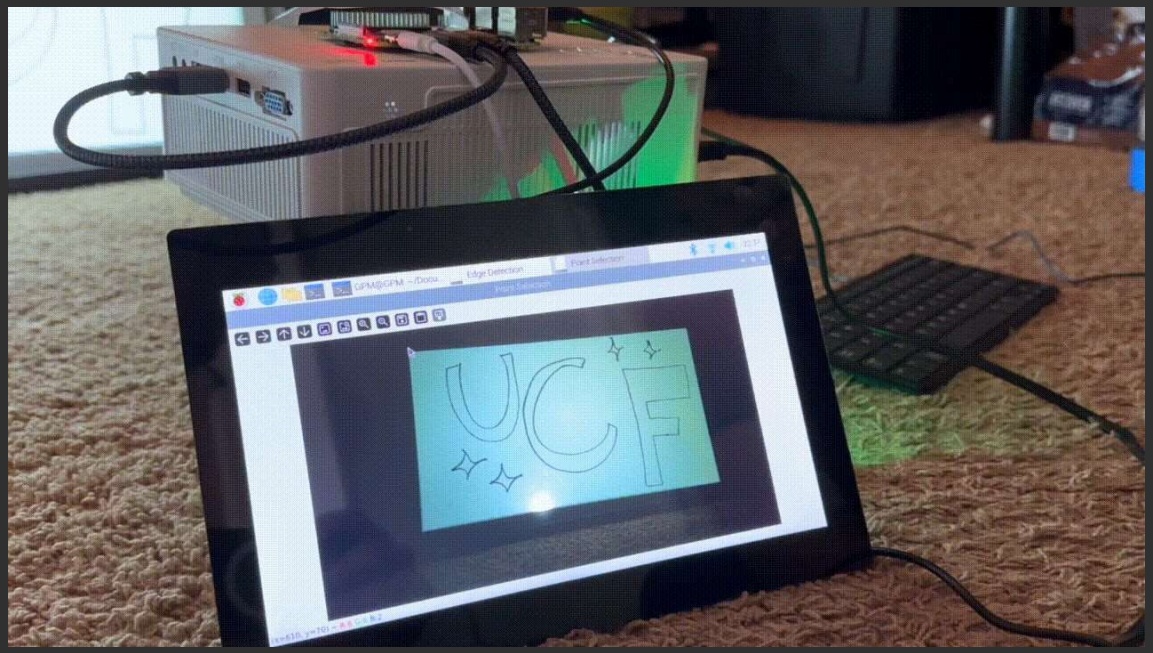
Selection justification – OpenCV integration simplicity

03.

