Vision-based Human Activity Recognition (HAR) using Transfer Learning Approach for Internet-of-Things (IoT) Applications

Team Introduction

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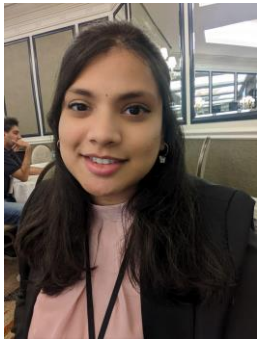

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Problem Description

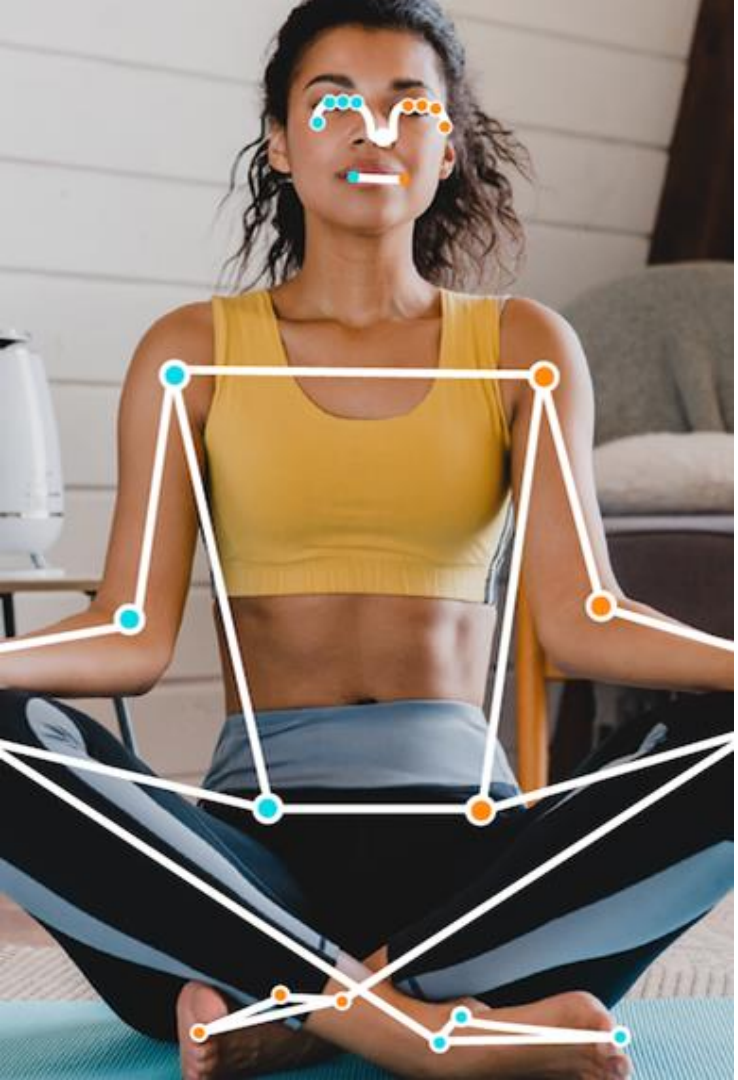
- Smart Homes and Buildings (SHaB) improve the user's quality of life and resource usage.
- Kind of activity influence thermal behaviour of the space.
- Strong autonomous HVAC system considers this as a factor.
- Use a vision-based machine learning model to classify images as active or passive

Dataset

- 12,000+ labeled images featuring 15 different classes of human activities.

Pre-Processing

- Mapped 15 classes into 2 classes
- Convert the multi-class classification problem to binary classification.



Mediapipe Pose

- ML solution for high-fidelity body pose tracking.
- Infers 33 3D landmarks from RGB video frames.
- Locates person/pose ROI in the frame.
- Predicts pose landmarks within ROI.

