Team C6: Proj^2

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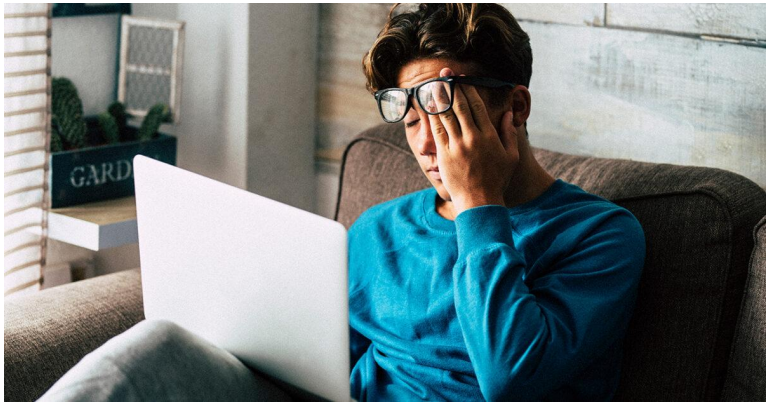
Introduction

It has become the ‘norm’ to stare at a screen for hours on end, creating eye strain and stagnation for many people



Proj^2 (Project Projective) aims to increase worker mobility and decrease eye stress through an interactive projection of your work

Use Cases

Solution: Projected monitor integrated with web application for touchless file navigation and moveable camera, intended for reviewing files by yourself or with a group

Areas: Hardware, Software Systems, Signal Processing

- Reducing eye strain by using projected screen, light is less stressful than emitted light from computer screens
- Going through files in a comfortable setting-standing, sitting, whichever the user prefers
- Lectures and presentations made easy by not having to stand by a computer
- Useful for medical technicians, academics, or avid readers

Requirements: Projection + Camera

Projection Resolution:

- Full HD Resolution of 1920x1080
- 16:9 Aspect Ratio

System Adjustment:

- Projection can be placed on any wall in a room
- Projector and camera are portable and easily mounted
    - Each should weigh less than 3 lb

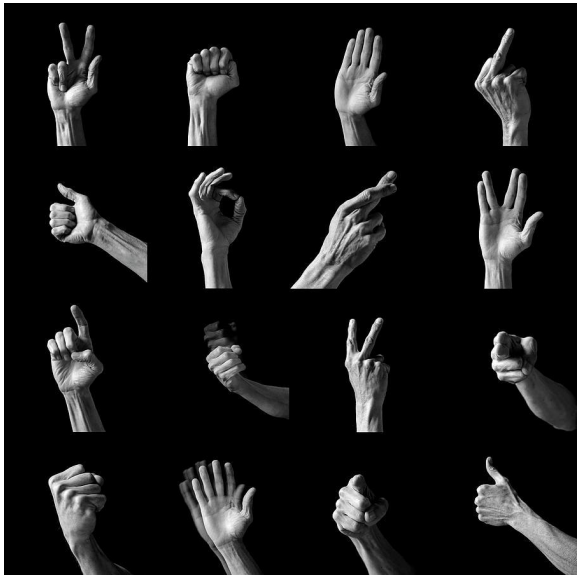
Requirements: Computer Vision

Accuracy:

- 95% accuracy for hand gesture to complete corresponding task
- For every 20 minutes of use, natural body movement is mistaken for gesture only once
- Gestures can be detected within 1 to 10 feet of camera and in bright and dim lighting

Latency:

- CV algorithm detects gesture command in under 30 ms
- Command is processed to web-app in under 2 seconds



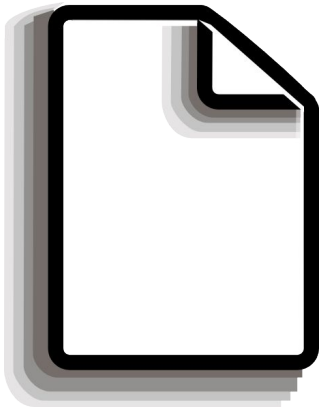
Requirements: Web Application

Web Application Feature Requirements:

- Able to upload image, pdf, and presentation files below 2.5 GB each
- User Authentication using OAuth
- Storage capacity of 15 GB per user
- Ability to support 20 users

Hand Gesture Interface Commands:

- Turn to next or previous page
- Scroll up and scroll down
- Zoom in or Zoom out
- Annotate



Technical Challenges

Projection:

- Ensure user gestures do not interfere with projection
- Simple mounting of system

Computer Vision:

- Calibration so only one person's hand is detected
- Detects user gestures in low lighting and far away
- *Risk Mitigation: Use an easily-detected glove or simpler hand gestures*

Web Application:

- Understanding API to connect computer vision gestures to website functionality
- Creating file viewing capability than can be managed by functions

Solution Approach - Web App, Projection

Web App:

- User authenticated
- Upload files of choice
- Files can be navigated via application functions
- Takes in commands to navigate files via CV pipeline output

