Taichine–

A New Way to Learn Tai Chi

18-500 ECE Capstone Project, Team B4
Sirui (Ray) Huang, Hongzhe Cheng, Shiheng Wu, Jerry Feng

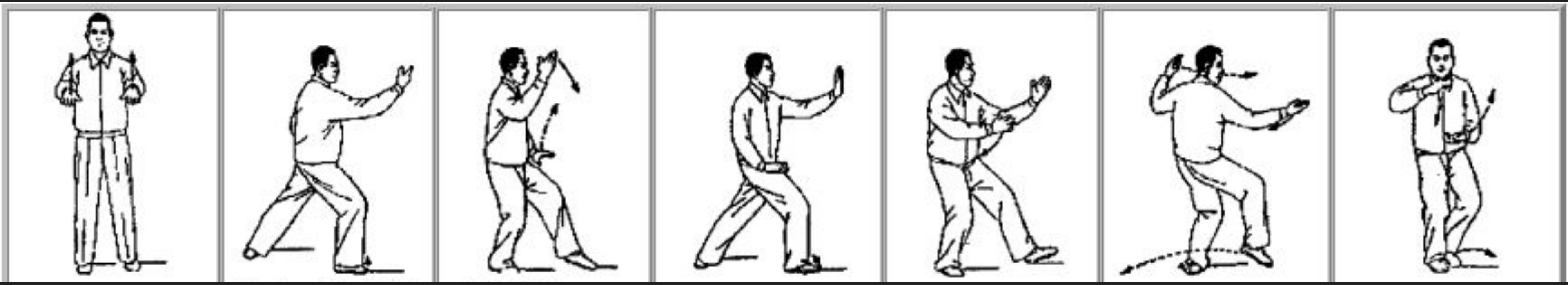
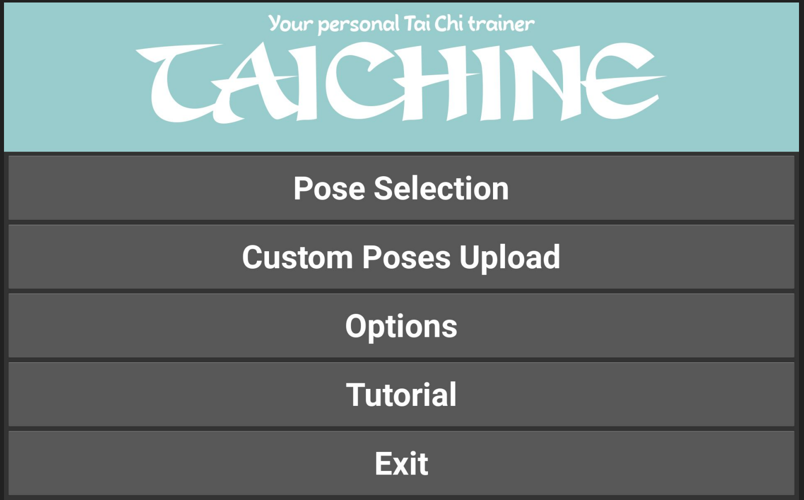
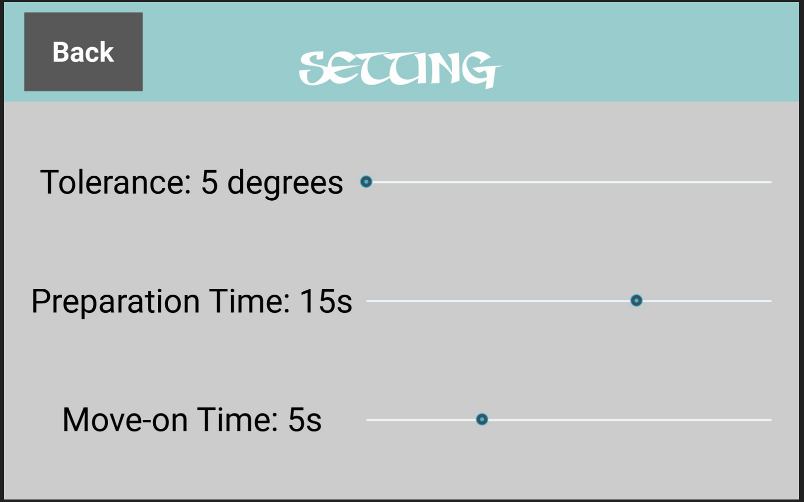


