Work It

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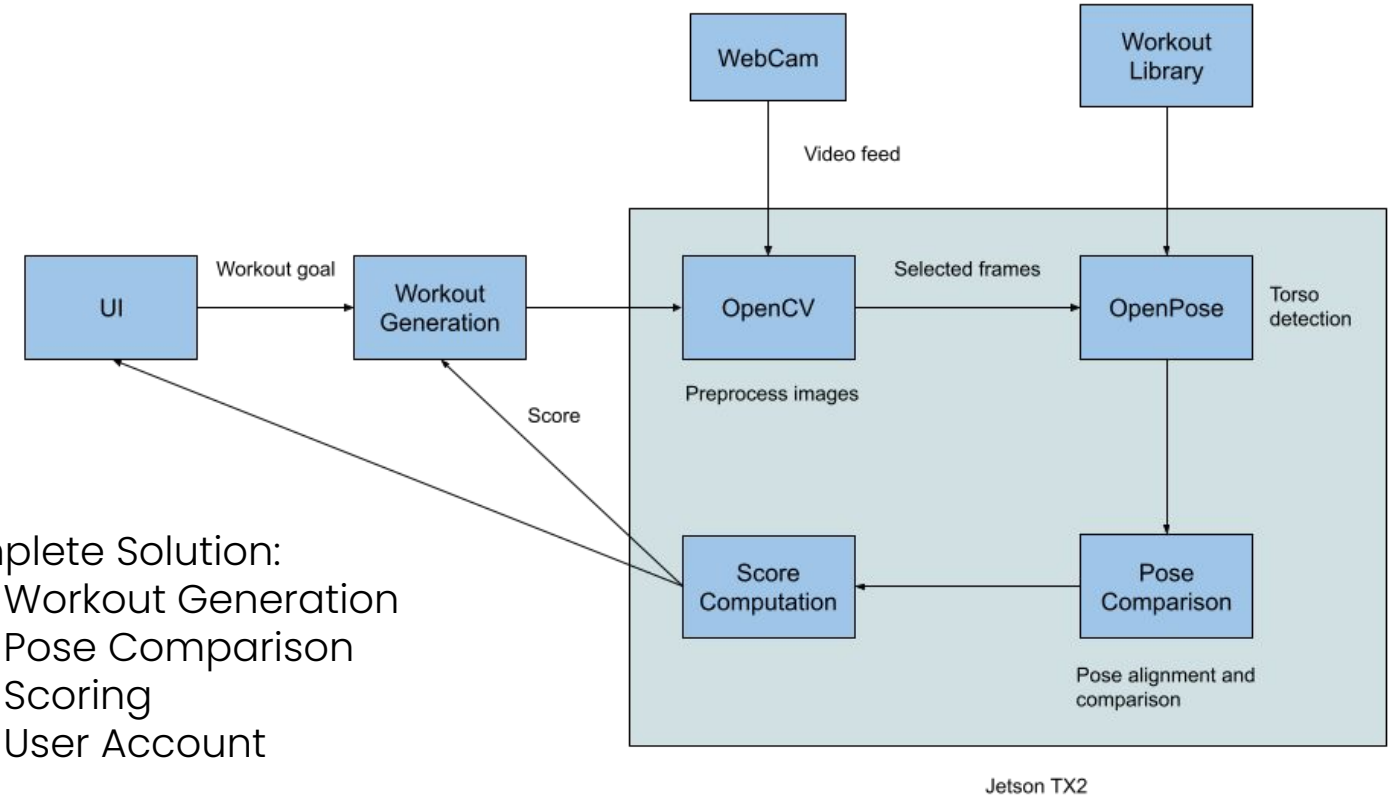
1. Generate user specific workouts to cater to their fitness level

2. Use Tensorflow OpenPose to analyze body position of the model and the user

3. Give the user a score for their workout

Block Diagram



Complete Solution:

- Workout Generation
- Pose Comparison
- Scoring
- User Account

Software & Hardware

Generate workout sequence based on user's workout goal and the fitness level

Workout Generation

OpenCV
- Preprocessing
- Frame Selection

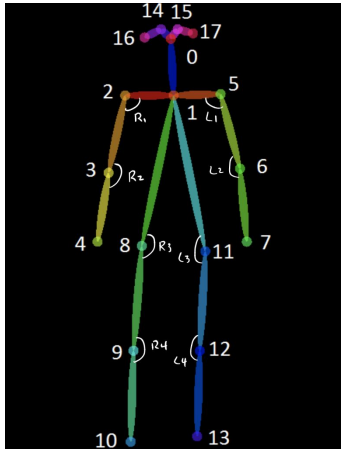
OpenPose
- Torso Detection
- Calibration

Pose Comparison
- Pose Alignment

Score Computation

Compute the user's score based on the comparison results

Evaluate the user's fitness level based on the score and adjust the difficulty level



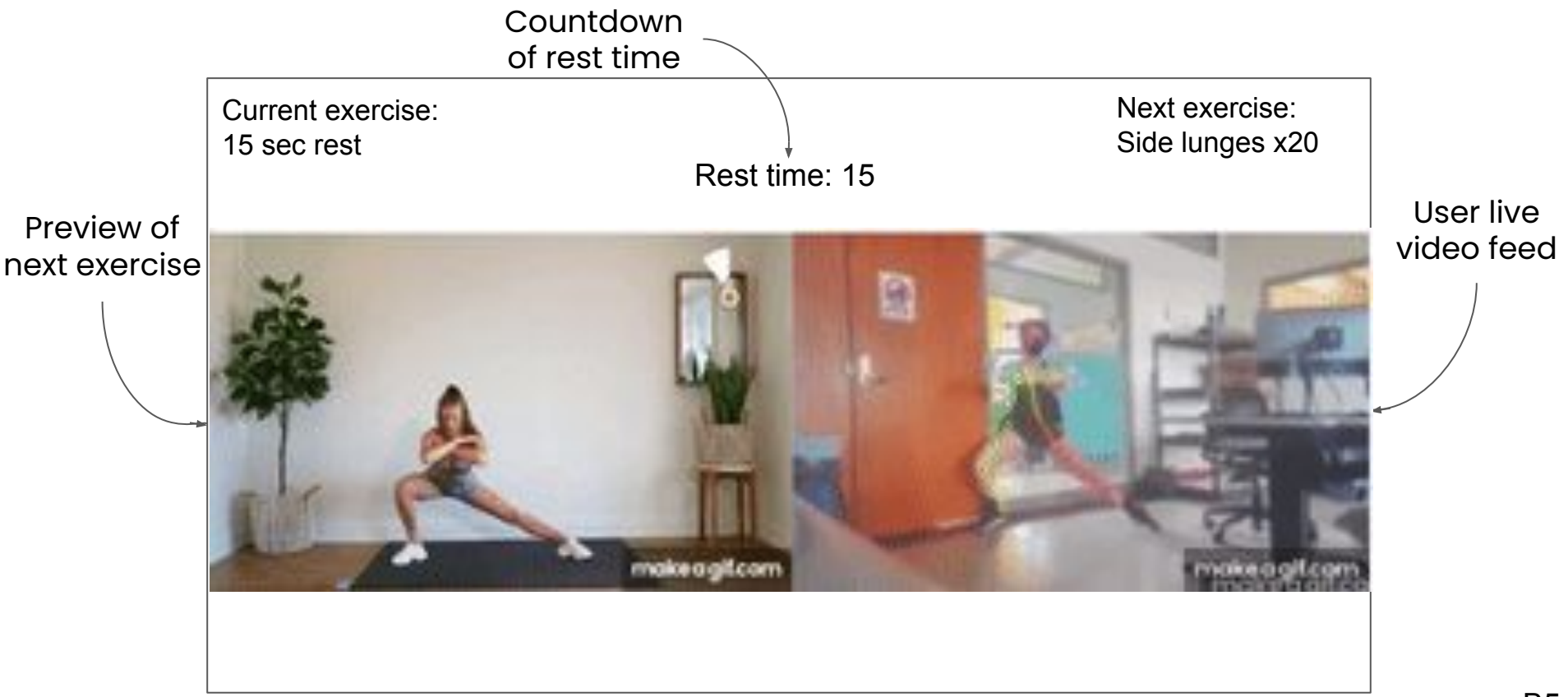
WebCam

Laptop
- UI
- Workout Generation
- Workout Library

NVIDIA Jetson TX2
- OpenCV
- OpenPose
- Posture Analysis

System Specification - UI

System Specification - UI



Pose Comparison

	A	B	C	D	E	F	G	H
1	workout	frame_numb	timestamp	duration	total_frame	coordinates	angles	
2	arm1_1	3	[4, 11, 23]	1.7	27	[[(231, 60), (	[[2.4227626539681686,	
3	arm1_2	2	[1, 9]	0.8	14	[[(231, 60), (	[[2.9708574421145104,	
4	arm1_5	2	[1, 18]	3	44	[[(316, 225),	[[1.6718996985311951,	
5	arm1_6	4	[1, 30, 53, 75	6.2	94	[[(158, 182),	[[0, 0, 2.5884951166780	
6	leg1_1	2	[1, 35]	5	77	[[(267, 134),	[[1.317902261699299, 1	
7	leg1_2	2	[1, 23]	2.5	41	[[(200, 56), (	[[0.7378150601204649,	
8	leg1_3	2	[5, 29]	2.1	41	[[(227, 66), (	[[0.4831256648173338,	
9	leg1_2.1	2	[1, 17]	2.2	36	[[(273, 57), (	[[2.8883268873590406,	