Data Augmentation

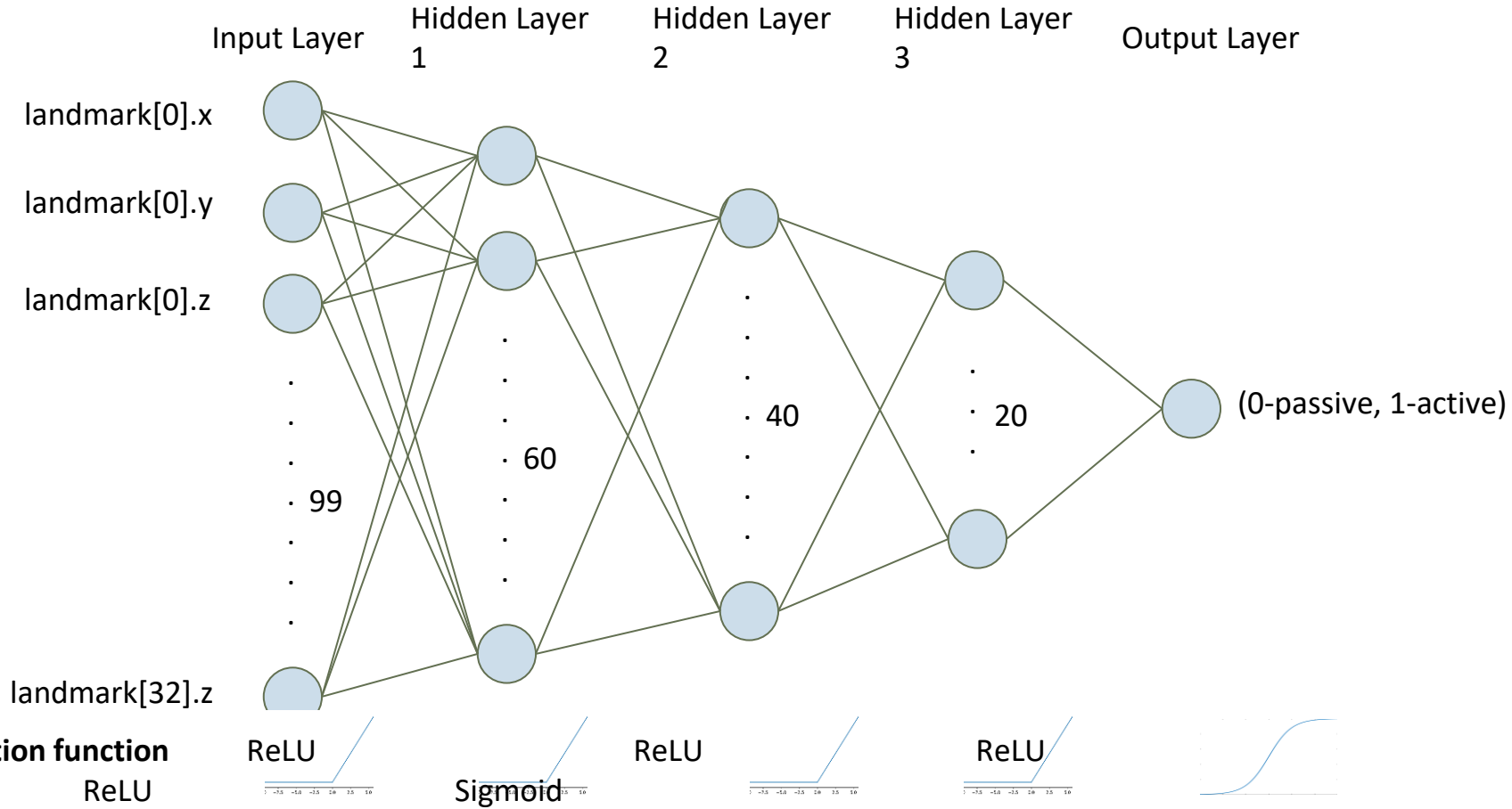
+random_rotation

+random_resize

+random_flip

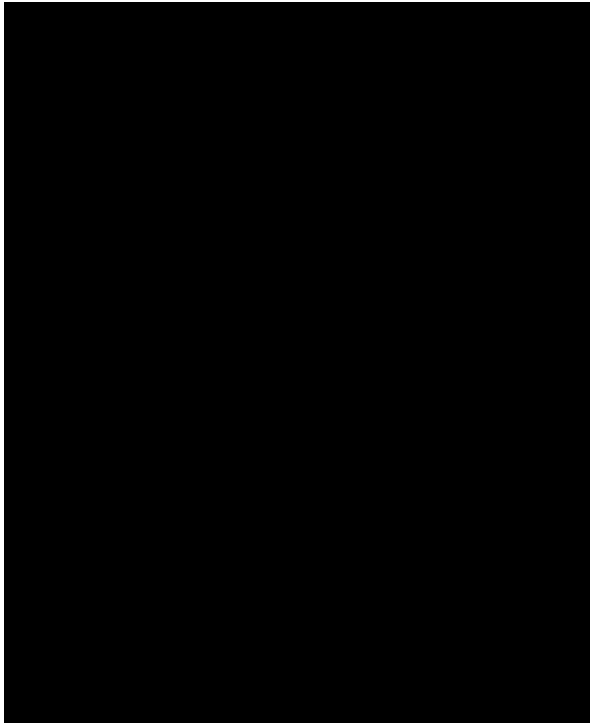
augment_image(image)

Model Training



Model Training

- Training framework = Tensorflow + Keras
- Loss function = Binary Cross-Entropy
- Optimizer = Adam
- Batch size = 32
- Epochs = 22 (early stopping)
- Train/Test split = 80/20



Training Results

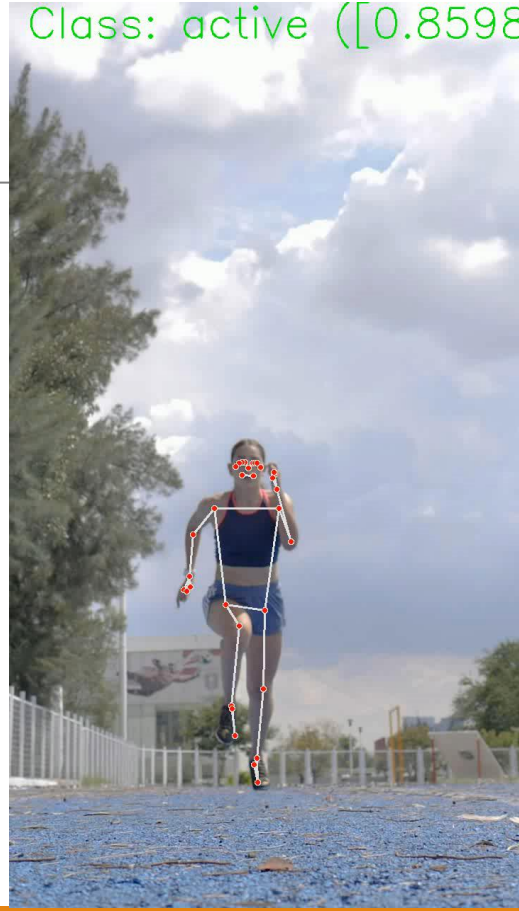
- Results after running for 22 epochs:
  - Precision: 0.79
  - Recall: 0.79
  - F1-Score: 0.79
  - Accuracy: 0.79

```
51/51 [==============================] - 0s 2ms/step
              precision    recall  f1-score   support

           0       0.74      0.75      0.74       658
           1       0.83      0.82      0.82       972

    accuracy                           0.79      1630
   macro avg       0.78      0.78      0.78      1630
weighted avg       0.79      0.79      0.79      1630

accuracy: 0.7907975460122699
```