Prototype

Prototype

Initial Computer Vision Implementation



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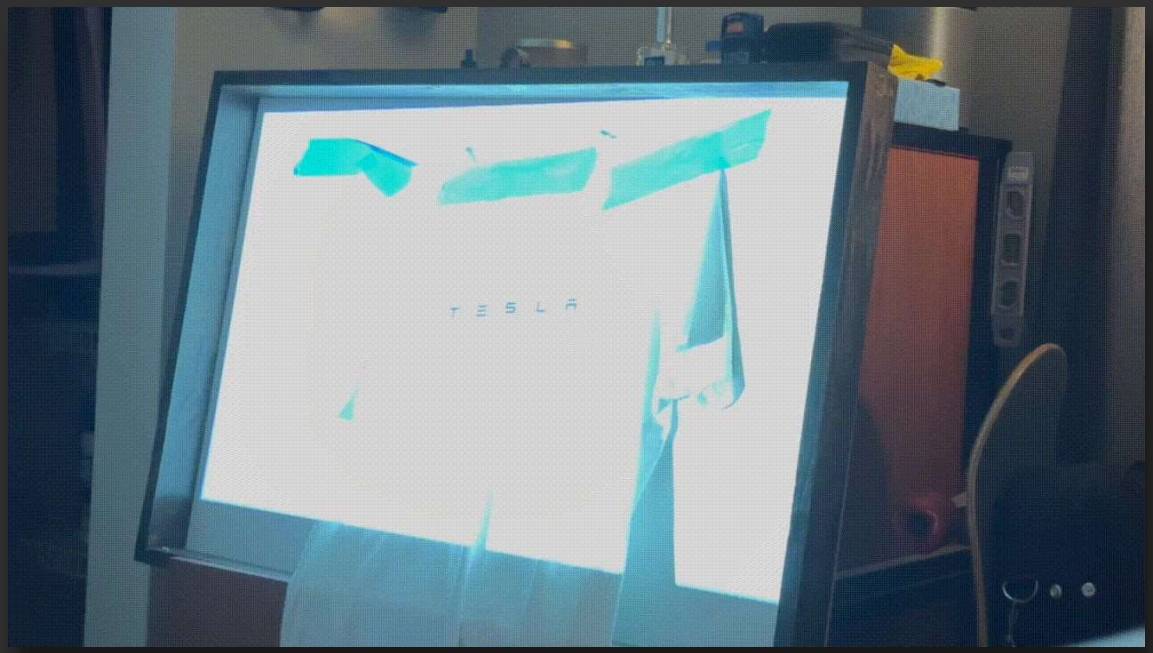