10	leg1_4	3	[8, 20, 43]	3	46	[[(256, 62), (	[[3.004526479279605, 0	
11	core1_1	3	[1, 23, 62]	6	79	[[(158, 207),	[[2.5207447236329314,	
12	core1_4	1	[19]	2.2	34	[[(193, 200),	[[0, 0, 1.7089392929813	
13	arm1_8	3	[1, 31, 91]	7.4	112	[[(280, 157),	[[0, 0, 0, 0, 1.986510201	
14	leg1_5	2	[1, 30]	4.1	52	[[(160, 104),	[[0.47835243137865757	
15	leg2_2	2	[1, 18]	2.4	37	[[(238, 59), (	[[0.5328438876193887,	
16	leg2_3	3	[1, 18, 51]	4	63	[[(247, 60), (	[[1.7625844687816017,	
17	arm1_5.1	2	[1, 23]	2.8	44	[[(196, 178),	[[1.406374921979318, 2	
18	arm1_13	2	[1, 45]	5.4	81	[[(187, 69), (	[[3.141592653589793, 2	
19	core2_5	4	[1, 29, 55, 83	7.2	108	[[(160, 191),	[[0, 0, 2.3482790882236	
20	core1_11	3	[1, 18, 45]	3	57	[[(164, 219),	[[0.3332443011116726,	
21	arm2_5	3	[1, 23, 62]	4.7	72	[[(342, 176),	[[2.203214145589375, 3	
22	arm2_6	2	[6, 12]	0.7	12	[[(329, 186),	[[0.8760580505981935	

Metrics

Requirements	Testing	Metrics
Hardware Performance	Time how long it takes to analyze sets of images	< 1 min time limit
OpenPose Detection	Analyze runtime and accuracy for different image sizes/poses	90% accuracy
Pose Alignment	Analyze comparison results over different body types	90% accuracy
Pose Comparison	Test with similar poses/workout exercises	90% accuracy
Score Computation	Analyze the scores over different levels of completion	Score should reflect user's completion and accuracy

