**Process**

Started with developing a model for face recognition  
tried using yolo intially as the face detector along with facenet and ViT for face prediction  
but didn’t work out  
then found the the best combination of MTCNN for face detection and the google’s FaceNet model to face recognition

In this after the face is detected from mtcnn then these faces are passed to facenet model to extract the face embeddings of each of them  
and then these extracted features are classified using a simpler machine learning classifier SVC initially  
but ran into overfiiting issues with it and tried out different ways to overcome it  
and finally decided to go along with making a stacking model with both the SVC and KNN to train those features and ultimately do the predictions

Then moved onto the Hybrid spatio-temporal model development

For the preprocessing the image to get the player exactly I used YOLOv3 to the detection process

In it also many boxes were detected so in order to detect the player correctly I used the logic to detect the biggest vertical box as the player is walking/running making it obvious to take the vertical and the biggest neglecting any background detections

Started with the spatial model and initially with a custom CNN model

but the performace was so poor and had to move onto other models

Namely DenseNet, EfficientNet, Inception, MobileNet, VGG16, Xception, ResNet50

Now out of these ResNet50 gave the best performace

And also I tried Vision Transformers ,5 different ViT models that took 1 hour and 40 min to train a single epoch. Each of the models had 5-10 epochs

Hence with lack of performace and very much computationally expencsive, again moved to ResNet

And I researched more about this ResNet architecture and tried out same architecture model to it like InceptionResNetv2, NasNet, ResNeXT but still didn’t get the expected results along with some overfitting issues

Then I searched out find out that the problem to this overfitting might be with classification layer of the model   
So I decided to go with the ResNet50 model finally  
so the solution I found for this problem is to introduce fusion here.

To be precise you have extract the features from the Deep Learning model and then try to classify this with simpler machine learning architectures  
how to improve deep learning models with machine learning classifers was the turining point in the research

So I extracted the features with ResNet50 model and then pass these features to a machine learining classifier  
tried many classifiers like SVC, KNN, Random Forest, Gradient Boost Machine and Decision Tree  
out of these SVC and KNN stood out

These also faced overfitting issues and to solve it tried many things like cross validations and hyperparameter tuning and managed to recude the issue to some level

And still the issue persissted to some level I researched more and found out about rather than using a single model to classify we can you an ensemble

So that are some methods to ensemble this like Voting Classifier and Decision Level Fusion.

But the most effective one was the Stacking Enemble   
and with the help of tuned parameters I was able to solve this overfitting issue and acheve a good performace at the end.

Then I have created a OCR text detection logic for the inferencing part  
where a new video is first scanned for the player’s name or number on their back and if detected and identified as a certain player the the recognised player will be outputted.

Here for the detection of the text I have tried to use the tesseract library text detection but it did not perform as I expected so then found the EAST git repo. I was able to achieve the text detection I want where it will detect the name and number and this detections will be merged into a single box and then cropped and passed onto the pytesseract OCR to text recognition.  
if the player is not recognised here the system will automatically move onto the model where the prediction will take place

Then I moved onto the temporal model

Here I have the same preprocessing steps with YOLO and   
in order to create the temporal features I needed to detect the joints of the player first  
from the gooogle’s mediapipe I was able do that after trying out some others like openpose and alphapose (these had compatibilty issues with macos)

Then from this joint I then used some logical calculations to create(feature engineering like) the temporal features – (step length, velocity, joint angles, joint acceleration, angular velocity, hip displacement)  
then I feed these features to a LSTM to train and predict after also trying out GRU.  
tried out different combinations and decided to go GRU and a custom model architecture setup

Then after all that for the final full integration I have made smooth pipeline of code where a new video is given to the system it will first try to recognise any text and if not it will try the face recognition model , and if not still recognised it will go the spatial model and finally for the temporal model.

**SPATIAL MODEL**

1. **ViT with YOLO,4 players (model 1)** 8 hours and 30 min

epochs=5

optimizer = AdamWeightDecay(learning\_rate=3e-5, weight\_decay\_rate=0.01)

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generatedbatch\_size=16

Classification Report:

precision recall f1-score support Predicted

Axar\_Patel 0.50 0.74 0.60 993 NO

Kuldeep\_Yadav 0.45 0.40 0.42 474 NO

Ravindra\_Jadeja 0.57 0.24 0.34 571 NO

Virat\_Kohli 0.57 0.48 0.52 629 YES

accuracy 0.51 2667

macro avg 0.52 0.47 0.47 2667

weighted avg 0.52 0.51 0.49 2667

F1 Score (macro-average): 0.47000779288034167

Accuracy: 0.5114360704911886

Mean Average Precision (mAP): 0.4309001207919875

A blue squares with black text

Description automatically generated

1. **ViT with YOLO,4 players (model 2)** 17 hours

epochs=10

optimizer = AdamWeightDecay(learning\_rate=1e-5, weight\_decay\_rate=0.01

batch\_size=32

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Axar\_Patel 0.40 0.95 0.57 993 YES

