

The background is a dark, almost black, space filled with vibrant neon lines in shades of cyan and magenta. These lines form various geometric shapes, including triangles, rectangles, and abstract patterns. Some lines are solid, while others are broken or dashed, creating a dynamic and futuristic aesthetic. The lines vary in thickness and brightness, giving the impression of glowing digital elements.

danCe-V

A Computer Vision Dance Game

[Akul Singh](#), Danny Cui, Rex Kim

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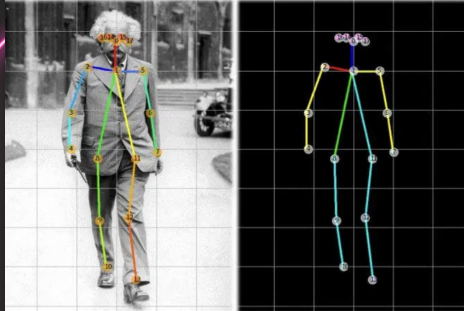
7 SCHEDULE

Use Case

- The **problem**: Traditional rhythm games (e.g., Just Dance) require expensive and non-accessible motion-tracking hardware (wearable controllers, game consoles, cameras)
- Our **solution**: Real-time AI pose detection and haptic feedback
- Tracks and scores dance moves using AI-powered computer vision
- Uses a webcam instead of physical controllers for motion tracking
- Haptic feedback support to improve player immersion
- Provides an accessible and inexpensive rhythm-based dance game experience



Components and Features



Computer Vision

ECE Concentration:
Signals and Systems



Game Design

ECE Concentration:
Software Systems



Haptic Feedback

ECE Concentration:
Circuits

Computer Vision Requirements

Latency

- Average input latency for non-professional gamers is 114.33 ms¹
- Therefore, aim for < 100 ms latency

Accuracy:

- Accuracy of 90% may make game frustrating for the user
- Aim for $\geq 95\%$ classification accuracy

Detection:

- Detect and discern between 5-8 moves individually
- Provide outputs if the user is Off, Close, or Perfect

¹Banatt, Eryk. "Input Latency Detection in Expert-Level Gamers." Yale University, 2017.

Game Requirements

Functionality

- Take processed data from camera and reflect CV outputs in game UI

UI/User Experience

- Select from 3 different difficulty levels, where harder difficulties would include more complicated songs/beats/rhythms to follow
- View detailed performance statistics on game completion

Visual/Audio Stimuli

- Standard movie codec is ~24 FPS, so aim for at least 30 FPS on Apple M3
- Elevate user experience with smooth tracking and 3D graphics

Haptic Feedback Requirements

Feedback

- Incorporate different kinds of feedback with vibration motors
- Quick bursts for mistakes, subtle pulses for correct moves

Latency

- Target ≤ 50 ms to keep haptic feedback in sync with the game outputs
- Less than the 100 ms latency for the CV processing, but want to prioritize an immersive experience for the user with haptic feedback

Weight

- Aim for ≤ 50 g, as standard fitness watches in the current market fall in this range

Benefits Beyond Requirements

Physical and Mental Health Benefits

- Dancing helps 98% of people to relax from their daily responsibilities¹
- Provides a unique and fun experience to exercise and improve overall health

Low Barrier to Entry

- Can be played anywhere without any expensive cameras or gaming setups

Diversity in Music/Cultures

- Will include music from different cultures/backgrounds, appealing to a large variety of individuals

¹Marosz, Szymon & Borkowska, Aleksandra & Borkowska, Katarzyna & Krysiak, Patrycja & Kuligowska, Monika & Pieciewicz-Szczęśna, Halina. (2022). The impact of dance on human health. *Journal of Education, Health and Sport*. 12. 297-304. 10.12775/JEHS.2022.12.11.039.