Image from: http://taichisnob.blogspot.com/2013/03/an-introduction-to-24-posture-yang-tai.html

Use Case & Requirement

- Interactive Taichi Instruction App for Beginners
  - Accessibility
  - Customizability
- Verbal instructions
  - 90% – error joint detection
  - 10 degree – body angle error
  - 4s – feedback generation
- Custom Pose Upload/Processing
- Tunable Parameters
- Easy to use once installed





Tolerance: 5 degrees

Preparation Time: 15s

Move-on Time: 5s

Solution Approach

- **Real-time Instruction Pipeline**
  - Allow users to practice Tai Chi/Custom Pose in front of camera
  - Real-time user input -> Pose Processing -> Reference Comparison -> Verbal Instruction
- **Customization Pipeline**
  - Allows user to store postures as new reference

System Diagram

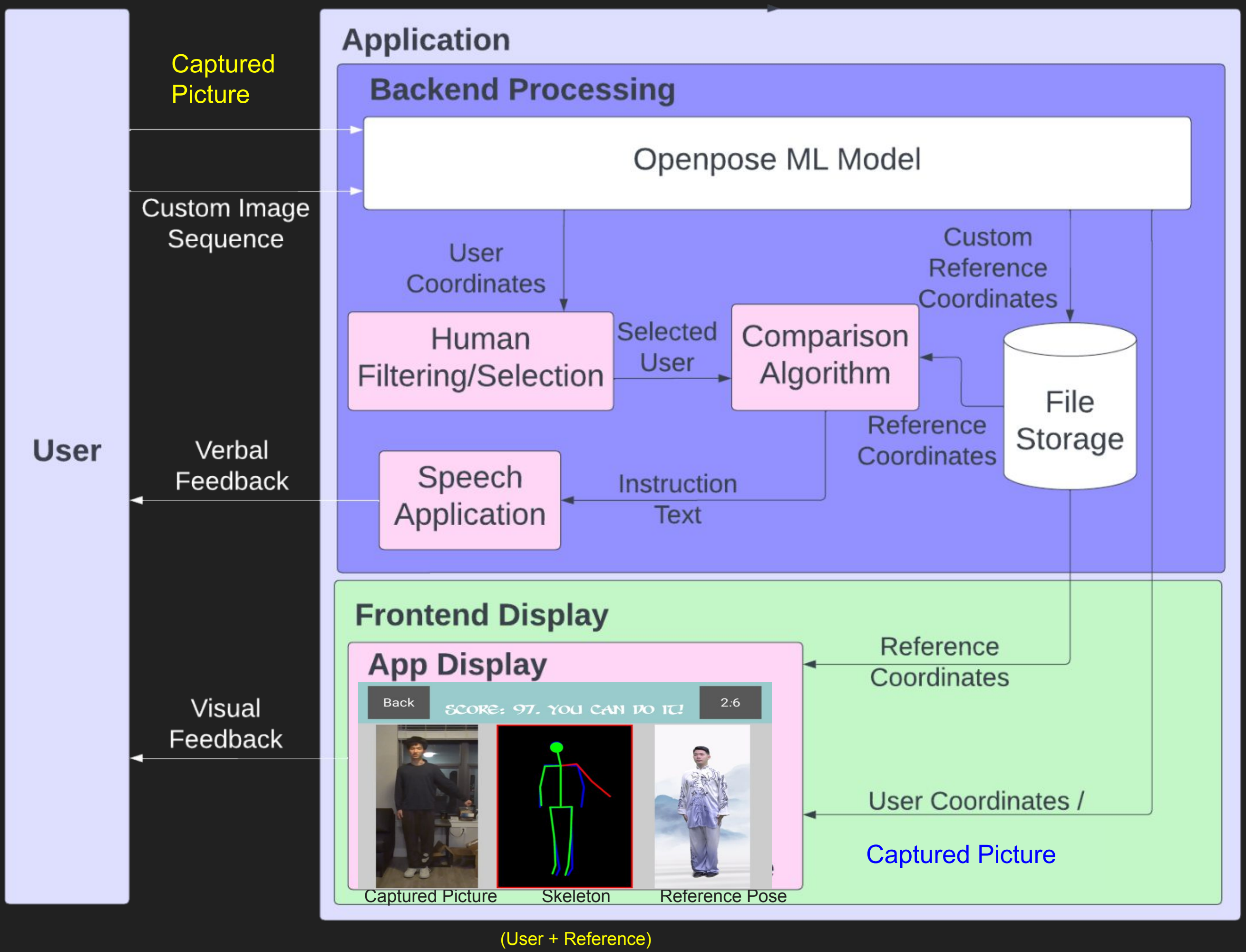
Diagram Key

□ Off the Shelf Library/Framework

🟪 New Design

🟦 Backend Module

🟩 Frontend Module



User

Captured Picture

Custom Image Sequence

Verbal Feedback

Visual Feedback

Application

Backend Processing

Openpose ML Model

User Coordinates

Custom Reference Coordinates

Human Filtering/Selection

Selected User

Comparison Algorithm

Reference Coordinates

File Storage

Speech Application

Instruction Text

Frontend Display

App Display

Back

SCORE: 97. YOU CAN DO IT!