Kuldeep\_Yadav 0.58 0.34 0.43 474 YES

Ravindra\_Jadeja 0.27 0.01 0.01 571 NO

Virat\_Kohli 0.50 0.03 0.05 629 NO

accuracy 0.42 2667

macro avg 0.44 0.33 0.26 2667

weighted avg 0.43 0.42 0.30 2667

F1 Score (macro-average): 0.2642639045353383

Accuracy: 0.4225721784776903

Mean Average Precision (mAP): 0.39568228096691377

A blue squares with white text

Description automatically generated

1. **ViT with YOLO,9 players,25 images per player (model 3)** 15hours

epochs=10

optimizer = AdamWeightDecay(learning\_rate=3e-5, weight\_decay\_rate=0.01

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generatedbatch\_size=32

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.00 0.00 0.00 35

Axar\_Patel 0.00 0.00 0.00 117

Hardik\_Pandya 0.06 0.17 0.09 24

Jasprit\_Bumrah 0.25 0.37 0.30 142

Kuldeep\_Yadav 0.00 0.00 0.00 33

Ravindra\_Jadeja 0.00 0.00 0.00 118

Rohit\_Sharma 0.00 0.00 0.00 58

Suryakumar\_Yadav 0.10 0.49 0.17 77

Virat\_Kohli 0.00 0.00 0.00 43

accuracy 0.15 647

macro avg 0.05 0.11 0.06 647

weighted avg 0.07 0.15 0.09 647

F1 Score (macro-average): 0.06168571007340383

Accuracy: 0.14528593508500773

Mean Average Precision (mAP): 0.12839186696721797

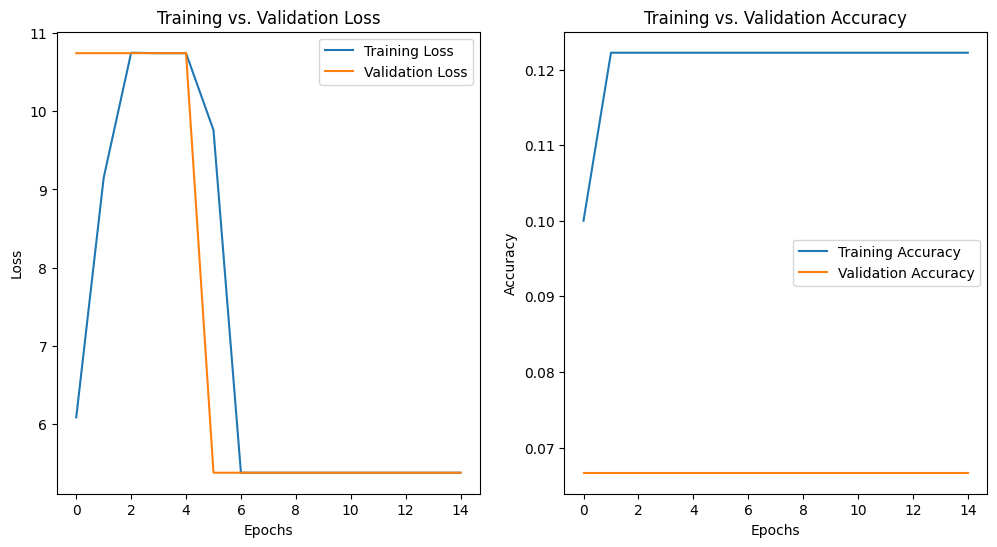
A graph with blue squares and white text

Description automatically generated

1. **ViT with YOLO+Normalized+CLAHE, 9 players,25 images per player (model 4)** 19 hours