Technical Challenges



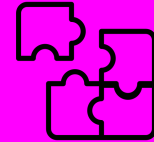
Input Latency
< 100 ms



CV Accuracy of
At Least 95%

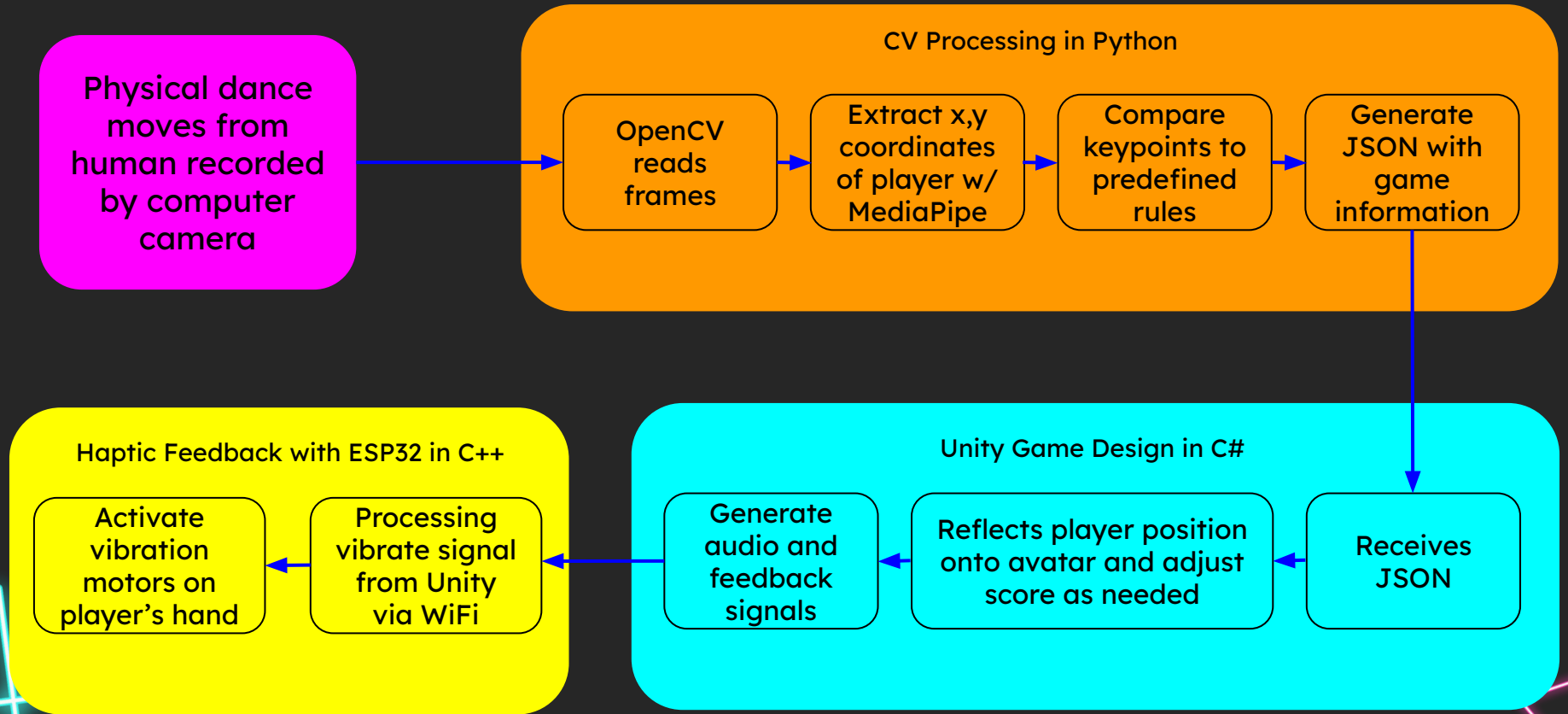


Unity Game
Design and
Intuitive UI



Seamless
Integration of
Components

Solution Approach



Testing, Verification, and Metrics

Metric	Test Plan
Input/Output Latency	Time the input latency to make sure CV latency < 100ms and haptic feedback latency < 50ms
Gameplay Smoothness	Use FPS display to ensure average FPS ≥ 30 during 10 minute long gameplay
Computer Vision Accuracy	Run 25+ test examples and check both false positives/negatives to see if we reach goal of 95% accuracy
Weight of Haptic Feedback Device	Use a scale to ensure weight $\leq 50g$, and collect user feedback to evaluate its comfort when worn while playing
Intensity of Haptic Feedback Device	Ask 15+ players to try wearing the device while playing the game and share feedback about the intensity of the haptic feedback
Gameplay Usability	Ask 15+ players to try the game and ask for gameplay feedback

Tasks and Division of Labor

Rex

- Game Design
- Unity and Game Implementation
- Computer Vision (Interfacing with Game)
- Overall Test/Debug

Akul

- Game Design
- Haptic Feedback Integration
- Computer Vision (Player Detection, Recognizing Moves)
- Overall Test/Debug

Danny

- Game Design
- Haptic Feedback Integration
- Computer Vision (Mapping Key Points, Optimization)
- Overall Test/Debug