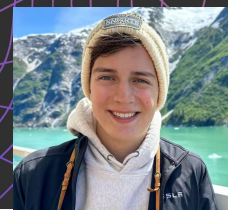
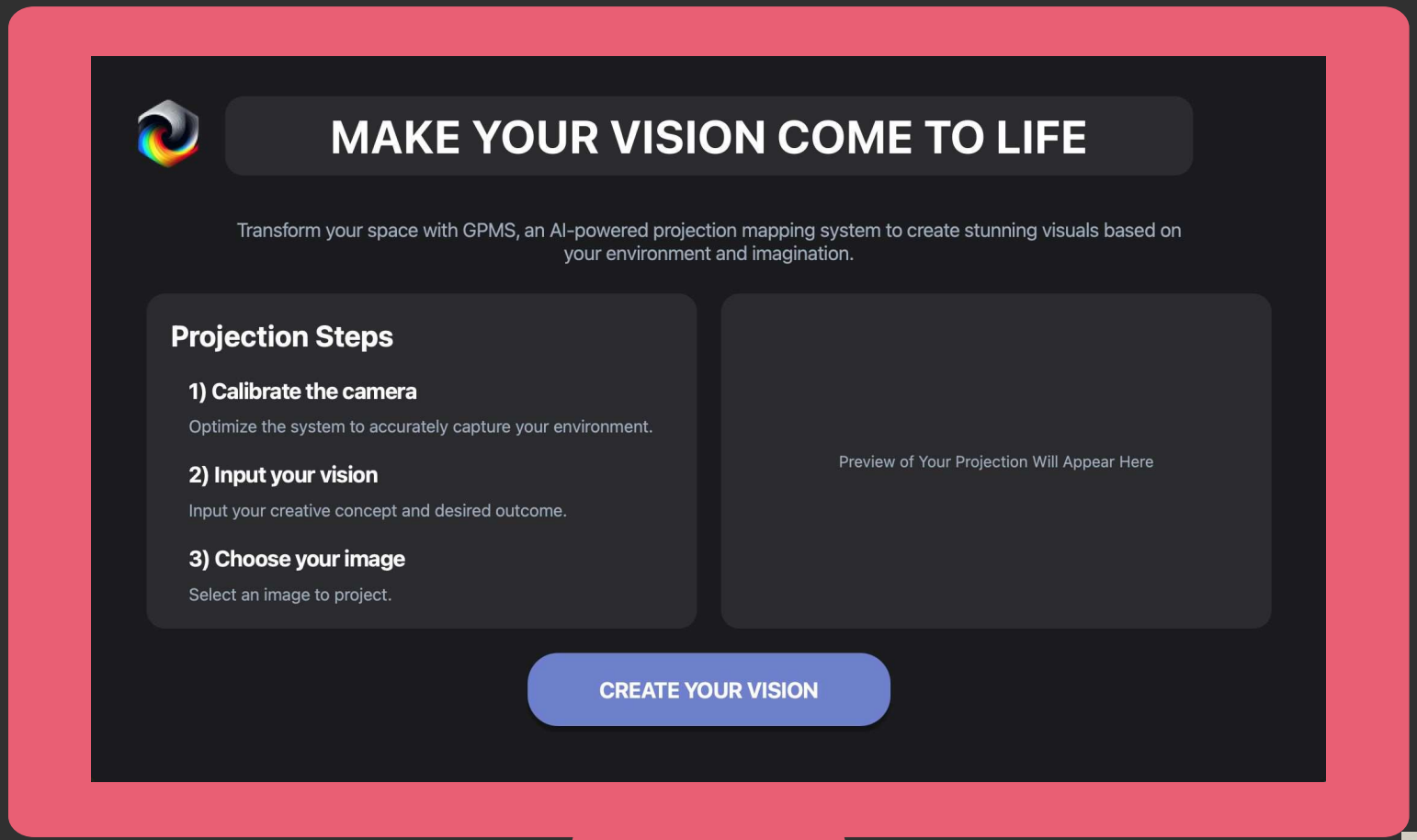
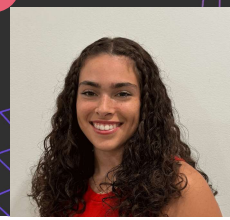
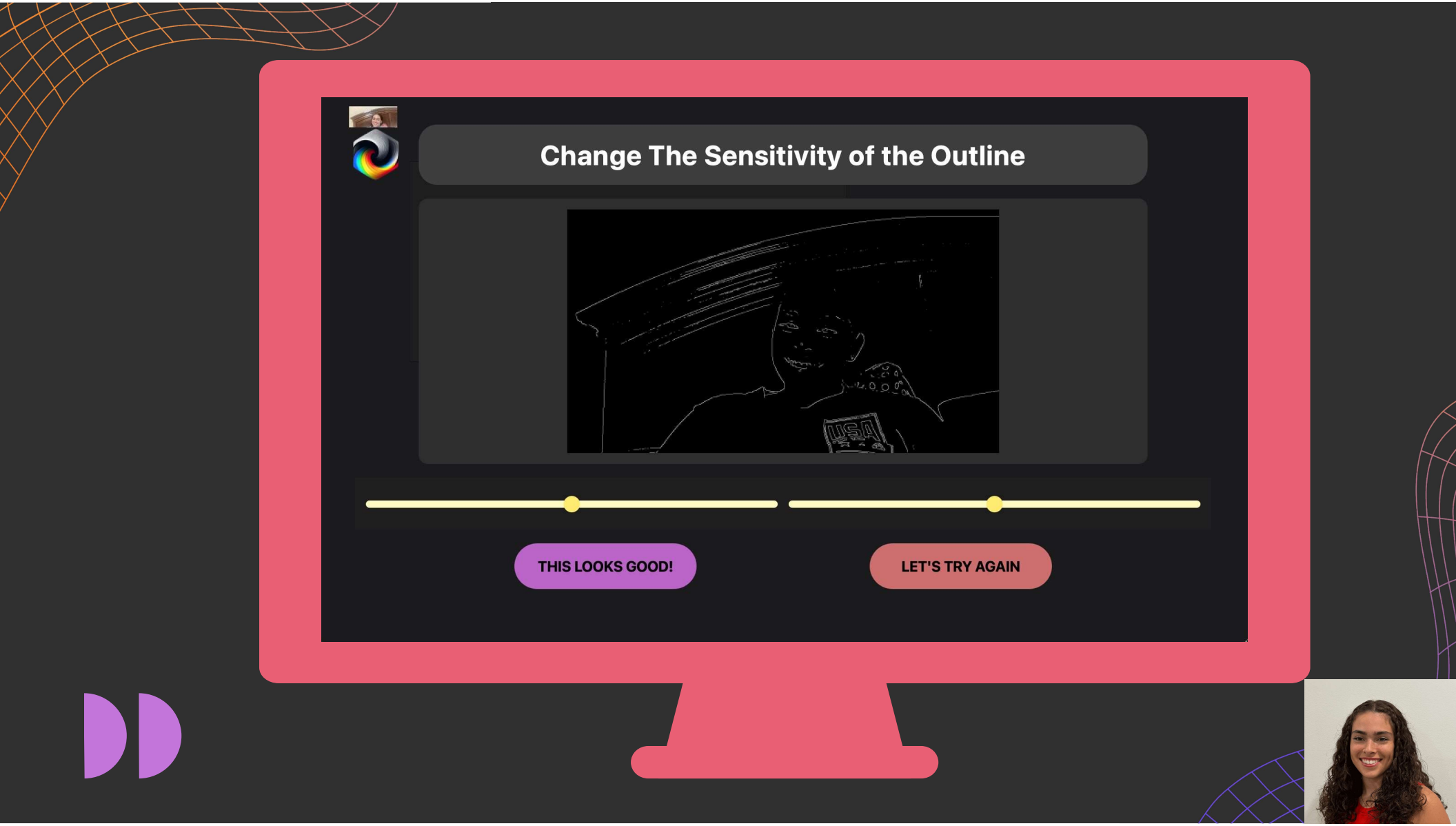