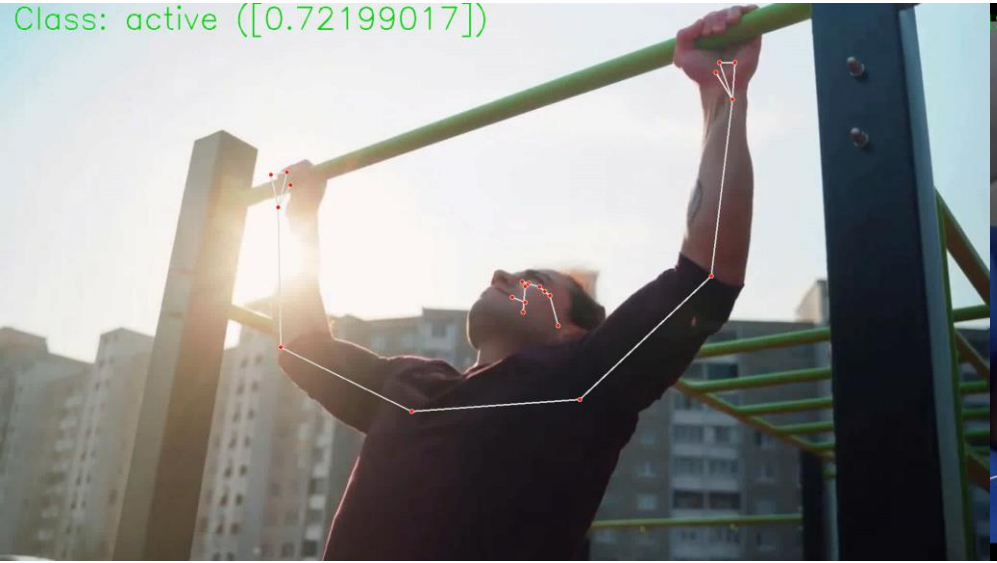
Evaluation on External Video

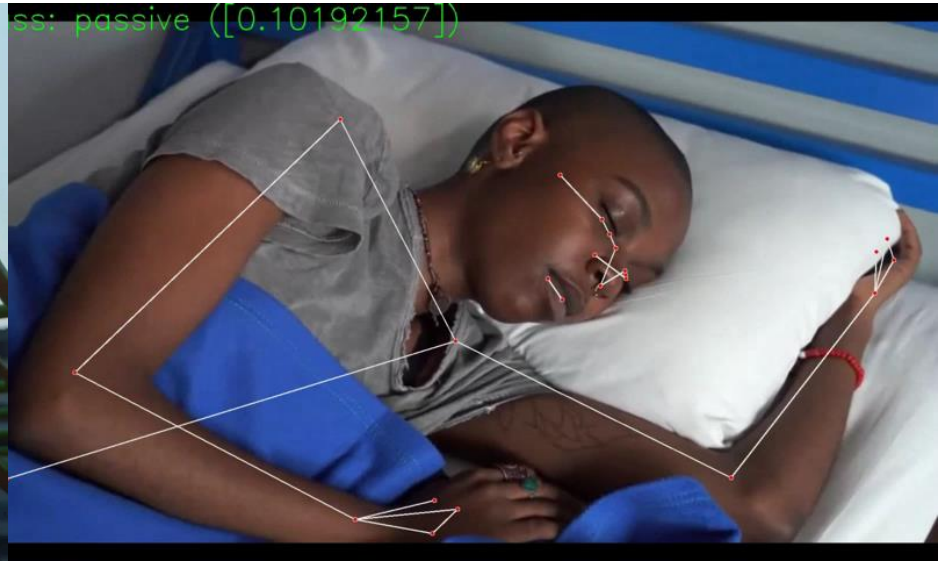
- Testing on shown video outside of data set
- Results:

```
8/8 [==============================] - 0s 9ms/step
              precision    recall  f1-score   support

           0       1.00      0.97      0.98       242
           1       0.00      0.00      0.00         1

    accuracy                           0.96       243
   macro avg       0.50      0.48      0.49       243
weighted avg       0.99      0.96      0.98       243

accuracy: 0.9629629629629629
```



Evaluation on External Video





Lessons Learned

- Neural Networks are powerful ML techniques that can extract hidden patterns
- More data = improved accuracy = more training time
- AI models require extremely large amounts of data to be effective
- Data augmentation can be a useful technique to increase size of training dataset

Future work

- An input-action mapping needs to be created that performs certain action on the HVAC system based on the recognized human activity