epochs=15

optimizer = AdamWeightDecay(learning\_rate=3e-5, weight\_decay\_rate=0.01

batch\_size=32

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.00 0.00 0.00 4

Axar\_Patel 0.00 0.00 0.00 7

Hardik\_Pandya 0.00 0.00 0.00 5

Jasprit\_Bumrah 0.00 0.00 0.00 7

Kuldeep\_Yadav 0.00 0.00 0.00 5

Ravindra\_Jadeja 0.00 0.00 0.00 6

Rohit\_Sharma 0.00 0.00 0.00 6

Suryakumar\_Yadav 0.07 1.00 0.12 3

Virat\_Kohli 0.00 0.00 0.00 2

accuracy 0.07 45

macro avg 0.01 0.11 0.01 45

weighted avg 0.00 0.07 0.01 45

F1 Score (macro-average): 0.013888888888888888

Accuracy: 0.06666666666666667

Mean Average Precision (mAP): 0.17052455944177378

A chart with blue and white squares

Description automatically generated with medium confidence

1. **ViT with YOLO+CLAHE, 6 players, all images (model 5)** 16 hours

epochs=10

optimizer = AdamWeightDecay(learning\_rate=3e-5, weight\_decay\_rate=0.01

batch\_size=32

A graph of loss and training

Description automatically generated with medium confidence

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.00 0.00 0.00 320 NO

Axar\_Patel 0.00 0.00 0.00 537 YES

Jasprit\_Bumrah 0.00 0.00 0.00 560 NO

Kuldeep\_Yadav 0.06 0.25 0.10 168 NO

Ravindra\_Jadeja 0.00 0.00 0.00 492 NO

Virat\_Kohli 0.19 0.77 0.30 453 NO

accuracy 0.15 2530

macro avg 0.04 0.17 0.07 2530

weighted avg 0.04 0.15 0.06 2530

F1 Score (macro-average): 0.06710638335220341

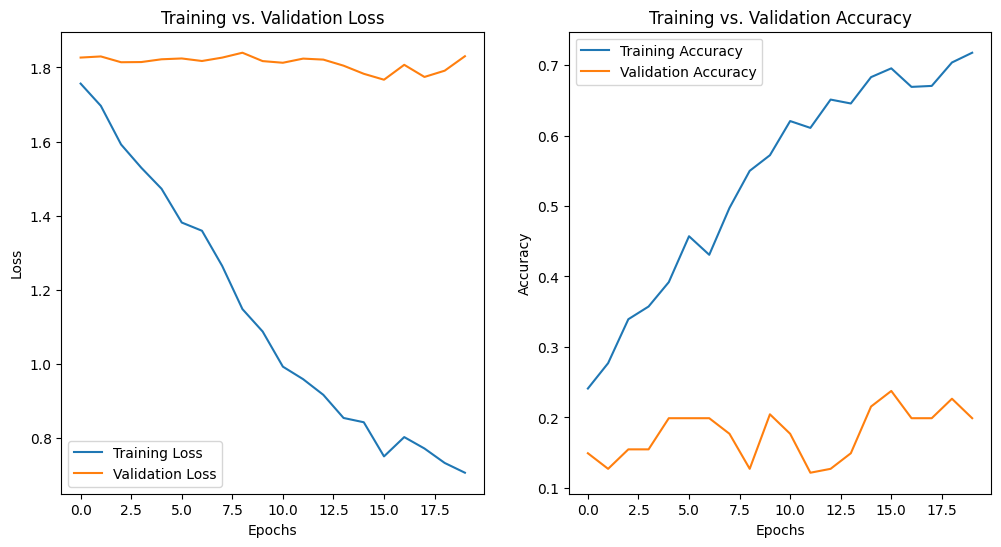
Accuracy: 0.15454545454545454

Mean Average Precision (mAP): 0.17949712994277509

A graph with blue squares and white text

Description automatically generated

1. **EfficientNetB0 with YOLO+Normalized+CLAHE, 6 players, all images**



Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.00 0.00 0.00 34 NO

Axar\_Patel 0.00 0.00 0.00 23 NO

Jasprit\_Bumrah 0.00 0.00 0.00 28 YES

Kuldeep\_Yadav 0.00 0.00 0.00 27 NO

Ravindra\_Jadeja 0.00 0.00 0.00 33 NO

Virat\_Kohli 0.20 1.00 0.33 36 NO

accuracy 0.20 181

macro avg 0.03 0.17 0.06 181

weighted avg 0.04 0.20 0.07 181

F1 Score (macro-average): 0.05555555555555556

Accuracy: 0.19889502762430938

Mean Average Precision (mAP): 0.2689384839762784

A chart with blue squares and white text

Description automatically generated

1. **EfficientNetB0 with YOLO+CLAHE, 6 players, all images**

A graph of a training and training loss

Description automatically generated with medium confidence

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.91 0.88 0.90 34 NO

Axar\_Patel 0.82 0.78 0.80 23 YES

Jasprit\_Bumrah 1.00 1.00 1.00 28 NO

Kuldeep\_Yadav 0.96 0.96 0.96 27 NO

Ravindra\_Jadeja 0.94 0.94 0.94 33 NO

Virat\_Kohli 0.92 0.97 0.95 36 NO

accuracy 0.93 181

macro avg 0.93 0.92 0.92 181

weighted avg 0.93 0.93 0.93 181

F1 Score (macro-average): 0.9239708727270916

Accuracy: 0.9281767955801105

Mean Average Precision (mAP): 0.9821984095466108

A graph with blue squares and white text

Description automatically generated

1. **ResNet with YOLO+CLAHE, 6 players, all images-20 epochs**

**A graph of training and validation loss

Description automatically generated**

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.93 0.82 0.87 34 NO

Axar\_Patel 0.77 0.74 0.76 23 YES

Jasprit\_Bumrah 0.90 0.96 0.93 28 NO

Kuldeep\_Yadav 0.92 0.89 0.91 27 YES

Ravindra\_Jadeja 0.82 0.94 0.87 33 YES

Virat\_Kohli 0.94 0.92 0.93 36 NO

