Real-Time Pose-Based Emote Detection on Raspberry Pi 4

Team VisionMasters
Members: Allen Chen, Marvin Rivera, Sami Kang

Team & Role

Marvin Rivera (Team Lead)	Allen Chen (Hardware)	Sami Kang (Software)
Coordination, Documentation, Presentation.	RPi setup, Camera integration, Deployment.	Model training, Optimization, Metrics.

Shared Responsibility: Evaluation, Benchmarking, Data Collection.

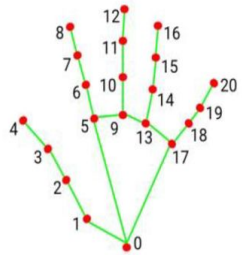
Project Motivation & Use Case

The Challenge: Real-time recognition (>10 FPS) on CPU-only hardware.
The Use Case: Interactive Gaming/Entertainment.

- *User Pose -> System Detection -> Clash Royale Emote Output*.

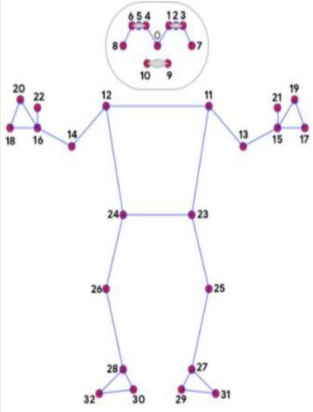
Why Edge AI? Privacy, low latency, and offline capability.

Platform Selection & Methodology



0. Wrist	11. Middle_finger_DIP
1. Thumb_CMC	12. Middle_finger_TIP
2. Thumb_MCP	13. Ring_finger_MCP
3. Thumb_IP	14. Ring_finger_PIP
4. Thumb_TIP	15. Ring_finger_DIP
5. Index_finger_MCP	16. Ring_finger_TIP
6. Index_finger_PIP	17. Pinky_MCP
7. Index_finger_DIP	18. Pinky_PIP
8. Index_finger_TIP	19. Pinky_DIP
9. Middle_finger_MCP	20. Pinky_TIP
10. Middle_finger_PIP	

(a)



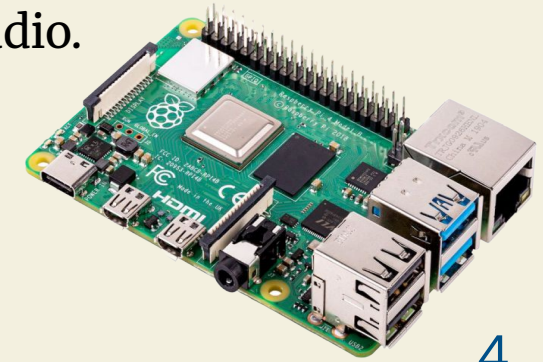
0. Nose	17. Left_pinky
1. Left_eye_inner	18. Right_pinky
2. Left_eye	19. Left_index
3. Left_eye_outer	20. Right_index
4. Right_eye_inner	21. Left_thumb
5. Right_eye	22. Right_thumb
6. Right_eye_outer	23. Left_hip
7. Left_ear	24. Right_hip
8. Right_ear	25. Left_knee
9. Mouth_left	26. Right_knee
10. Mouth_right	27. Left_ankle
11. Left_shoulder	28. Right_ankle
12. Right_shoulder	29. Left_heel
13. Left_elbow	30. Right_heel
14. Right_elbow	31. Left_foot_index
15. Left_wrist	32. Right_foot_index
16. Right_wrist	

(b)

Edge Platform: Raspberry Pi 4 Model B (4GB RAM, Cortex-A72).

Methodology:

1. **Input:** Logitech Brio Webcam (1080p).
2. **Detection:** MediaPipe Holistic (Lite complexity).
3. **Classification:** Random Forest (Scikit-learn).
4. **Output:** Visual Overlay + Audio.



The Comparative Analysis Goal

EDGE
(System A)

Raspberry Pi 4
(Constrained, Thermal limits, ARM-based)

- Thermal limits
- Constrained
- ARM-based

Slow
(>100ms)

Inference Latency (ms)

Fast
(<10ms)

Low FPS
(10-15 FPS)

Frames Per Second (FPS)

High FPS
(60+ FPS)

Throttling

Thermal Throttling over time (>30 min)

Throttling

High Load
(90-100%)

CPU Utilization %

Low Load
(10-20%)

WORKSTATION
(System B)

