CS512 - COMPUTER VISION

Real-time Hand Gesture Recognition

Source: GitHub-HaGRID dataset

Project Presentation

Spring 2023

ILLINOIS INSTITUTE OF TECHNOLOGY

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Problem Statement

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Implement AI models for live hand detection and gesture recognition.

Example of applications:
- Video conferencing services
- Home automation systems
- Automotive sector
- Services for people with speech and hearing impairments, etc.
- Human-computer interaction

Paper that we used:
- Dataset: HaGRID — HAnd Gesture Recognition Image Dataset
- MediaPipe: On-device Real-time Hand Gesture Recognition
- Models: Real-time Dynamic Sign Recognition using MediaPipe

Proposed Solution

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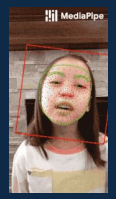
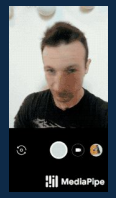
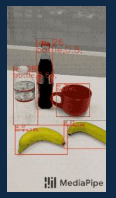
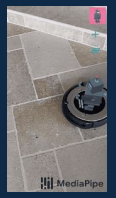
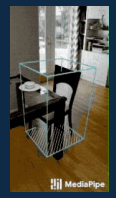
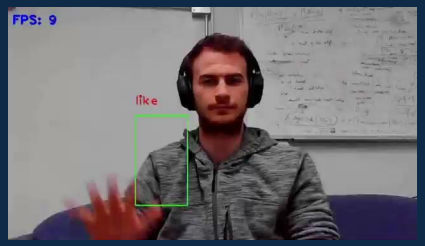
ML solutions in MediaPipe

Face Detection	Face Mesh	Iris	Hands	Pose	Holistic
					
Hair Segmentation	**Object Detection**	**Box Tracking**	**Instant Motion Tracking**	**Objectron**	**KNIFT**
					

Live Application

MediaPipe Hand Detector (landmarks + boxes) + Conv1D Classifier

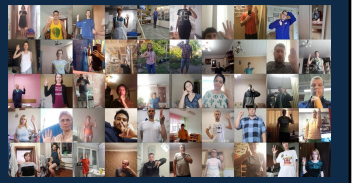


1-Hand MobileNet Classifier (boxes + hand gesture)

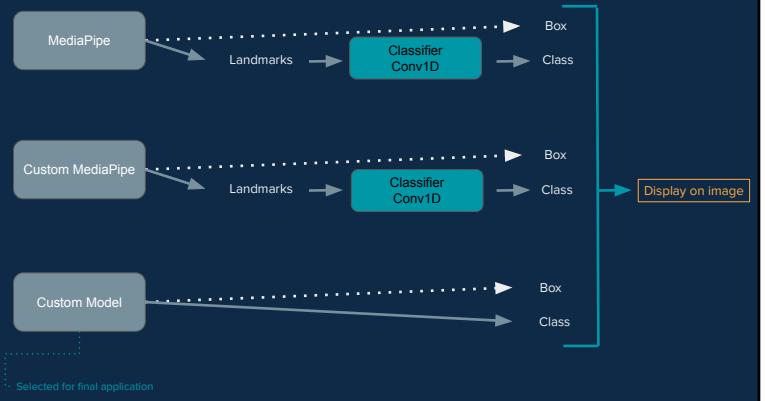
Dataset Presentation

HaGRID – HAnd Gesture Recognition Image Dataset:

- Created in June 2022.
- Size: 716GB – 552,992 RGB images (with majority FullHD) divided into 18 classes of gestures.
- Extra class “no_gesture” with 123,589 samples.
- Collected mainly indoors in various conditions (lighting variations, blur, distance from camera, ...)
- Only kept between 2000 and 3000 samples per class.
- Include whole set of annotations containing image_ID, labels, bboxes, leading hand, label.