accuracy 0.88 181

macro avg 0.88 0.88 0.88 181

weighted avg 0.89 0.88 0.88 181

F1 Score (macro-average): 0.8783445528468529

Train Accuracy: 0.9986149584487535

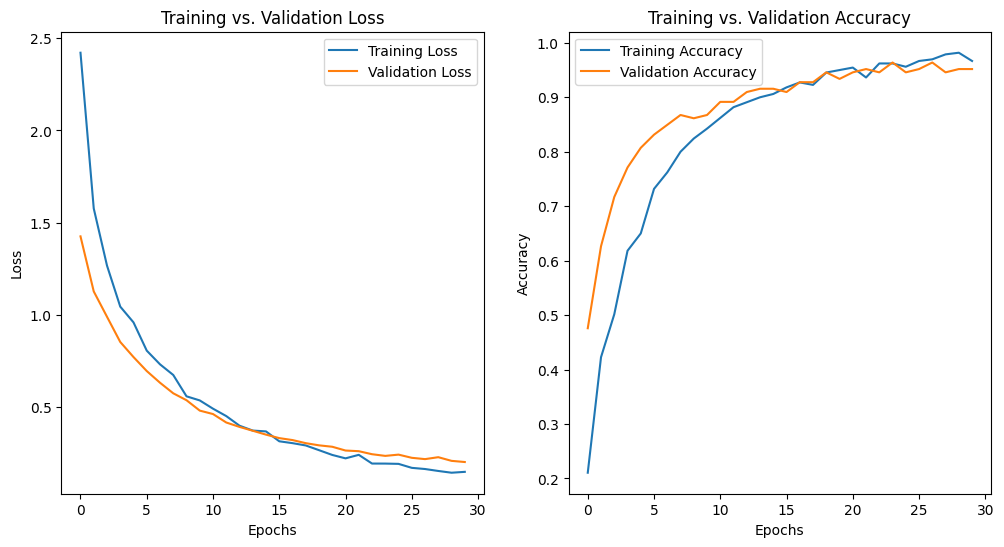
Test Accuracy: 0.8839779005524862

Mean Average Precision (mAP): 0.9431579158478929

A graph with blue squares and white text

Description automatically generated

1. **ResNet with YOLO+CLAHE, 6 players, all images-30 epochs**



Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.88 0.97 0.92 30 YES

Axar\_Patel 0.96 0.89 0.93 28 YES

Jasprit\_Bumrah 1.00 0.97 0.98 30 NO

Kuldeep\_Yadav 0.94 1.00 0.97 3 YES

Ravindra\_Jadeja 0.95 0.88 0.91 24 YES

Virat\_Kohli 1.00 1.00 1.00 23 NO

accuracy 0.95 166

macro avg 0.96 0.95 0.95 166

weighted avg 0.95 0.95 0.95 166

F1 Score (macro-average): 0.9519008620465571

Train Accuracy: 1.0

Test Accuracy: 0.9518072289156626

Mean Average Precision (mAP): 0.9929924762723799

A graph with blue squares and white text

Description automatically generated

1. **ResNet with YOLO+Normalized+CLAHE, 6 players, all images**

A graph of a graph of a training loss

Description automatically generated with medium confidence

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.53 0.74 0.62 34 NO

Axar\_Patel 0.67 0.35 0.46 23 NO

Jasprit\_Bumrah 0.62 0.64 0.63 28 NO

Kuldeep\_Yadav 0.52 0.63 0.57 27 YES

Ravindra\_Jadeja 0.47 0.52 0.49 33 NO

Virat\_Kohli 0.71 0.47 0.57 36 NO

accuracy 0.56 181

macro avg 0.59 0.56 0.56 181

weighted avg 0.58 0.56 0.56 181

F1 Score (macro-average): 0.5553487852750503

Train Accuracy: 0.7714681440443213

Test Accuracy: 0.56353591160221

Mean Average Precision (mAP): 0.6781088403586856

A blue squares with white text

Description automatically generated

1. **MobileNetV2 with YOLO+CLAHE, 6 players, all images**

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.66 0.74 0.69 34 YES

Axar\_Patel 0.71 0.43 0.54 23 NO

Jasprit\_Bumrah 0.86 0.86 0.86 28 NO

Kuldeep\_Yadav 0.87 0.74 0.80 27 NO

Ravindra\_Jadeja 0.56 0.82 0.67 33 NO

Virat\_Kohli 0.80 0.67 0.73 36 YES

accuracy 0.72 181

macro avg 0.74 0.71 0.71 181

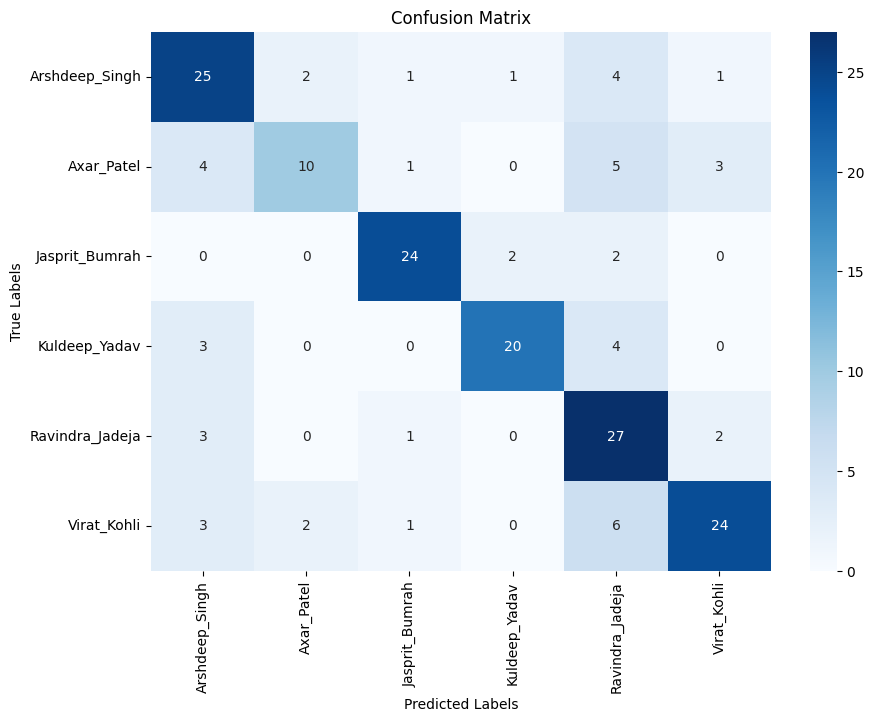
weighted avg 0.74 0.72 0.72 181

F1 Score (macro-average): 0.7143445393445393

Train Accuracy: 0.9958448753462604

Test Accuracy: 0.7182320441988951

Mean Average Precision (mAP): 0.8081841479772186



1. **InceptionV3 with YOLO+CLAHE, 6 players, all images**

A graph of training and validation loss

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.36 0.41 0.38 34 NO

Axar\_Patel 0.45 0.43 0.44 23 NO

Jasprit\_Bumrah 0.57 0.46 0.51 28 NO

Kuldeep\_Yadav 0.28 0.26 0.27 27 NO

Ravindra\_Jadeja 0.39 0.48 0.43 33 NO

Virat\_Kohli 0.68 0.58 0.63 36 NO

accuracy 0.45 181

macro avg 0.45 0.44 0.44 181

weighted avg 0.46 0.45 0.45 181

F1 Score (macro-average): 0.4443898138589468

Train Accuracy: 0.6620498614958449

Test Accuracy: 0.44751381215469616

Mean Average Precision (mAP): 0.49936544603165217

A blue squares with white text

Description automatically generated

1. **DenseNet with YOLO+CLAHE, 6 players, all images**

A graph of training and validation loss

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.66 0.62 0.64 34 YES

Axar\_Patel 0.63 0.52 0.57 23 NO

Jasprit\_Bumrah 0.82 0.64 0.72 28 NO

Kuldeep\_Yadav 0.64 0.67 0.65 27 NO

