ECE 49595CV Term Project

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Project Introduction

Fruit Ninja Reimagined

- Fruit Ninja is a classic mobile game that was released in 2010
  - Slice fruit by sliding your finger on the screen
  - What if we could make this game more interactive?
- Our project explores real-time hand tracking and gesture-based controls to bring Fruit Ninja to life

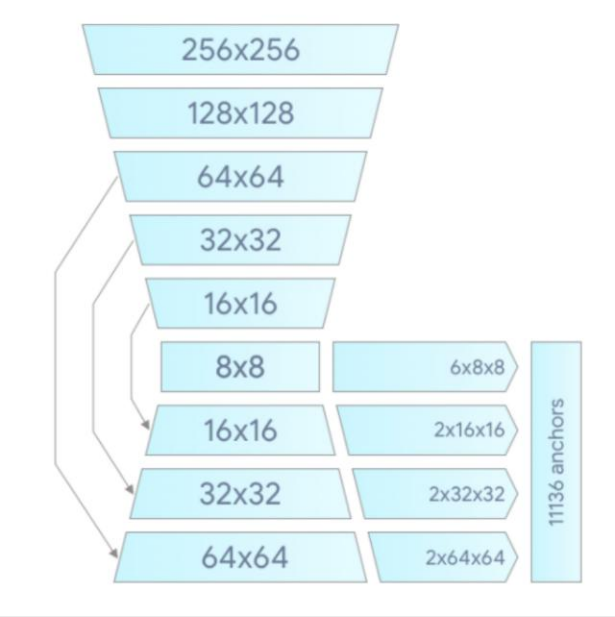
Methodology

Hand Detection with MediaPipe Hands

- Published by Google Research in 2020
- Consists of a 2-stage pipeline

1.) Palm Detector

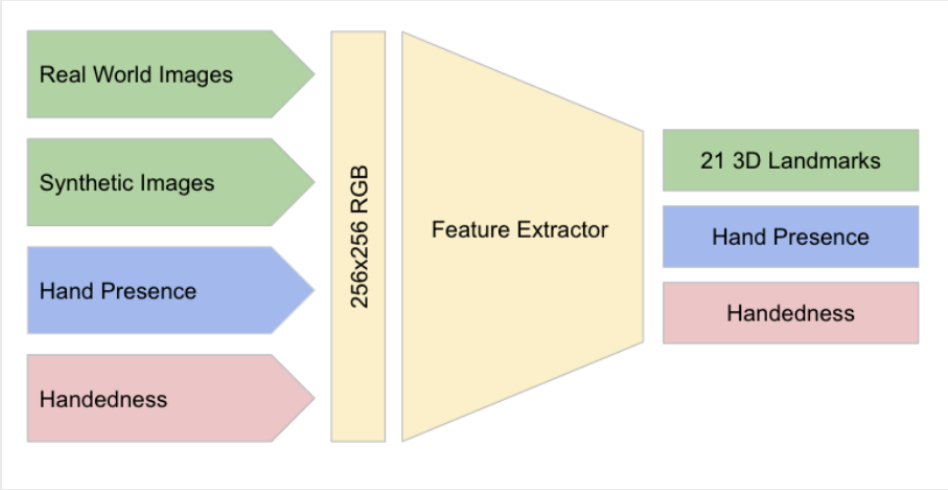
- Single-shot detector model
- Trained with in-the-wild dataset



(Zhang et al., 2020, Figure 2)

2.) Hand Landmark Model

- Predicts 21 hand landmarks
- Predicts hand presence
- Predits handedness (left or right)
- Trained with in-the-wild dataset, in-house gesture dataset, and synthetic data

