Project Proposal:

PosePal

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Use Case

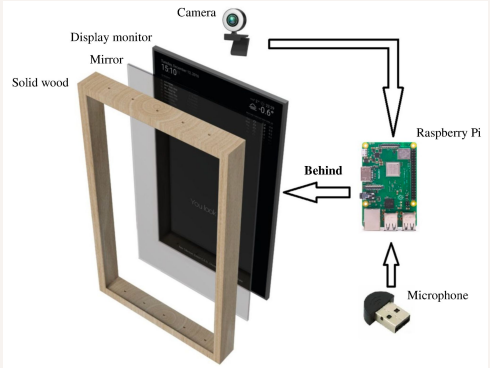
- Many beginners find yoga to be difficult!
- Learning in front of a mirror helps to self-correct and track improvement over time
- In-home solutions to learn yoga are growing in popularity

ECE Areas:

- **Software Systems**: Pose detection and correction algorithms, Mirror UI components
- **Hardware Systems**: Raspberry Pi, LCD screen, Mirror, Camera

OUR SOLUTION:

Smart Mirror that can aid with Pose correction!



Software Solution

STEP 01

Estimate user's pose and position

STEP 02

Compare user pose with reference model

STEP 03

Render and dictate corrections to user for pose improvement

STEP 04

Continue to next pose when pose accuracy within threshold for >= 5s

REQUIREMENTS:

01

Live Feedback

02

Accuracy

03

Accessibility

Requirement #1: LIVE FEEDBACK

Users need to get feedback and corrective suggestions on their poses in real-time to be able to accurately adjust and evaluate their performance to improve over time

- Humans on average take ~100ms to process and recognize visual images
- Benchmark inference time performance of the BlazePose model on a 2019 macbook pro was measured to have a lower bound speed of 38 FPS (approx. 26.3ms)
- We should aim for <= 100 ms overall latency from pose estimation to correction rendering

Requirement #2: ACCURACY

To effectively replace the need for more expensive and inconvenient yoga classes with human instructors, PosePal needs to have reliable corrective suggestions for an enjoyable, positive learning experience that users can trust

- Need high rate of accuracy => (>= 90%) is an achievable goal given reported accuracy of BlazePose model for the pose estimation component (absolute 2D Euclidean error)
- Must maintain this bar of accuracy in our pose correction component, measure accuracy similarly using the same metrics

Requirement #3: ACCESSIBILITY

PosePal system needs to be easy to interact with such that the fitness experience is not disrupted and everyone able to participate in a traditional yoga class can use PosePal

- Users should not need to interrupt the flow of their yoga to interact with the mirror in the middle of an exercise
- Corrective suggestions should be delivered in such a way that users can adjust their pose simultaneously
- Achieve >= 90% user satisfaction rate on survey evaluating accessibility of PosePal

Technical Challenges

Pose Correction

The challenge is to compare the ideal pose with the user's pose and identify the parts of the body that have errors.

Proposed Approaches:

- Comparing body angles
- Scaling the poses to match body height and width
- Creating a machine learning model

Backup Plan:

Do not identify the body parts that have errors and just provide an overall psoe accuracy percentage.

Technical Challenges

Camera and Mirror Coordination

The challenge is to map the coordinates of the reflection in the mirror with the monitor display behind it so the overlay being shown on the monitor matches the person's reflection.

Proposed Approach:

- Calibrate location on camera and understand the parts of the feed that shows up on the mirror
- Determine the scaling ratio of the camera feed and the mirror and identify what monitor coordinate maps to what part of the mirror

Backup Plan:

Do not use a mirror and just show the camera feed of the person on the monitor

Testing & Verification

Test	Metric
Pose Correction Accuracy - Work with a yoga instructor to test our pose correction system.	Absolute 2D Euclidean Error (%)
Latency of the system - Monitor the time it takes the system to provide pose correction feedback	Number of millisecond for feedback (ms)
Accessibility - Have multiple users test the system and monitor how long it takes them to understand how the system works	Average number of questions per user (#); Average time it takes a person to understand the instructions (sec)

Tasks breakdown

Topic	Task	Week ->	February 3	4	5	6	March 7	8	9	10	April 11	12	13	14
Yoga Expert Interview	Gather ideal yoga poses													
	Identify currect error detection methods													
Pose Teaching	Pose Detection													
	Pose Comparison													
	Error Identification													
Hardware Construction	Material Acquisition													
	Woodworking													
	Physical Contstruction													
	Camera Integration													
Mirror-Camera Coordination	Camera Callibration													
	Coordinate Mapping													
Mirror UI	Error Display													
	Magic Mirror Library Integration													
	Audio Feedback on error													
Testing & Validation	Pose Accuracy testing													
	Latency testing													
	User Testing													
Slack & Bonus	Yoga Mat usage													
	Adding user profile													
	Hand gesture interaction													

Ankita: Hardware construction, Mirror Camera Integration

Sruti: Mirror UI and Error Display

Youssef: Pose Detection/Correction