Ravindra\_Jadeja 0.62 0.79 0.69 33 NO

Virat\_Kohli 0.82 0.86 0.84 36 YES

accuracy 0.70 181

macro avg 0.70 0.68 0.69 181

weighted avg 0.70 0.70 0.69 181

F1 Score (macro-average): 0.6855848055848056

Train Accuracy: 0.8878116343490304

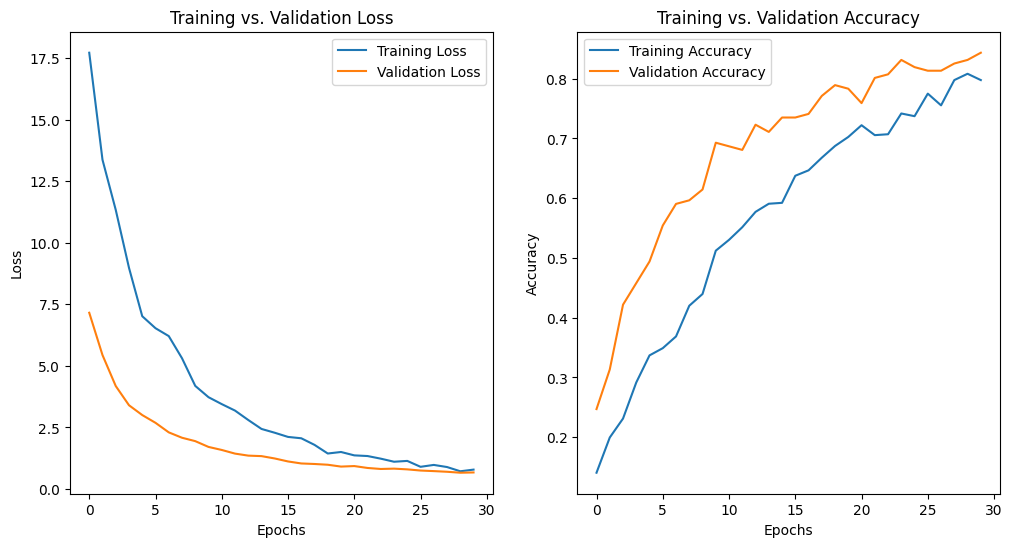
Test Accuracy: 0.6961325966850829

Mean Average Precision (mAP): 0.7465469869226823

A blue squares with white text

Description automatically generated

1. **VGG16 with YOLO+CLAHE, 6 players, all images**



Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.84 0.90 0.87 30 YES

Axar\_Patel 0.81 0.88 0.84 24 NO

Jasprit\_Bumrah 0.84 0.93 0.89 29 NO

Kuldeep\_Yadav 0.78 0.86 0.82 29 NO

Ravindra\_Jadeja 0.90 0.63 0.75 30 NO

Virat\_Kohli 0.91 0.88 0.89 24 NO

accuracy 0.84 166

macro avg 0.85 0.85 0.84 166

weighted avg 0.85 0.84 0.84 166

F1 Score (macro-average): 0.8424334725357753

Train Accuracy: 0.972809667673716

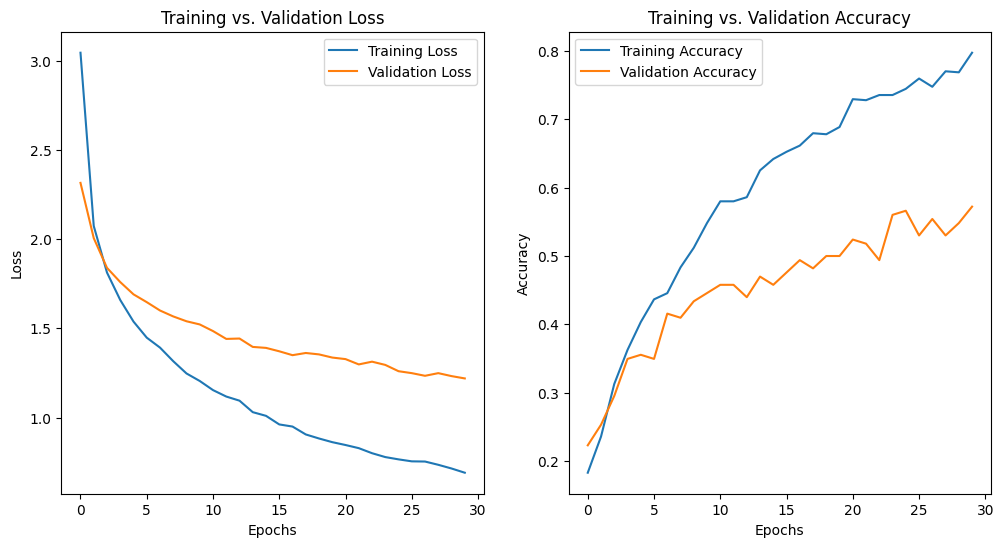
Test Accuracy: 0.8433734939759037

Mean Average Precision (mAP): 0.8990265556710101

A blue squares with white text

Description automatically generated

1. **NASNet with YOLO+CLAHE, 6 players, all images**



Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.39 0.50 0.44 30 NO

Axar\_Patel 0.61 0.58 0.60 24 NO

Jasprit\_Bumrah 0.79 0.52 0.62 29 NO

Kuldeep\_Yadav 0.55 0.59 0.57 29 NO

Ravindra\_Jadeja 0.57 0.57 0.57 30 NO

Virat\_Kohli 0.68 0.71 0.69 24 NO

accuracy 0.57 166

macro avg 0.60 0.58 0.58 166

weighted avg 0.59 0.57 0.58 166

F1 Score (macro-average): 0.5815220059655068

Train Accuracy: 0.8172205438066465

Test Accuracy: 0.572289156626506

Mean Average Precision (mAP): 0.6190944697638547

A blue squares with white text

Description automatically generated

1. **Inception-ResNet-V2 with YOLO+CLAHE, 6 players, all images**

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.00 0.00 0.00 30 NO

Axar\_Patel 0.00 0.00 0.00 24 NO

Jasprit\_Bumrah 0.00 0.00 0.00 29 NO

Kuldeep\_Yadav 0.00 0.00 0.00 29 NO

Ravindra\_Jadeja 0.00 0.00 0.00 30 NO

Virat\_Kohli 0.14 1.00 0.25 24 NO

accuracy 0.14 166

macro avg 0.02 0.17 0.04 166

weighted avg 0.02 0.14 0.04 166

F1 Score (macro-average): 0.042105263157894736

Train Accuracy: 0.18277945619335348

Test Accuracy: 0.14457831325301204

Mean Average Precision (mAP): 0.1750410697024074

A graph with blue squares and white text

Description automatically generated

1. **Xception with YOLO+CLAHE, 6 players, all images**

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Classification Report:

precision recall f1-score support Predicted

Arshdeep\_Singh 0.71 0.73 0.72 30 YES

Axar\_Patel 0.58 0.46 0.51 24 YES

Jasprit\_Bumrah 0.38 0.41 0.39 29 NO

Kuldeep\_Yadav 0.61 0.66 0.63 29 NO

Ravindra\_Jadeja 0.72 0.60 0.65 30 NO

Virat\_Kohli 0.71 0.83 0.77 24 NO

accuracy 0.61 166

macro avg 0.62 0.62 0.61 166

weighted avg 0.62 0.61 0.61 166

F1 Score (macro-average): 0.6139152604078262

Train Accuracy: 0.9924471299093656

Test Accuracy: 0.6144578313253012

Mean Average Precision (mAP): 0.6867499680486353

A blue squares with white text

Description automatically generated

**ResNet50**

1. With 5 fold Cross Validation

A graph of loss and loss of a curve

Description automatically generated with medium confidence A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.94 1.00 0.97 30