2:6

Captured Picture

Skeleton

Reference Pose

Reference Coordinates

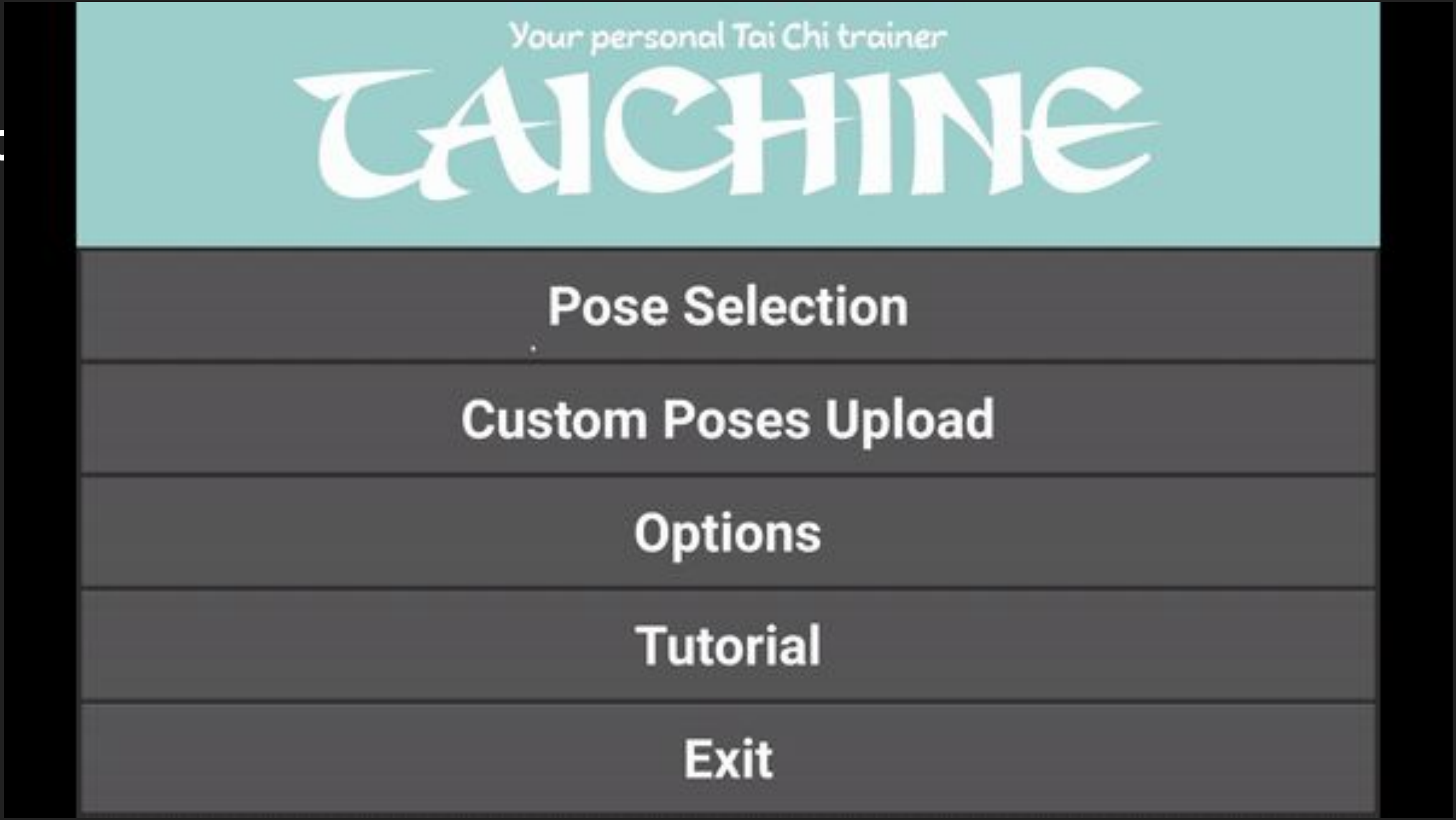
User Coordinates /

Captured Picture

(User + Reference)