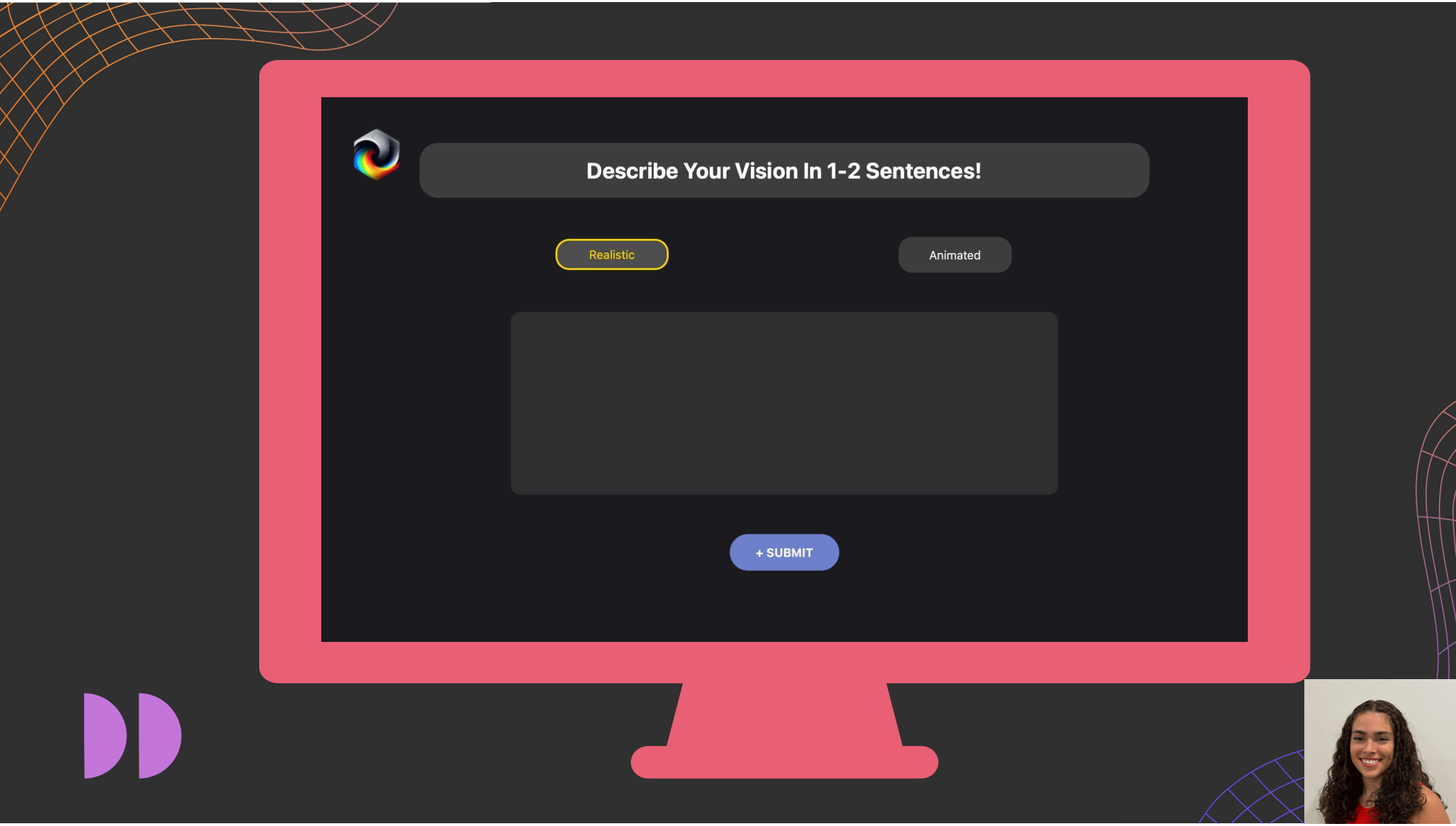


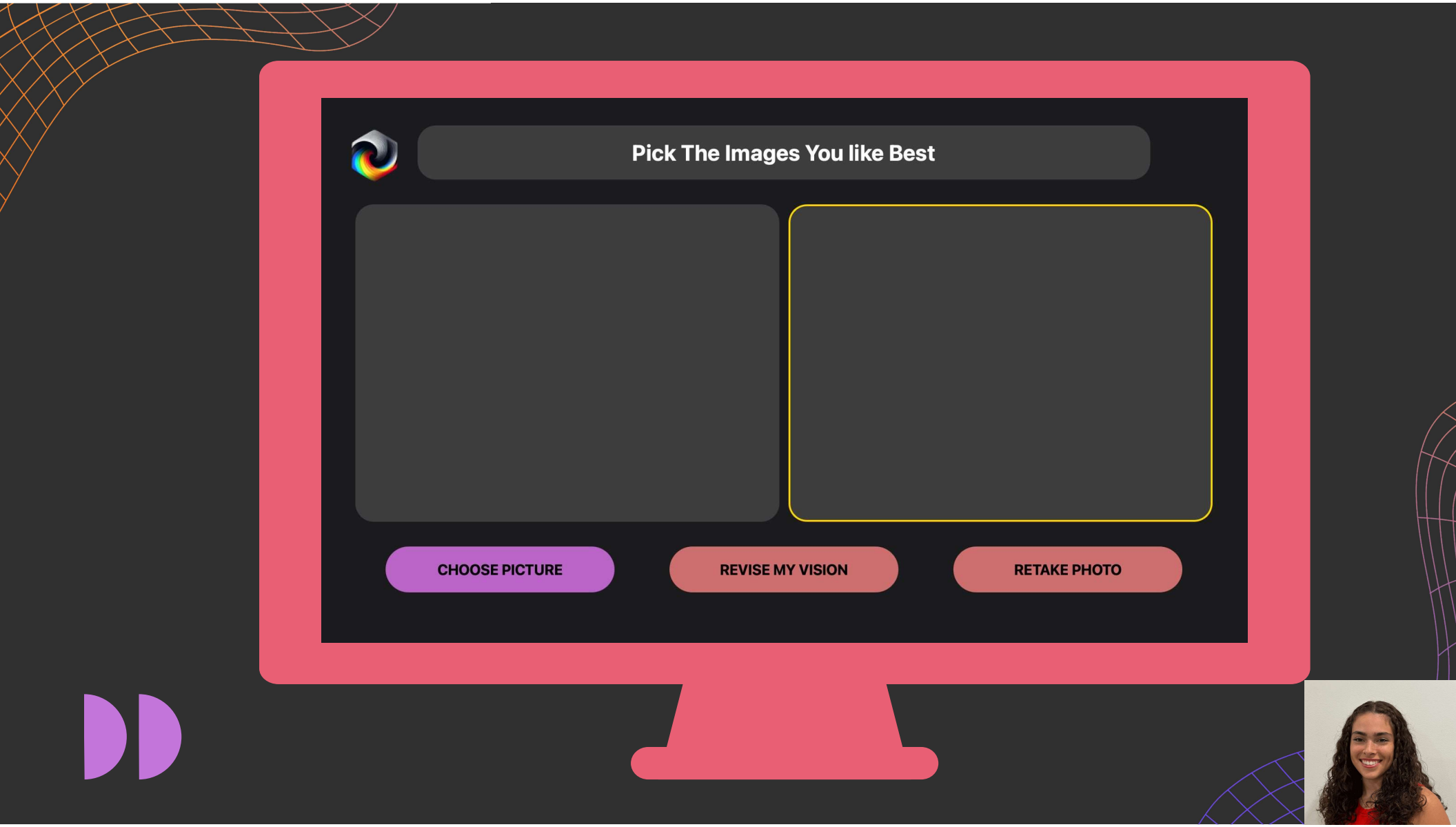
GUI Walkthrough


MAKE YOUR VISION COME TO LIFE
Transform your space with GPMS, an AI-powered projection mapping system to create stunning visuals based on your environment and imagination.
Projection Steps
1) Calibrate the camera
Optimize the system to accurately capture your environment.
2) Input your vision
Input your creative concept and desired outcome.
3) Choose your image
Select an image to project.
Preview of Your Projection Will Appear Here
CREATE YOUR VISION