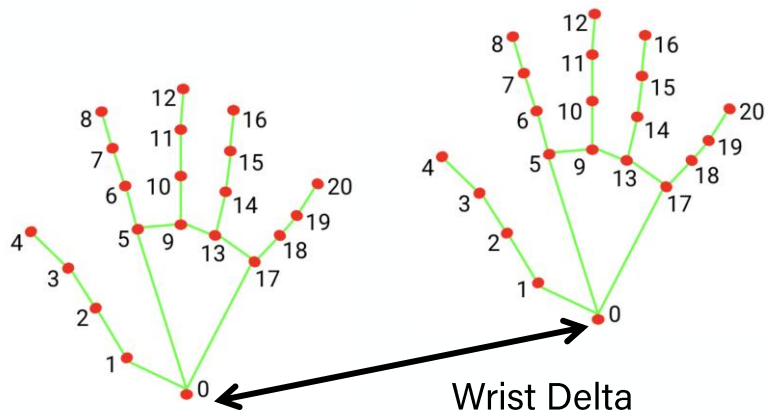


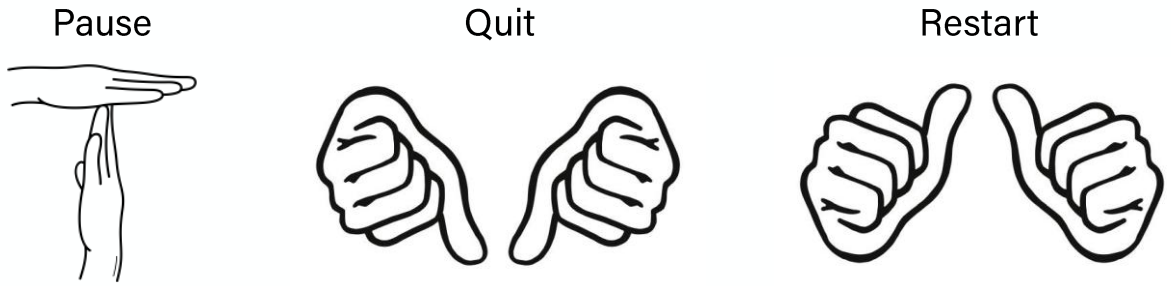
(Zhang et al., 2020, Figure 3)

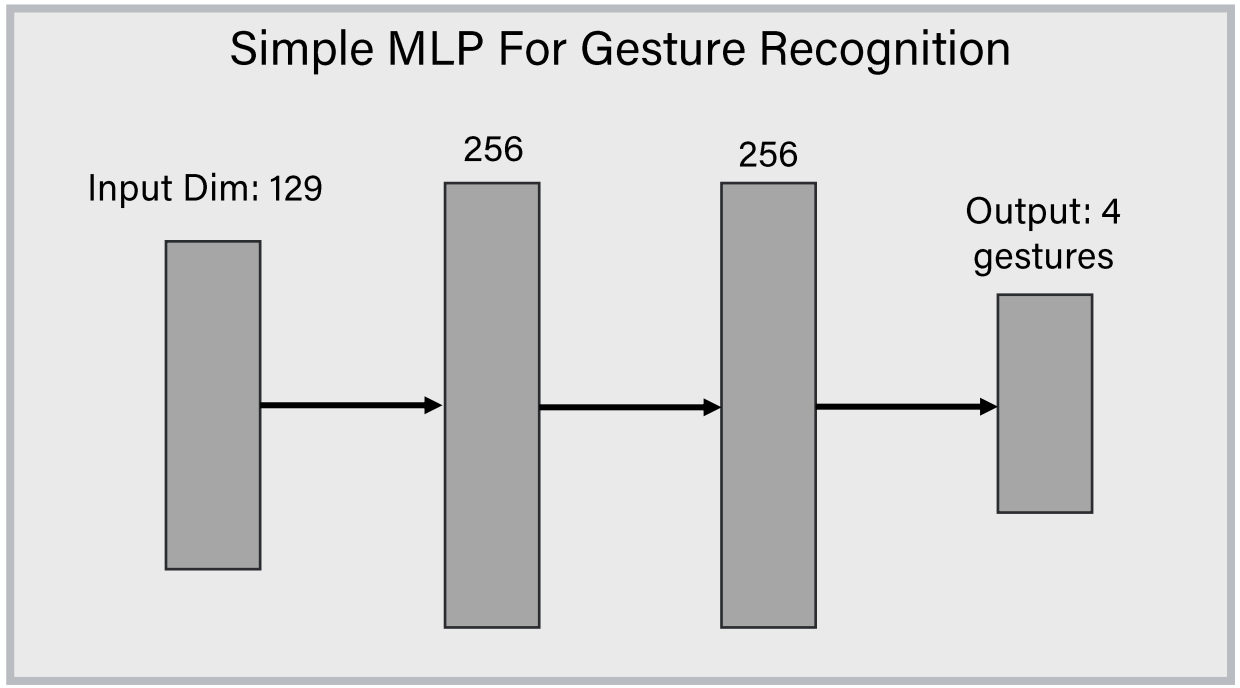
Interpreting Landmarks for Gesture Recognition