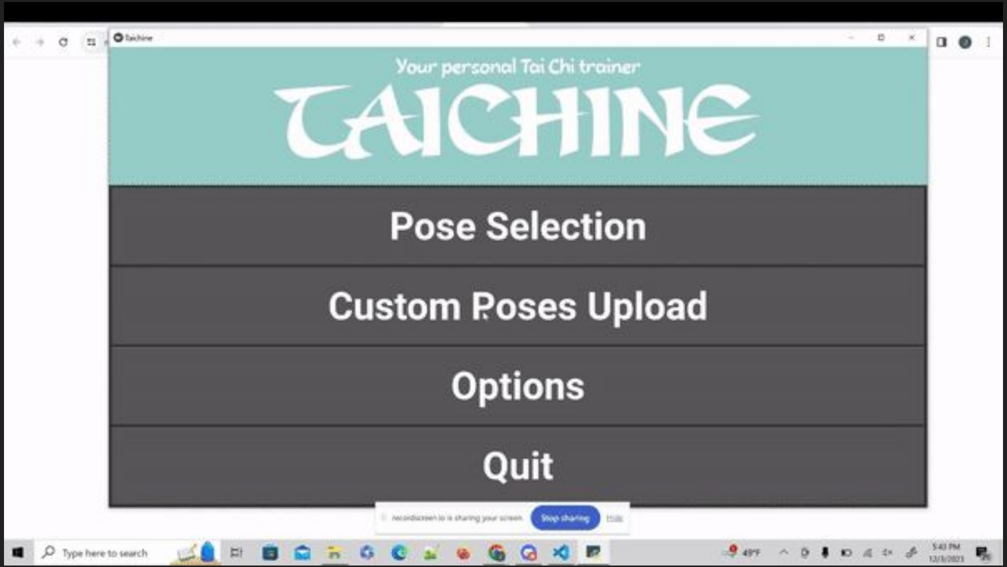
Complete Solution

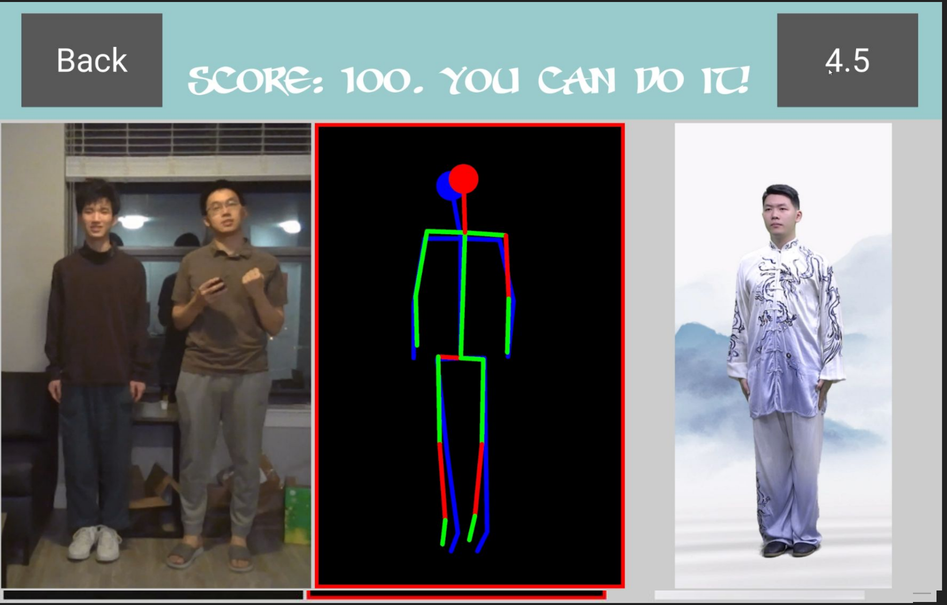
- Po



Complete Solution

- **Custom Pose Upload**
  - Upload, order and name a sequence of custom images
  - Automatic OpenPose image processing





Testing Strategy and Process

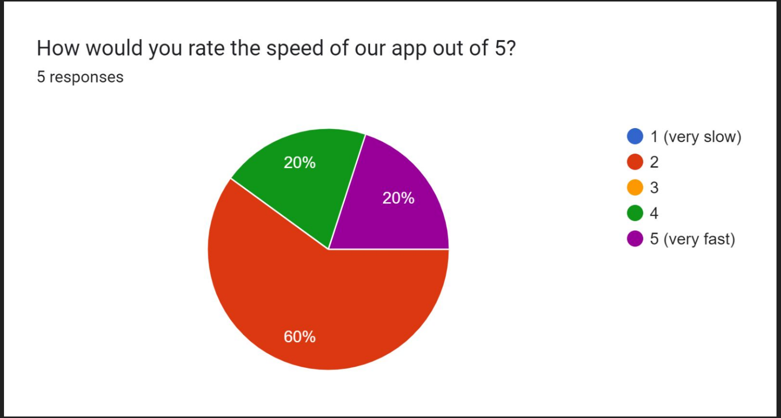
- Error body part testing
- Error priority testing
- Environment Lighting
- User pose selection

Metrics

Metric Name	**Desired**	Actual
Total Backend Runtime	/	7s
Wait Time until Instruction	4s	3.6s
OpenPose Runtime	/	3.1s
Comparison Algorithm Runtime	/	0.5s
Accuracy for error body part	90%	95%
Average angle difference	10 degrees	5 degrees