Axar\_Patel 0.93 0.89 0.91 28

Jasprit\_Bumrah 0.97 1.00 0.98 30

Kuldeep\_Yadav 1.00 1.00 1.00 31

Ravindra\_Jadeja 1.00 0.96 0.98 24

Virat\_Kohli 1.00 0.96 0.98 23

accuracy 0.97 166

macro avg 0.97 0.97 0.97 166

weighted avg 0.97 0.97 0.97 166

F1 Score (macro-average): 0.9694900973308211

Train Accuracy: 1.0

Test Accuracy: 0.9698795180722891

Mean Average Precision (mAP): 0.9906417649610968

A graph with blue squares and white text

Description automatically generated

1. ResNet as a feature extractor and SVM as a classifier

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.91 1.00 0.95 30

Axar\_Patel 1.00 0.93 0.96 28

Jasprit\_Bumrah 1.00 0.93 0.97 30

Kuldeep\_Yadav 0.94 1.00 0.97 31

Ravindra\_Jadeja 0.95 0.88 0.91 24

Virat\_Kohli 0.96 1.00 0.98 23

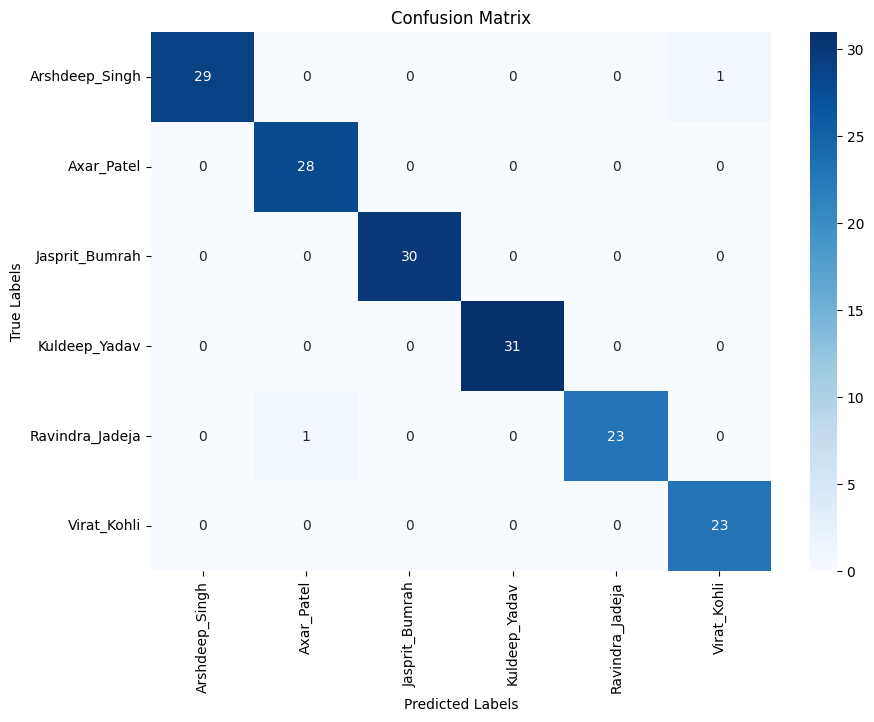
accuracy 0.96 166

macro avg 0.96 0.96 0.96 166

weighted avg 0.96 0.96 0.96 166

Training Accuracy: 0.9696969696969697

Testing Accuracy: 0.9578313253012049

A graph of a training set size

Description automatically generated with medium confidence

1. ResNet as a feature extractor and Random Forest as a classifier

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.94 0.97 0.95 30

Axar\_Patel 1.00 0.96 0.98 28

Jasprit\_Bumrah 1.00 0.90 0.95 30

Kuldeep\_Yadav 0.97 1.00 0.98 31

Ravindra\_Jadeja 0.92 0.92 0.92 24

Virat\_Kohli 0.92 1.00 0.96 23

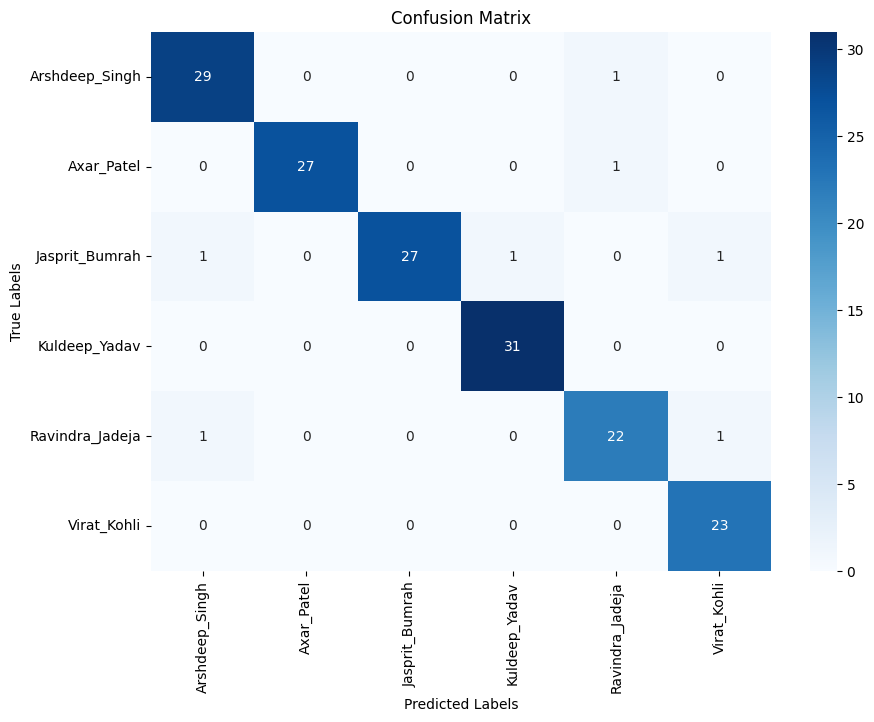
accuracy 0.96 166

macro avg 0.96 0.96 0.96 166

weighted avg 0.96 0.96 0.96 166

Training Accuracy: 1.0