Game Controls via Hand Gestures

- Three gestures for game controls
  - Timeout gesture: Pause game
  - Double thumbs up: Restart game
  - Double thumbs down: Quit game
- MediaPipe hands provides 21 landmarks
  - Each landmark has (x, y, z) coordinates
  - Input dim $= ((21 \times 3) \times 2) + 3 = 129$





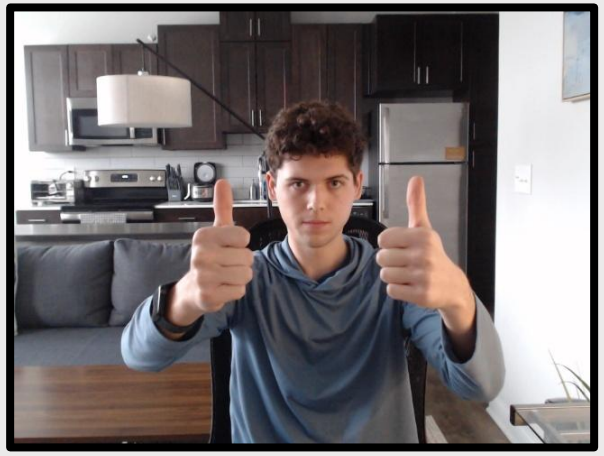


Training Gesture Detection

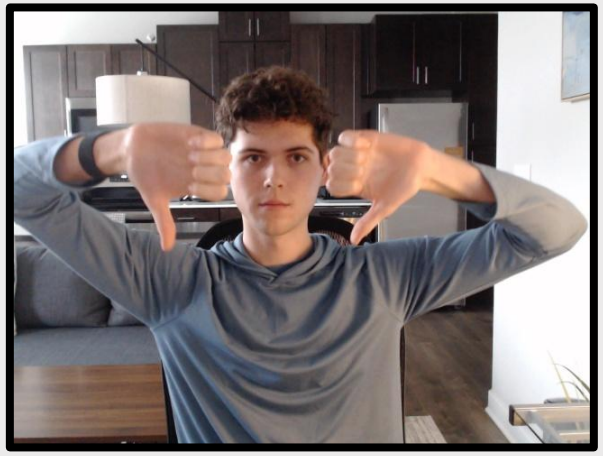
Creating Custom Dataset

- Created our own dataset using webcam captures
  - 4 classes
    - Restart gesture
    - Quit gesture
    - Pause gesture
    - No gesture
  - 250 samples per class