Change The Sensitivity of the Outline
USA
THIS LOOKS GOOD!
LET'S TRY AGAIN

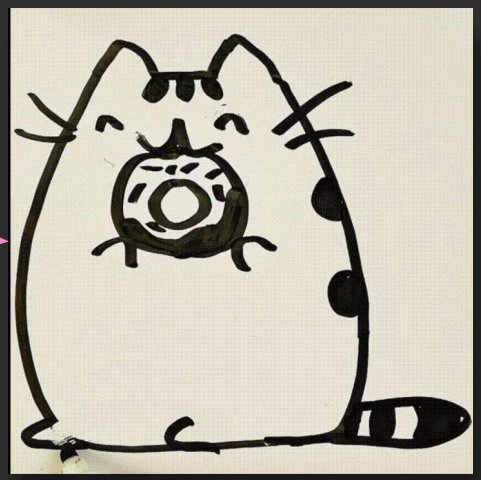

Describe Your Vision In 1-2 Sentences!
Realistic
Animated
+ SUBMIT


Pick The Images You like Best
CHOOSE PICTURE
REVISE MY VISION
RETAKE PHOTO

Prototype

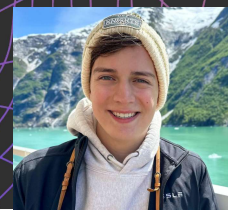
Initial Stable Diffusion Implementation

Doodles



Stable Diffusion

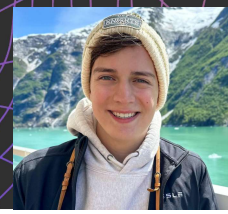
- Generates **images from text** descriptions using a compressed diffusion process



Prototype

Initial Stable Diffusion Implementation

Interior Decoration



04. Standards/ Constraints

Design Standards

HDMI

Provides a dependable/efficient communication channel

TCP

Reliable, acknowledgment drive Transport Protocol

USB

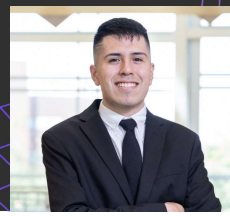
Higher power delivery, versatile

Projector

Resolution for image details

Camera

Resolution, noise, sensitivity, and image quality,



Design Constraints

Economic

Affordable to developers and consumers

Time

Limited time due to administrative efforts of SD1 and integration issues

Ethics

Concerns regarding copyright and inappropriate images

Security

When networking on UCF Wifi safety comes first to protect UCF and our sponsor's machine

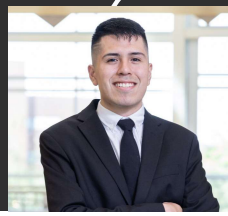
Network Integration

Because the Server exists on UCF's network, you must be on campus to use GPMS

05. Administrative Content

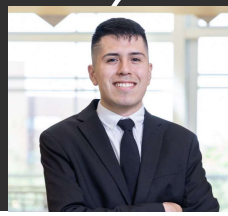
Work Distribution

	Francisco Soriano	Declan Carter	Victoria Moreno
PSU/Hardware Integration	1st	2nd	
Computer Vision Software Stack		2nd	1st
UI Interface Design	2nd		1st
Generative AI Pipeline		1st	2nd
Administrative Contributions	1st	2nd	
Prototype Design	X	X	X