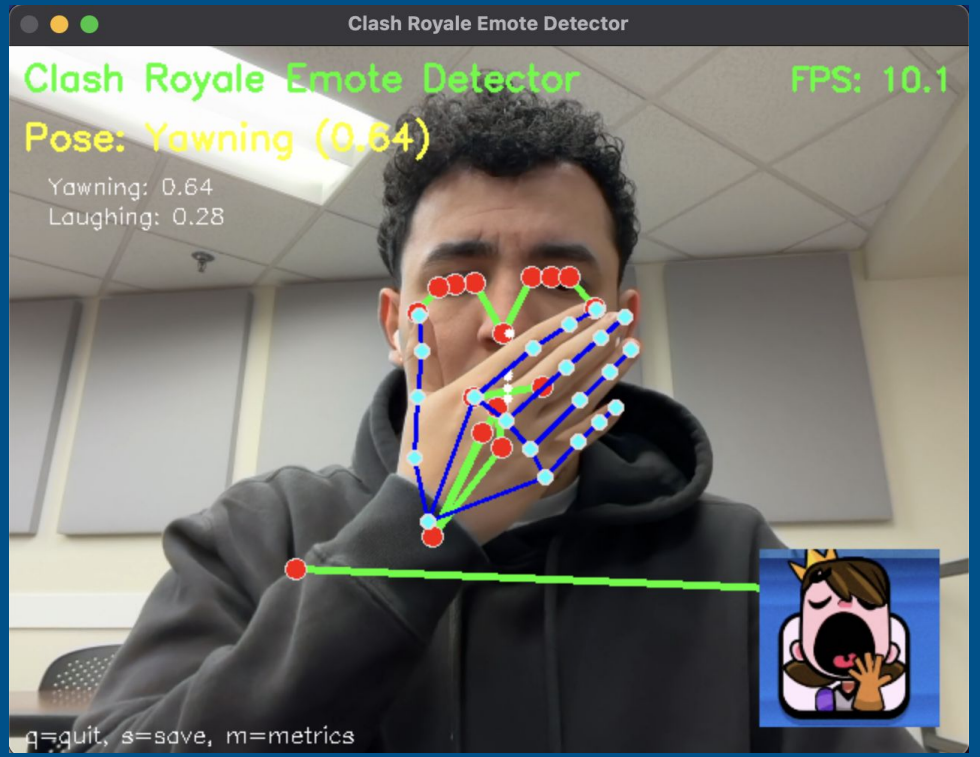
MacBook
(High performance, Active cooling, x86/M-series)

- Active cooling
- High performance
- x86/M-series

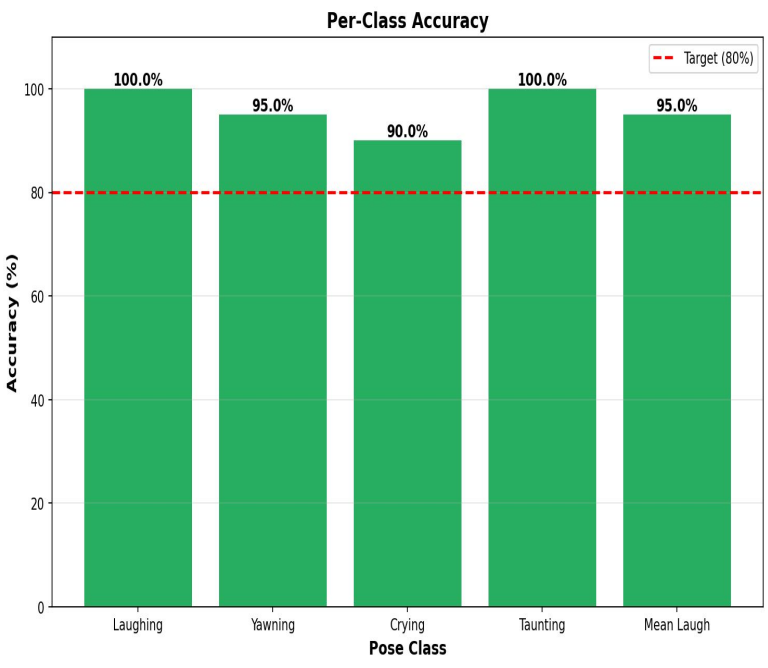
Current Status (Implementation)

Accomplished:

- Real-time detection running on RPi 4.
- Custom training data collected (~500 samples).
- Interactive display with 5 pose classes (Laughing, Yawning, etc.).
- Metric collection system (FPS, CPU temp) active.



Preliminary Observations



Optimization Techniques used so far:

- Reduced Resolution (320x240).
- Model Complexity = 0 (Lite).

Initial Findings:

- Random Forest inference is negligible (<1ms).
- Bottleneck identified: Video rendering and MediaPipe inference.
- Current RPi Performance: ~10-15 FPS (Target met).

Timeline & Next Steps

Remaining Timeline:

- **Week 6 (Dec 10):** Benchmarking & Analysis (The "MacBook vs Pi" data run).
- **Week 7 (Dec 17):** Final Presentation & Report.

Upcoming Deliverables:

- Thermal stability charts.
- Latency breakdown graphs.
- Live Demo refinement.