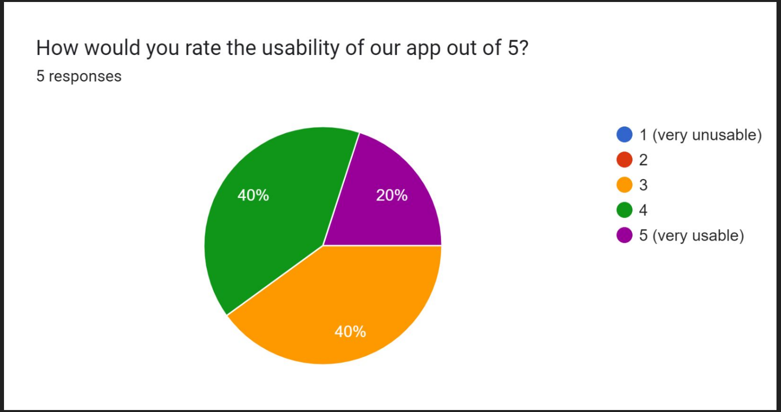
User Investigation

- Settings
  - Poses tested – Commence Form, Repulse the monkey
  - Tolerance tested – 15/20 degrees
  - User tuned preparation time
- Results
  - 20-degree Tolerance preferred
  - Varied opinions on Posture Scores
  - Varied opinions on Preparation Time



How would you rate the speed of our app out of 5?

5 responses



How would you rate the usability of our app out of 5?