Testing Accuracy: 0.9578313253012049



1. ResNet as a feature extractor and Decision Tree as a classifier

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.67 0.53 0.59 30

Axar\_Patel 0.56 0.64 0.60 28

Jasprit\_Bumrah 0.73 0.73 0.73 30

Kuldeep\_Yadav 0.76 0.81 0.78 31

Ravindra\_Jadeja 0.57 0.54 0.55 24

Virat\_Kohli 0.67 0.70 0.68 23

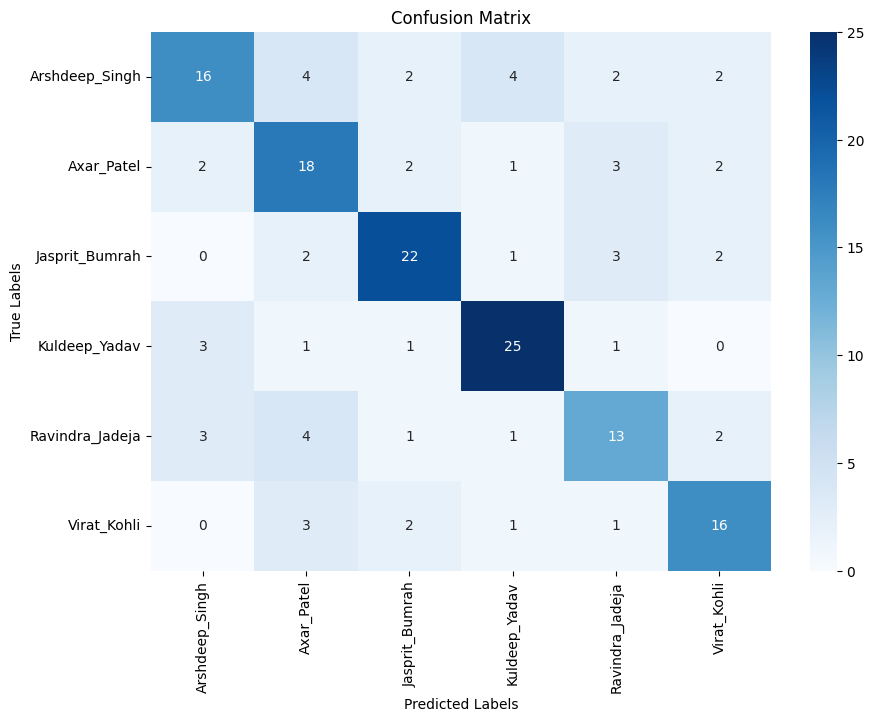
accuracy 0.66 166

macro avg 0.66 0.66 0.66 166

weighted avg 0.66 0.66 0.66 166

Training Accuracy: 1.0

Testing Accuracy: 0.6626506024096386



1. ResNet as a feature extractor and KNN as a classifier

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.91 0.97 0.94 30

Axar\_Patel 0.97 1.00 0.98 28

Jasprit\_Bumrah 1.00 0.87 0.93 30

Kuldeep\_Yadav 0.97 1.00 0.98 31

Ravindra\_Jadeja 1.00 0.92 0.96 24

Virat\_Kohli 0.92 1.00 0.96 23

accuracy 0.96 166

macro avg 0.96 0.96 0.96 166

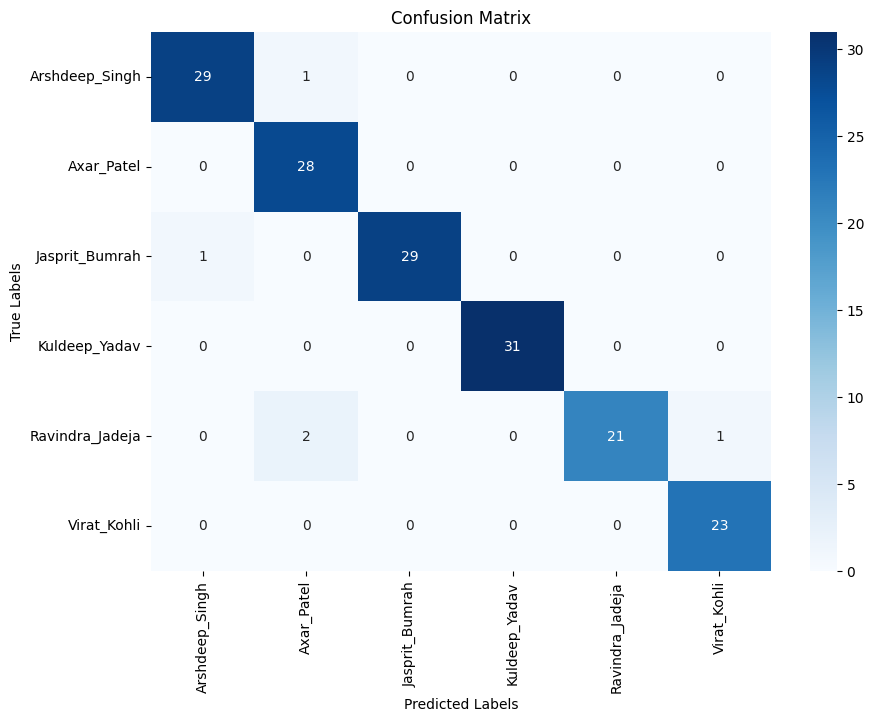
weighted avg 0.96 0.96 0.96 166

Training Accuracy: 0.9666666666666667

Testing Accuracy: 0.9578313253012049

A graph of a graph

Description automatically generated with medium confidence



1. ResNet as a feature extractor and Gradient Boost Machine as a classifier

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.82 0.93 0.87 30

Axar\_Patel 0.92 0.82 0.87 28

Jasprit\_Bumrah 0.93 0.93 0.93 30

Kuldeep\_Yadav 0.94 1.00 0.97 31

Ravindra\_Jadeja 0.90 0.75 0.82 24

Virat\_Kohli 0.92 0.96 0.94 23

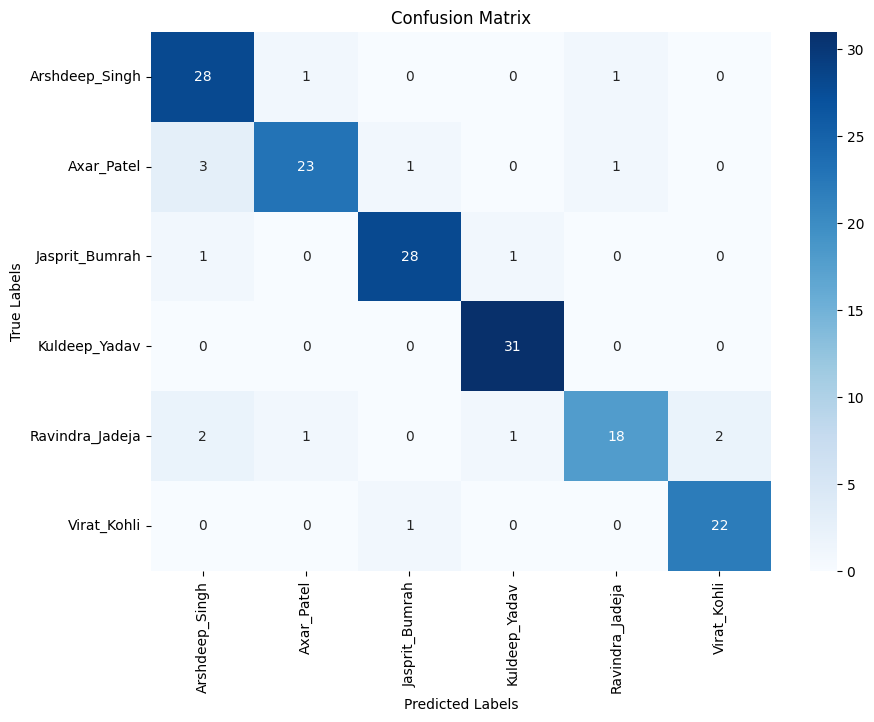
accuracy 0.90 166

macro avg 0.91 0.90 0.90 166

