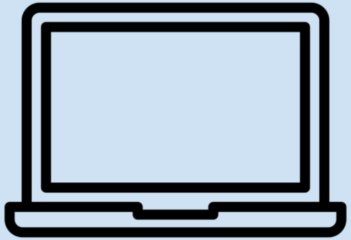
Content

Use Case

- ➔ The problem: Real time instruction is costly and inaccessible, especially for learning casual dances from social media
- ➔ Our solution: A virtual, AI powered dance coach that uses your webcam to analyze your moves and provide feedback as you follow along with any dance video
- ➔ Tracks and scores dance moves using computer vision tools
- ➔ Uses a webcam for motion tracking and 3D modeling
- ➔ Provides an accessible and inexpensive learning tool for casual dancers

Use Case Requirements



Hardware
Accessibility

Input Video
Compatibility

Computer Vision Requirements

Processing speed	Feedback on a 3 minute dance should take no more than 1 minute to generate on consumer grade hardware (Apple M3)
Depth	Full 3-dimensional movement reconstruction from 2D video
Granularity	>=20 key body points tracked
Accuracy	<=10cm for limb position tracking
UDP-Based Networking	CV packet transmission rate of ≥ 20 packets per second

Feedback Requirements

Score Accuracy	Per-limb accuracy scores within ±10%
Timing Tracking	Timing deviation measured in ±50ms increments
3D Modeled Avatar Representation	Generate corrections for moves with >20% deviation from reference input video
Improvement Metrics	Track improvement across 5+ key metrics
Progress Reporting	Generate progress reports after every 5 attempts
Performance Benchmarking	Maintain >= 30 FPS in Unity

Solution Approach

1. Motion Capture:

- OpenCV + AI-Driven LandMark Pose Detection

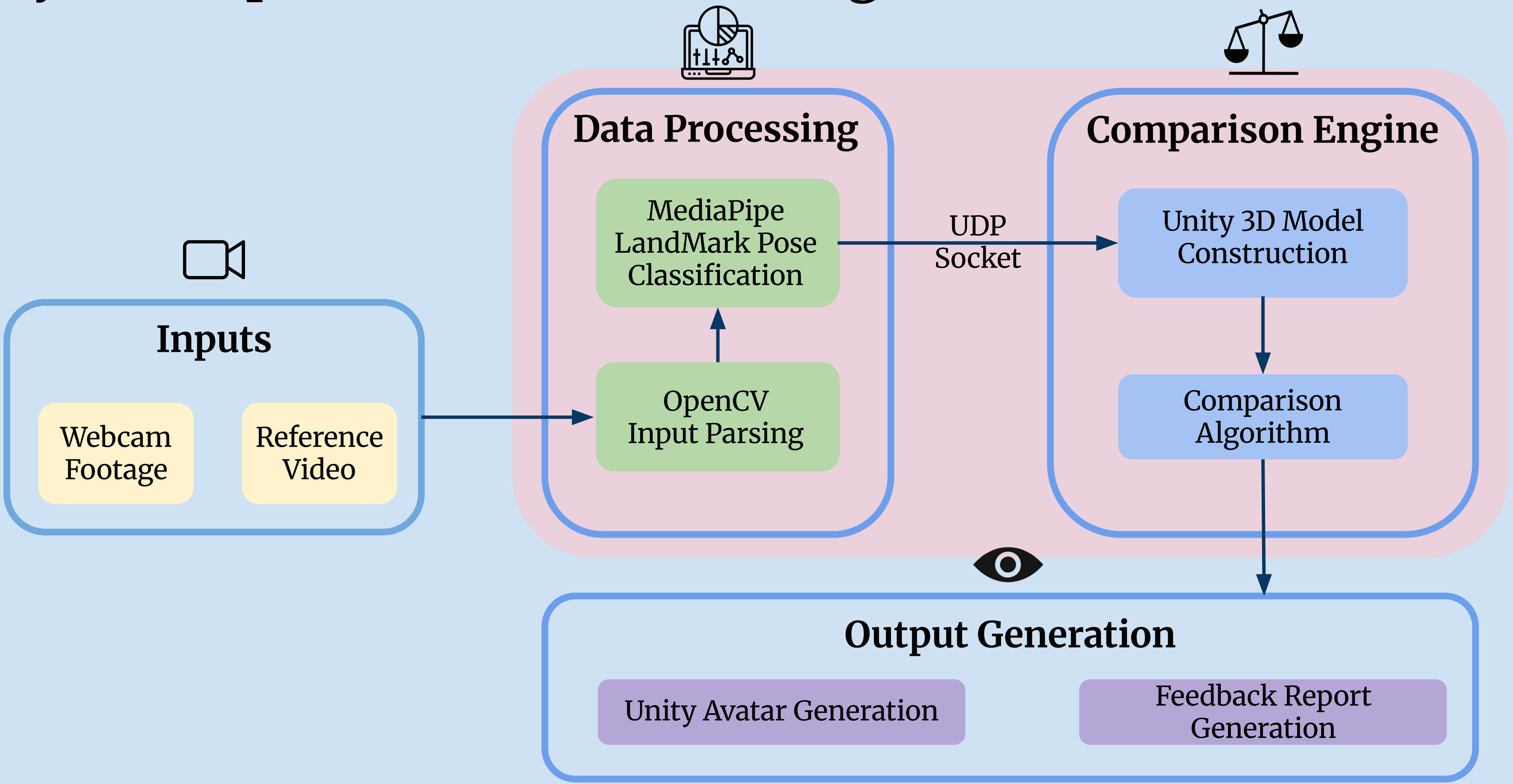
2. Reference Comparison:

- Unity based 3D comparison
- Dynamic Time Warping algorithm

3. Feedback:

- Joint-specific + Movement pattern heuristics
- 3D Avatar generation

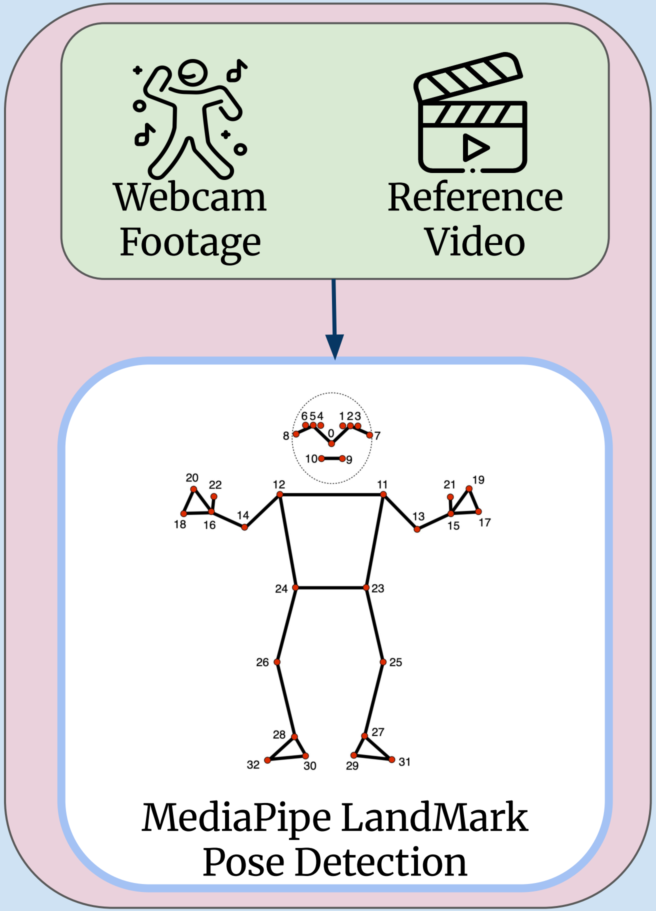
System Specification/Block Diagram



Implementation Plan - Computer Vision

What:
- OpenCV input processing
- MediaPipe LandMark Pose Detection

Why:
- Accessibility: No need for multiple cameras
- Accuracy: Tried and true libraries



Implementation Plan - 3D Comparison Engine

What:

- Cosine Similarity + Procrustes Analysis

Why:

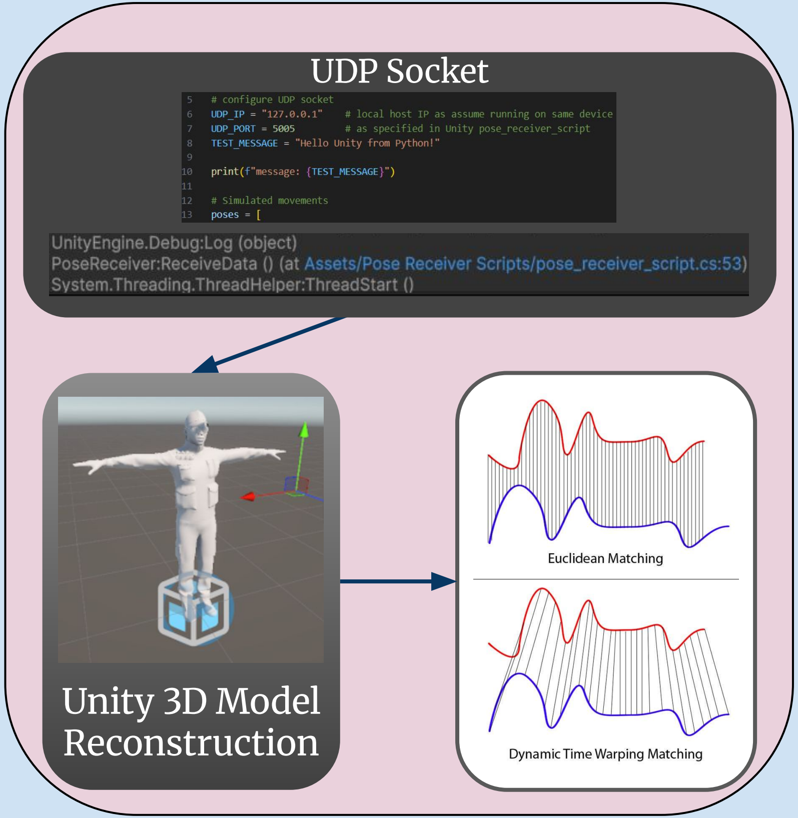
- Normalizes spatial variance in pose keypoints, enabling rotation/scale-invariant comparison

What:

- Dynamic Time Warping Algorithm

Why:

- Optimizes temporal alignment between movement sequences, accommodating non-linear timing variations and preserving sequential pose correspondences



Test, Verification and Validation

Computer Vision:

Processing speed	Input ~3 minute dances on Apple M3 laptop
Depth	Input complex dances that heavily involve 3D movement
Granularity	Count # of body points tracked consistently for the entire duration of the video input with at least 5 different human targets
Accuracy	Cross compare processed data with input for <= 10cm discrepancy
UDP-Based Networking	Utilize Python packet sending and timer to ensure sufficient throughput

Test, Verification and Validation

Feedback:

Score Accuracy	Compare output scores with at 3 preset dance videos to remain within ±10% deviation from the reference movements
3D Modeled Avatar Representation	Test dance sequence with known deviation quantities to verify system generates movement corrections for >20% pose deviations
Progress Reporting	Ensure that a detailed progress report is generated after every 5 attempts, summarizing performance trends
Performance Benchmarking	Measure Unity frame rate (≥ 30 FPS) while providing 3D avatar feedback

Project Management

TASK	OWNER	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
Initiation and Planning					
Project Abstract	All	1/13	1/22	1.5 Weeks	100%
Project Initiation	All	1/13	1/29	1.5 Weeks	100%
Website Setup	Rex	1/27	2/1	1 Week	100%
Project Proposal Presentation	Akul/Danny	1/27	2/2	1 Week	100%
Computer Vision Research	Akul	1/27	2/2	1 Week	100%
Unity 3D Graphics Research	Rex	1/27	2/2	1 Week	100%
Haptic Feedback Research	Danny	1/27	2/2	1 Week	100%
3D Comparison Engine Implementation/Testing					
Character and Animation Rigging	Rex	2/3	2/9	1 Week	100%
Video Input Synchronization	Rex	2/10	2/16	1 Week	100%
Grading algorithm implementation	Rex	2/17	2/23	1 Week	0%
Debugging 3D Engine	Rex	2/24	3/2	1 Week	0%
Testing	All	3/3	3/10	1 Week	0%
UI Implementation					
UI Implementation	Akul/Danny	3/24	3/30	1 Week	0%
CV Implementation/Testing					
Video Input Processing	Akul/Danny	2/3	2/9	1 Week	100%
Capture Web Cam Video (OpenCV)	Akul/Danny	2/10	2/16	1 Week	100%
Detect Body Key points (MediaPipe)	Akul/Danny	2/17	2/23	1 Week	0%
Debugging CV	Akul/Danny	2/24	3/2	1 Week	0%
Testing CV	Akul/Danny	3/3	3/9	1 Week	0%
Integration with 3D Engine	All	3/10	3/23	2 Weeks	0%
Testing with 3D Engine	All	3/24	3/30	1 Week	0%
Slack	All	3/31	4/13	2 Weeks	
Demo/Submissions					
Design Review Presentation	All	2/10	2/16	1 Week	50%
Design Review Report	All	2/17	2/28	2 Weeks	0%
Ethics Assignment	All	3/6	3/12	1 Week	0%
Interim Demo	All	4/2	4/2	0 Week	0%
Final Presentation	All	4/7	4/20	2 Weeks	0%
Final Poster	All	4/7	4/20	2 Weeks	0%
Final Video	All	4/7	4/20	2 Weeks	0%
Final Report	All	4/7	4/20	2 Weeks	0%