5 responses

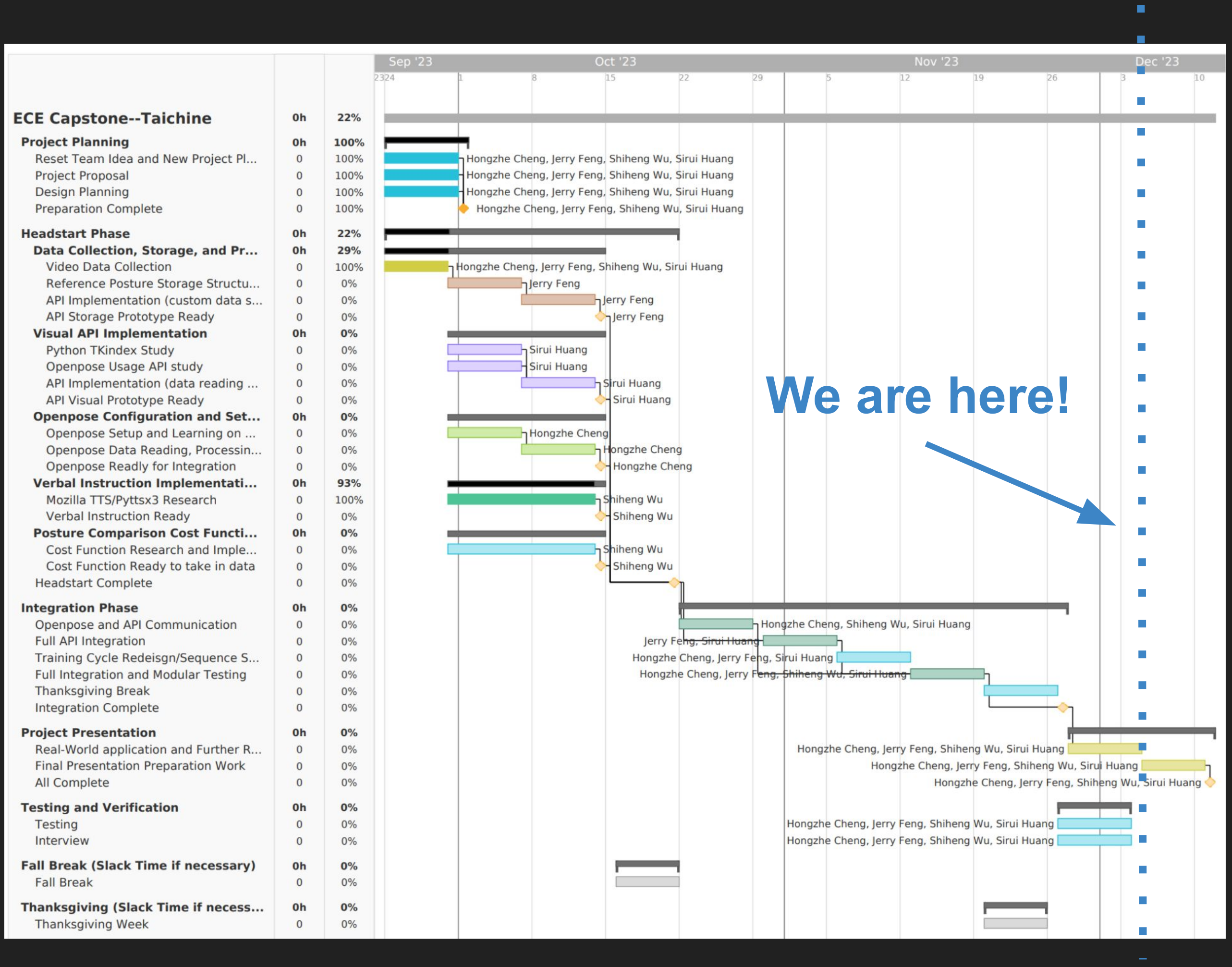
Design Tradeoffs

- TTS Engine Changed to pyttsx3
  - Performance (Voice Generation): 15s vs <1s
  - Storage concerns: 2 GB vs 40KB
- Training Screen Widget Size
  - Accessibility and size of widgets tradeoff
- Local Application
  - Speed and privacy
- PC Device choice
  - Screen size and accessibility

Project Management

Things to Try out

- Training screen display tuning
- Guidance Page Development
- More User testing
- Frontend design tweaking



We are here!

ECE Capstone--Taichine	0h	22%	
Project Planning	0h	100%	
Reset Team Idea and New Project Pl...	0	100%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Project Proposal	0	100%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Design Planning	0	100%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Preparation Complete	0	100%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Headstart Phase	0h	22%	
Data Collection, Storage, and Pr...	0h	29%	
Video Data Collection	0	100%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Reference Posture Storage Structu...	0	0%	Jerry Feng
API Implementation (custom data s...	0	0%	Jerry Feng
API Storage Prototype Ready	0	0%	Jerry Feng
Visual API Implementation	0h	0%	
Python TKindex Study	0	0%	Sirui Huang
Openpose Usage API study	0	0%	Sirui Huang
API Implementation (data reading ...	0	0%	Sirui Huang
API Visual Prototype Ready	0	0%	Sirui Huang
Openpose Configuration and Set...	0h	0%	
Openpose Setup and Learning on ...	0	0%	Hongzhe Cheng
Openpose Data Reading, Processin...	0	0%	Hongzhe Cheng
Openpose Readly for Integration	0	0%	Hongzhe Cheng
Verbal Instruction Implementati...	0h	93%	