OpenPose Testing

Model	Avg Runtime(s)	Accuracy
CMU	1.14478	86%
Mobilenet_thin	0.23142	42%
Mobilenet_v2_large	0.23196	60%
Mobilenet_v2_small	0.16870	36%

Number of images = 50, Resize = 432x368

Workout	Avg Runtime(s)	Accuracy
Elbow to Knee	1.08485	70%
Rotating T Plank	1.08589	100%
Russian Twist	1.09047	90%
Side Lunges	1.09385	100%
Standing Extension	1.09028	90%

Model = CMU, Number of images = 10 per workout, Resize = 432x368

CMU Mobilenet_thin

Pose Comparison Testing

Frame Size	Avg Accuracy
160x96	72%
432x368	90%
656x432	88%

Workout	Avg Threshold (radian)	Avg Accuracy
Arm	7.4	91.67%
Core	11.87	76.19%
Leg	9.12	94.12%

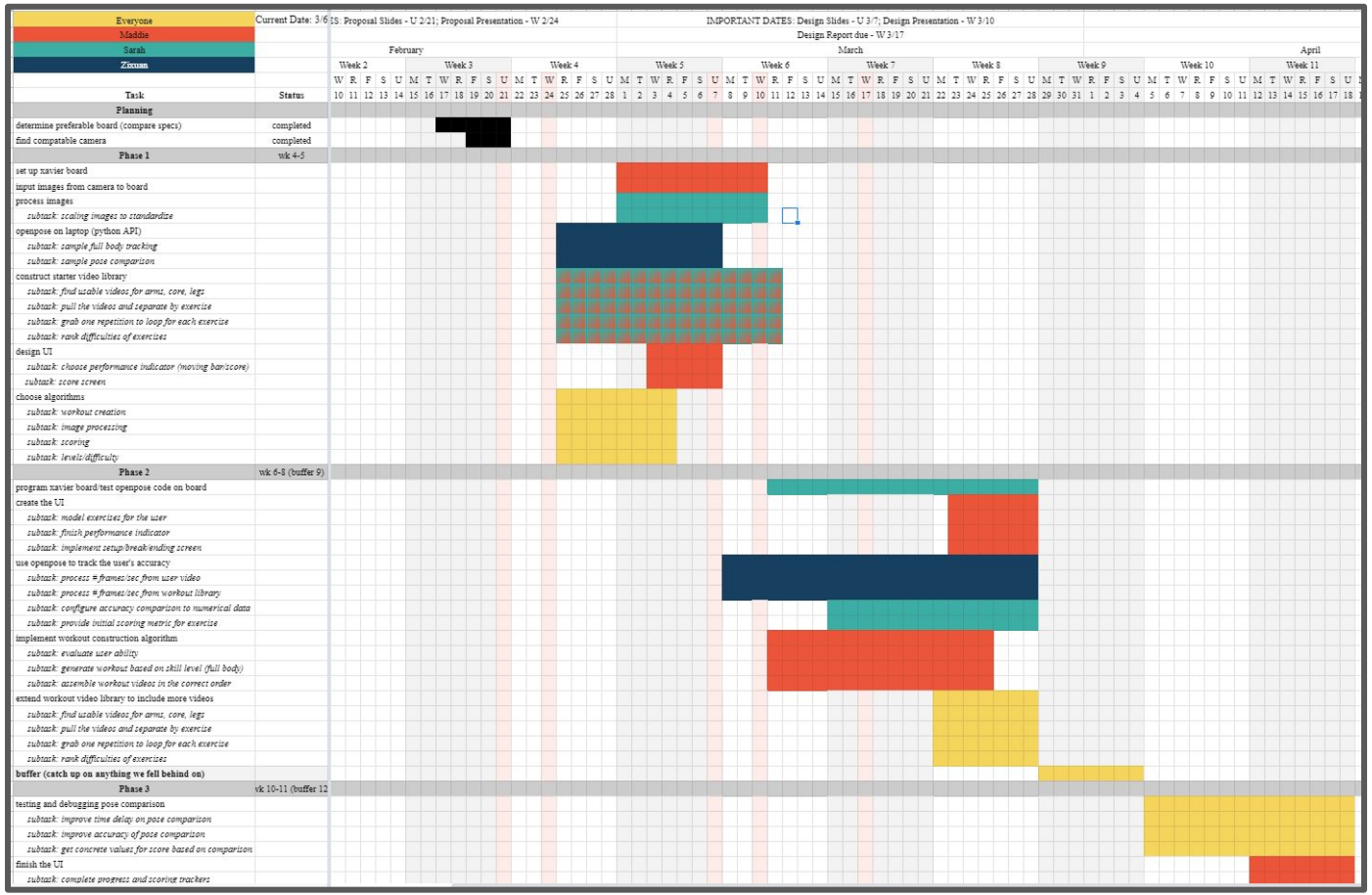
Pose Comparison Testing

	Full Repetitions (expected)	**Full Repetitions (actual)**	**Partial Repetitions** (50% of **expected** amount)	**Partial Repetitions (actual)**
Good Form ('User video' is a similar YouTube clip of same exercise)	Base score	600	≈ Base score * 0.5	300
Poor Form (Ex: side lunges that only go down to 45° bend that should be 90°)	≈ Base score * 0.5	400	<= Base score * 0.25	100

Challenges

- Dependencies on Xavier board
  - Tensorflow
- Ensuring UI and pose comparison code work in parallel
- Initial testing didn’t have a suitable background
  - Lighting
  - Plain background
- OpenPose detection for some exercises

Gantt Chart


Everyone
Maddie
Sarah
Zixuan
Current Date: 3/6
IMPORTANT DATES: Proposal Slides - U 2/21; Proposal Presentation - W 2/24
IMPORTANT DATES: Design Slides - U 3/7; Design Presentation - W 3/10
Design Report due - W 3/17
February
March
April
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Task
Status
Planning
determine preferable board (compare specs)
completed
find compatable camera
completed
Phase 1
wk 4-5
set up xavier board
input images from camera to board