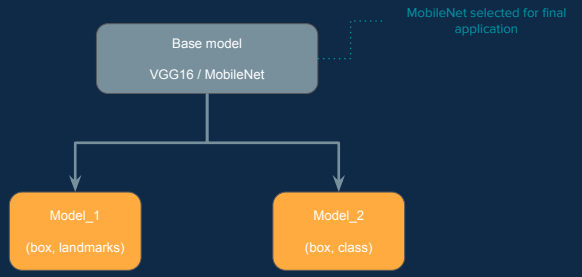


Pipeline

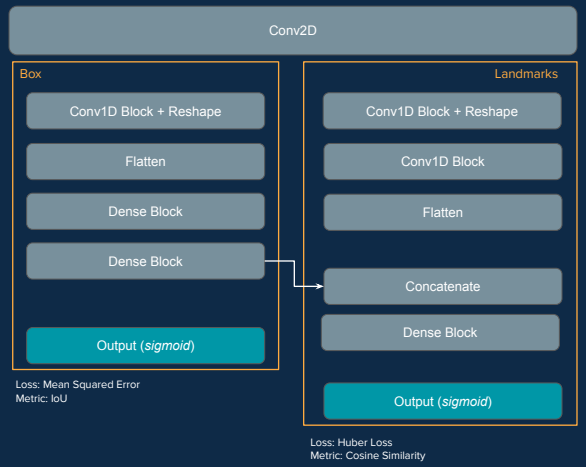


Implementation Details

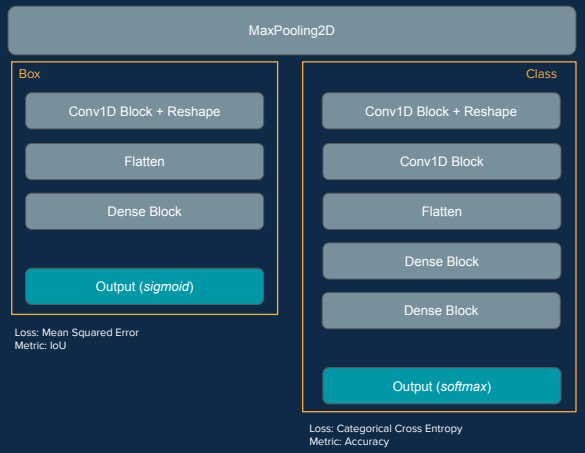
Models



Model_1 (box, landmarks)



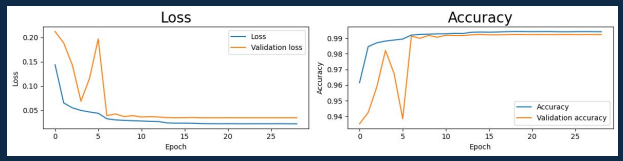
Model_2 (box, class)



Results & Discussion

Classifier (Conv1D)

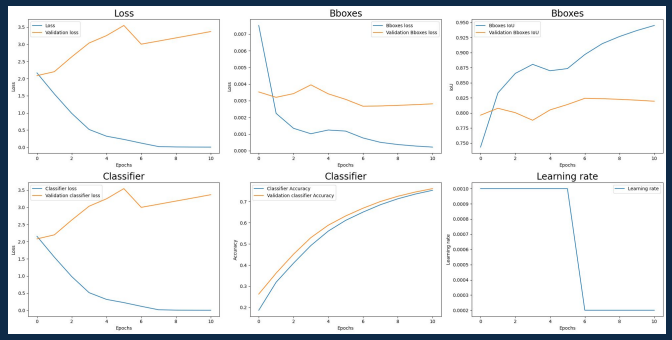
Trained on more than 490,000 landmarks from dataset annotations



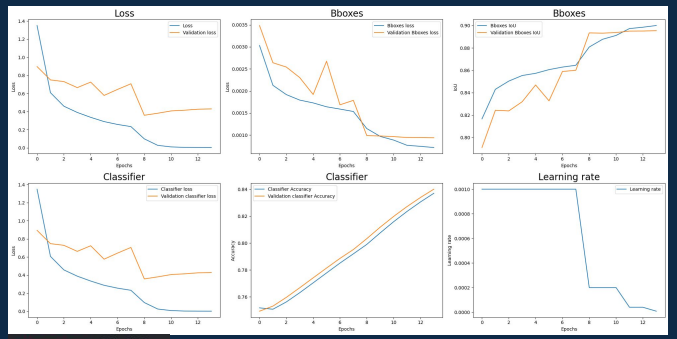

```
Loss: 0.024833479896187782
Accuracy: 99.384%

Precision: 99.387%
Recall: 99.391%
F1-Score: 99.389%

Min: 7.758509e-37
Mean: 0.052631583
Max: 1.0
```


Model – MobileNet (box, class)

Trained on more than 32,000 images



Model MobileNet (box, class) - Fine tuning




```
Accuracy: 86.21%
Precision: 87.368%
Recall: 84.984%
F1-Score: 86.16%
```

Problems & Conception choices

Model architecture and number of parameters

Goal: predictions from live video => need efficiency

=> Discarded VGG16 as base model
=> Selected MobileNet as base model

From custom MediaPipe to complete custom model

First: Implementation of the classifier from MediaPipe output landmarks

We wanted to implement custom MediaPipe to simply replace it by our model, predict the landmarks and use the same classifier as above

Problem: Predicted landmarks were not accurate enough to get a good accuracy

Solution: Custom model, predicting box and class

Dataset size

Classifier trained on more than 490,000 landmarks (21x2), from dataset annotations

Problem: Train CNN on 490,000 images very computer intensive

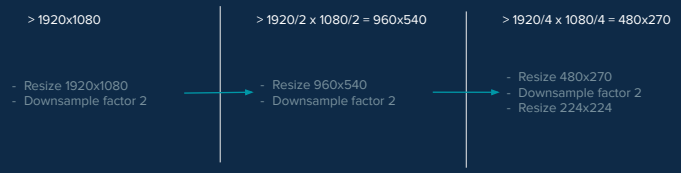
Solution: Sample the data (~ 40,000 images)

MobileNet input size

MobileNet takes an input shape (224, 224, 3)

Problem: Various sizes of the images from the dataset: from more than 1920x1080 to less than 480x270

Solution: Downsample and resize images



Thank you for your attention

Do you have any questions?