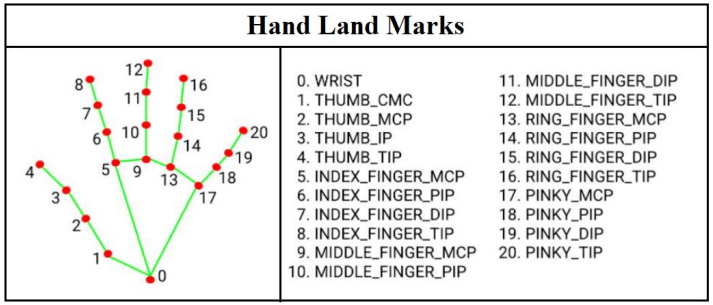
Projection:

- Projector + Camera with adhesive ability

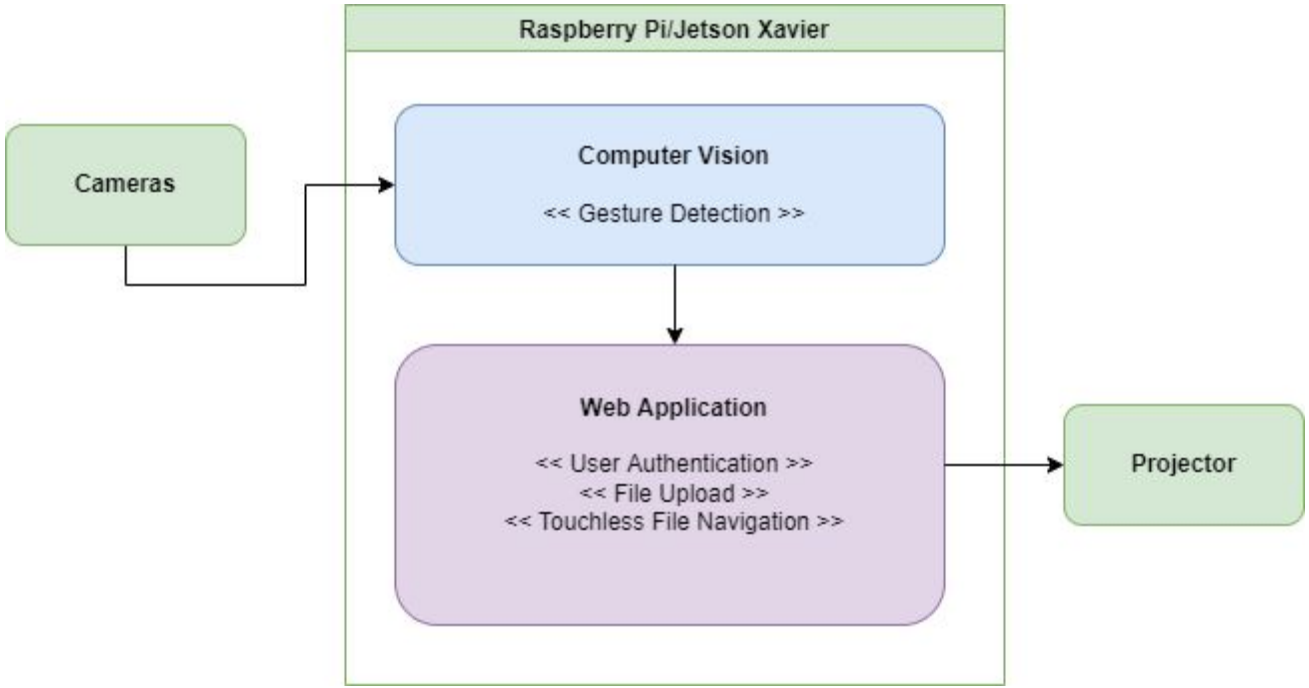
Solution Approach - Hand Detection

Hand Detection

- Camera
  - High pixel resolution
  - Night vision capabilities/Clear frames in low light rooms
- Computer Vision
  - OpenCV for image processing
  - MediaPipe to detect hand key points
  - Recognize gesture commands based on hand key point coordinates



Solution Approach - Diagram



Testing, Verification, and Metrics

Web Application:

- Django unit testing for all functions mapped to hand movement
- Web application responds in under 2 seconds

Hardware:

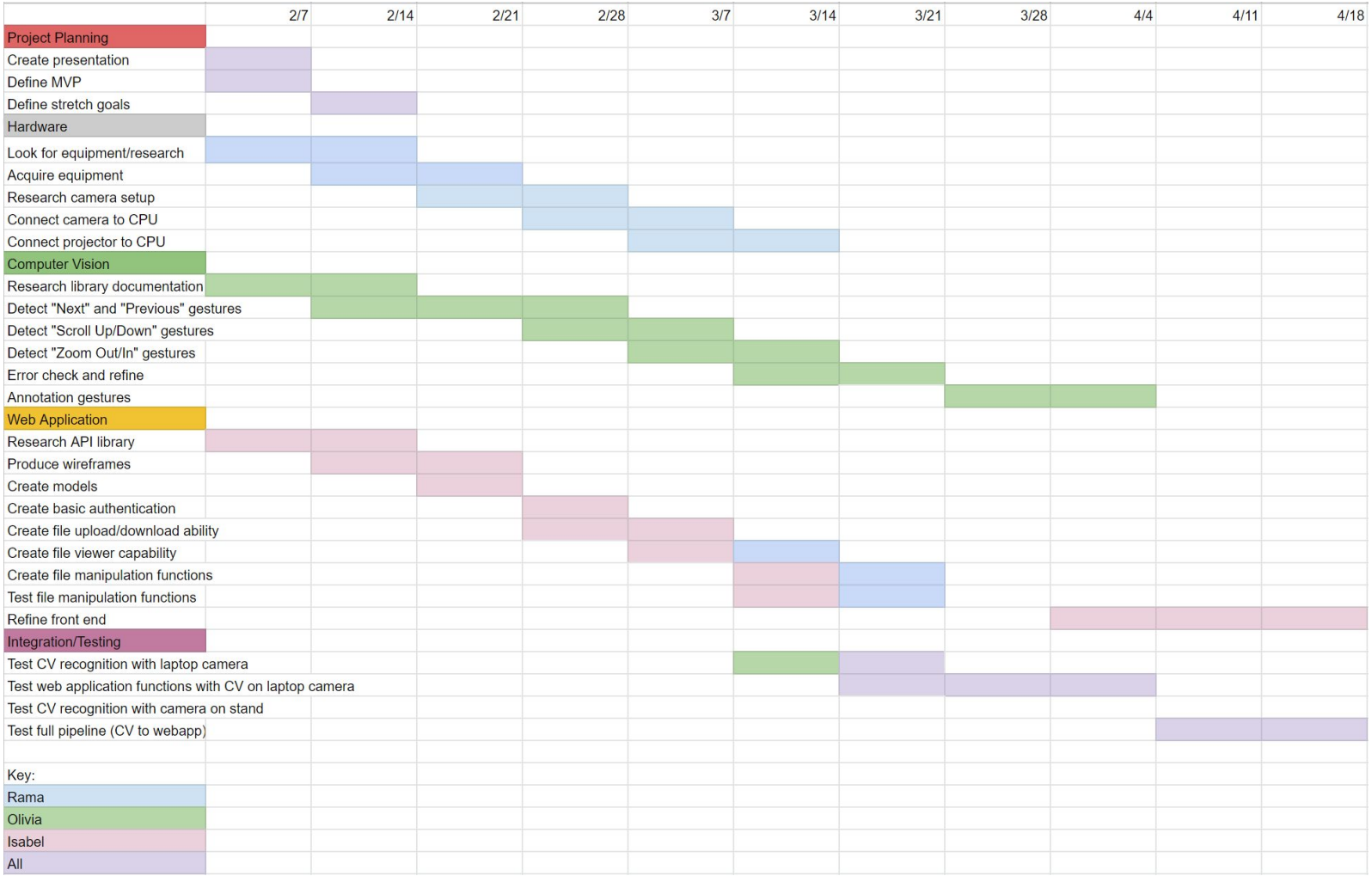
- Verify system mounts on a wall
- Verify that system dismounts without damaging wall

Computer Vision:

- Accuracy test
  - For every 20 gestures, only 1 gesture, at most, does not respond appropriately
  - Begin with testing gestures at 1 foot from camera, gradually increasing up to 10 feet
  - Get gesture accuracy in bright and dim lighting
  - Compare multiple gestures to see which ones perform the best and are the most intuitive
- Latency test
  - Confirm system processes command in < 2 seconds

Division of Work

Hardware/Integration *Rama*	Computer Vision *Olivia*	Web Application *Isabel*
- Build mount for camera - Build mount for projector - Integrate camera and web app	- Hand gesture detection research, implementation, and testing	-Wireframes -API research -User authentication -File viewing -File manipulation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Project Planning
Create presentation
Define MVP
Define stretch goals
Hardware
Look for equipment/research
Acquire equipment
Research camera setup
Connect camera to CPU
Connect projector to CPU
Computer Vision
Research library documentation
Detect "Next" and "Previous" gestures
Detect "Scroll Up/Down" gestures
Detect "Zoom Out/In" gestures
Error check and refine
Annotation gestures
Web Application
Research API library
Produce wireframes
Create models
Create basic authentication
Create file upload/download ability
Create file viewer capability
Create file manipulation functions
Test file manipulation functions
Refine front end
Integration/Testing
Test CV recognition with laptop camera
Test web application functions with CV on laptop camera
Test CV recognition with camera on stand
Test full pipeline (CV to webapp)
Key:
Rama
Olivia
Isabel
All