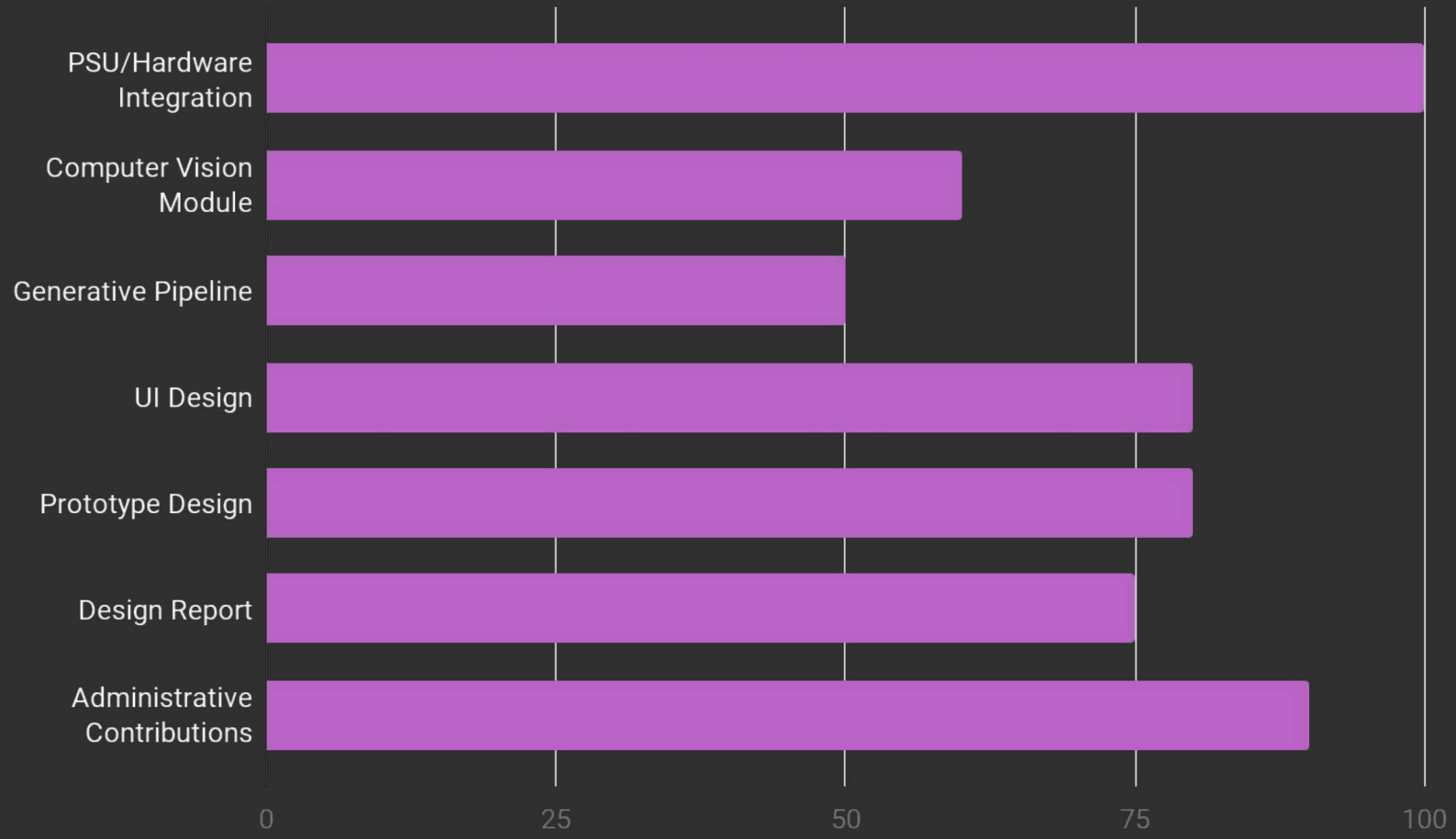


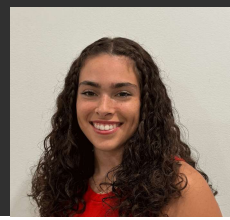
Bill of Materials

Item	Price (USD)
Raspberry Pi 5	60.79
Camera	5.00
Monitor	89.99
Projector	63.89
AMD Machine	3244.44
Total Pre Donation	~3,544.37
Total Post Donation	~219.67



Progress


PSU/Hardware Integration
Computer Vision Module
Generative Pipeline
UI Design
Prototype Design
Design Report
Administrative Contributions
0
25
50
75
100



06.

Closing Remarks

Next Steps

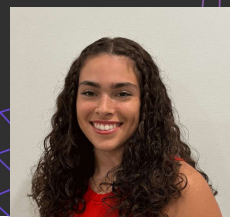
Automate AI Pipeline

Complete the UI

Project Images

Improve Calibration

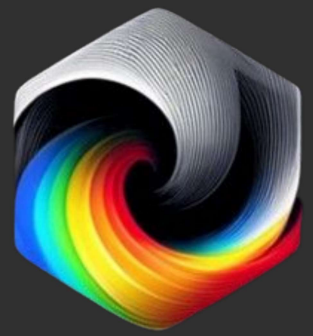
Run Final Tests



Thank You!

Do you have any questions? Let's collaborate!

Our website:
https://maverick.eecs.ucf.edu/seniordesign/sp2024su2024/g17/



GENERATIVE
PROJECTION MAPPING SYSTEM