process images
subtask: scaling images to standardize
openpose on laptop (python API)
subtask: sample full body tracking
subtask: sample pose comparison
construct starter video library
subtask: find usable videos for arms, core, legs
subtask: pull the videos and separate by exercise
subtask: grab one repetition to loop for each exercise
subtask: rank difficulties of exercises
design UI
subtask: choose performance indicator (moving bar/score)
subtask: score screen
choose algorithms
subtask: workout creation
subtask: image processing
subtask: scoring
subtask: levels/difficulty
Phase 2
wk 6-8 (buffer 9)
program xavier board/test openpose code on board
create the UI
subtask: model exercises for the user
subtask: finish performance indicator
subtask: implement setup/break/ending screen
use openpose to track the user's accuracy
subtask: process # frames/sec from user video
subtask: process # frames/sec from workout library
subtask: configure accuracy comparison to numerical data
subtask: provide initial scoring metric for exercise
implement workout construction algorithm
subtask: evaluate user ability
subtask: generate workout based on skill level (full body)
subtask: assemble workout videos in the correct order
extend workout video library to include more videos
subtask: find usable videos for arms, core, legs
subtask: pull the videos and separate by exercise
subtask: grab one repetition to loop for each exercise
subtask: rank difficulties of exercises
buffer (catch up on anything we fell behind on)
Phase 3
wk 10-11 (buffer 12
testing and debugging pose comparison
subtask: improve time delay on pose comparison
subtask: improve accuracy of pose comparison
subtask: get concrete values for score based on comparison
finish the UI
subtask: complete progress and scoring trackers