Restart

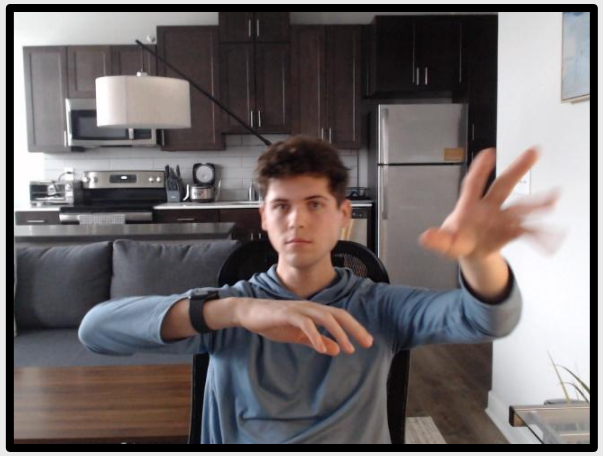


Quit

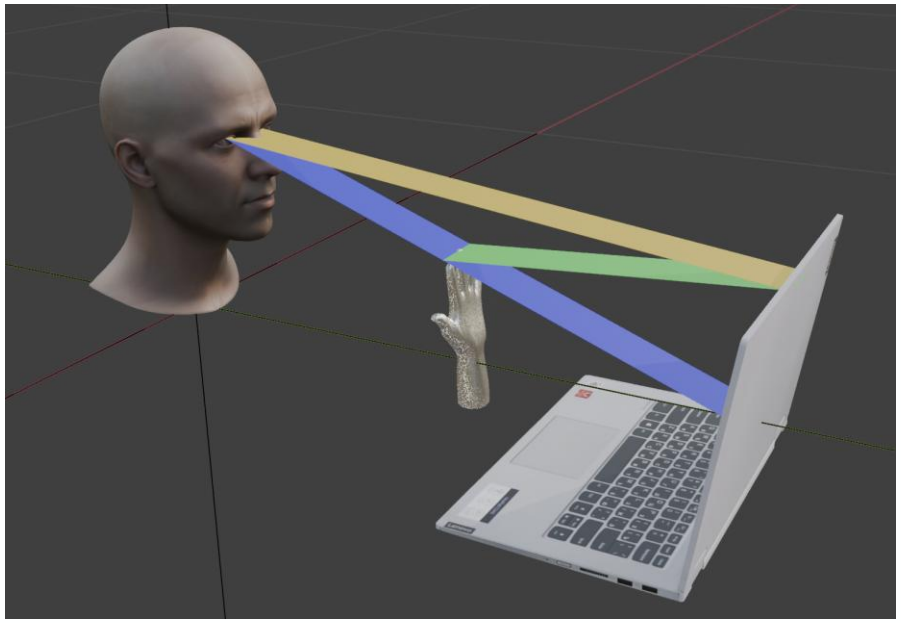


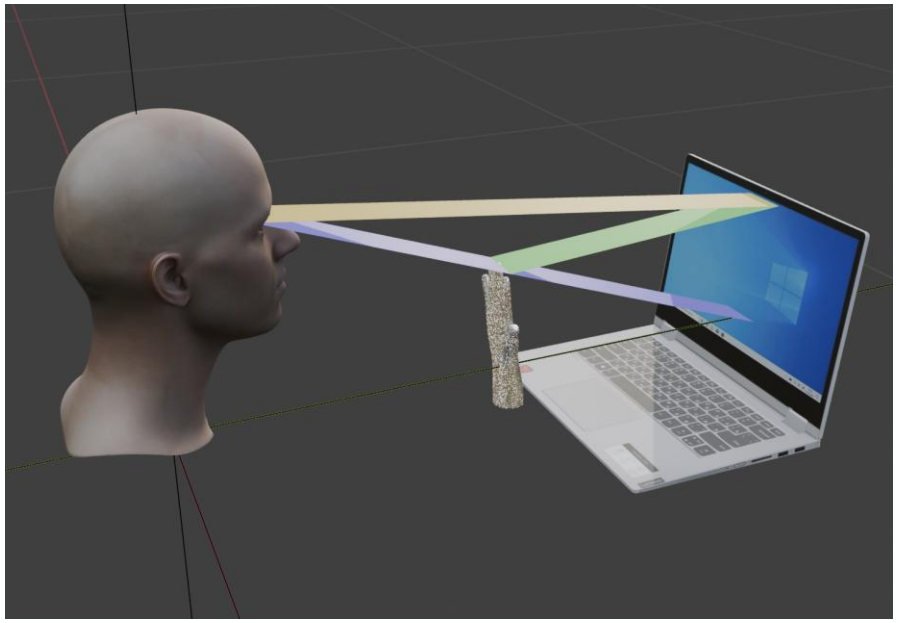
Pause

None



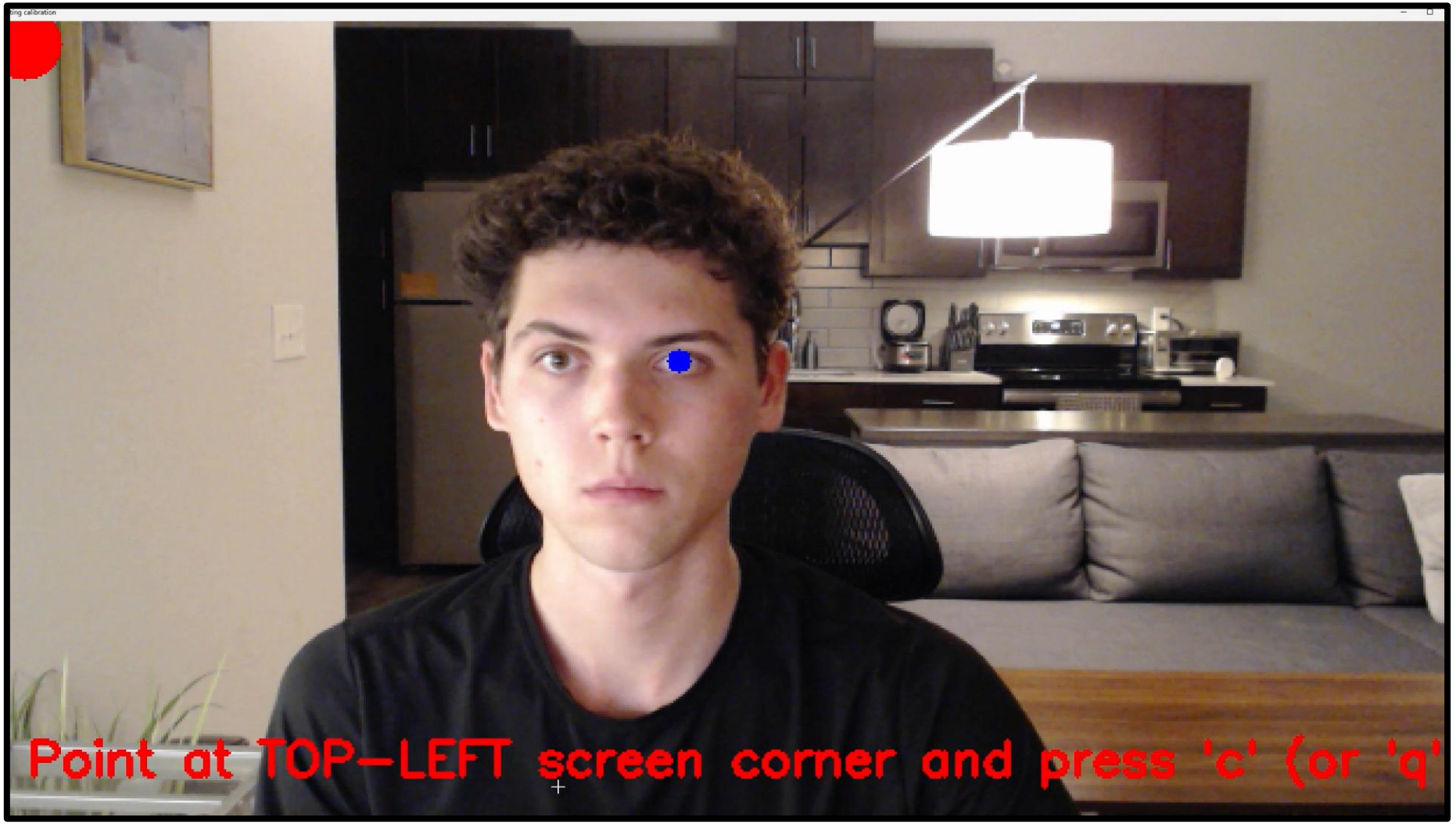
Ray Cast Pointing





Point with finger to where you are looking on the screen → Triangle is formed with finger, eyes, and camera as vertices → Cast ray from eyes past fingers, camera infers angle

Demo Video



Limitations , Applications, and Future Work

Limitations

- No real 3D depth
  - Attempted to implement MiDaS and DepthAnythingV2, but limited by real-time aspect for “smooth” game feel
- Sensitivity to camera model and user distance
  - Hard to transition between users
- Need for recalibration between each use
  - Different distances to between finger / eyes between each use
- One eye closed in ray cast version
  - Can be straining

Applications

- Pseudo-AR games
  - Human-camera interactive games
- General Computer UI
  - Pointing to things on screen instead of using mouse

Future Work

- Transitioning to 3D
  - Both in terms of depth and 3D graphics
- Making game UI completely between camera / person
  - No interaction with computer

Thank You

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References

[1] F. Zhang, V. Bazarevsky, A. Vakunov, A. Tkachenka, G. Sung, C. Chang, and M. Grundmann, “MediaPipe Hands: On-device real-time hand tracking,” arXiv preprint arXiv:2006.10214, 2020. [Online].

Available: https://arxiv.org/pdf/2006.10214