Mozilla TTS/Pyttsx3 Research	0	100%	Shiheng Wu
Verbal Instruction Ready	0	0%	Shiheng Wu
Posture Comparison Cost Functi...	0h	0%	
Cost Function Research and Imple...	0	0%	Shiheng Wu
Cost Function Ready to take in data	0	0%	Shiheng Wu
Headstart Complete	0	0%	
Integration Phase	0h	0%	
Openpose and API Communication	0	0%	Hongzhe Cheng, Shiheng Wu, Sirui Huang
Full API Integration	0	0%	Jerry Feng, Sirui Huang
Training Cycle Redeisgn/Sequence S...	0	0%	Hongzhe Cheng, Jerry Feng, Sirui Huang
Full Integration and Modular Testing	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Thanksgiving Break	0	0%	
Integration Complete	0	0%	
Project Presentation	0h	0%	
Real-World application and Further R...	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Final Presentation Preparation Work	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
All Complete	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Testing and Verification	0h	0%	
Testing	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Interview	0	0%	Hongzhe Cheng, Jerry Feng, Shiheng Wu, Sirui Huang
Fall Break (Slack Time if necessary)	0h	0%	
Fall Break	0	0%	
Thanksgiving (Slack Time if necess...	0h	0%	
Thanksgiving Week	0	0%	

Reflections

- Public health & Safety
  - Custom tolerances for users with limited mobility
  - Respect user privacy by not saving images
- Lessons Learned
  - Careful research on library latencies (Tkinter, Kivy, TTS, Openpose, etc.)
  - Don’t underestimate difficulty of integration
  - Importance of slack time
- Conclusion
  - Provide accessibility and flexibility for interactive teaching for people with modern technology