weighted avg 0.91 0.90 0.90 166

Training Accuracy: 1.0

Testing Accuracy: 0.9036144578313253



1. RestNet as a feature extractor and KNN and SVM as a classifier(Stacking)

Training Accuracy: 1.0

Testing Accuracy: 0.9939759036144579

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.97 1.00 0.98 30

Axar\_Patel 1.00 1.00 1.00 28

Jasprit\_Bumrah 1.00 0.97 0.98 30

Kuldeep\_Yadav 1.00 1.00 1.00 31

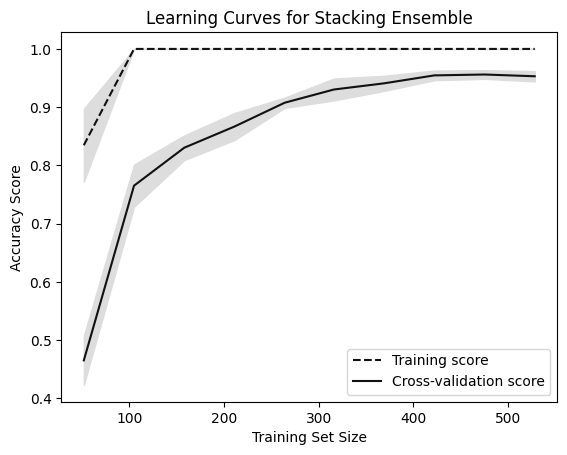
Ravindra\_Jadeja 1.00 1.00 1.00 24

Virat\_Kohli 1.00 1.00 1.00 23

accuracy 0.99 166

macro avg 0.99 0.99 0.99 166

weighted avg 0.99 0.99 0.99 166



A graph with blue squares and white text

Description automatically generated

1. RestNet as a feature extractor and KNN and SVM as a classifier (Stacking) with tuning the parameters

Training Accuracy: 0.9848484848484849

Testing Accuracy: 0.9939759036144579

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 1.00 1.00 1.00 30

Axar\_Patel 1.00 1.00 1.00 28

Jasprit\_Bumrah 1.00 1.00 1.00 30

Kuldeep\_Yadav 1.00 1.00 1.00 31

Ravindra\_Jadeja 1.00 0.96 0.98 24

Virat\_Kohli 0.96 1.00 0.98 23

accuracy 0.99 166

macro avg 0.99 0.99 0.99 166

weighted avg 0.99 0.99 0.99 166

A graph of a graph

Description automatically generated with medium confidence

A graph with blue squares and white text

Description automatically generatedA graph with blue squares and white text

Description automatically generated

1. RestNet as a feature extractor and KNN and SVM as a classifier(Voting Classifier) with tuning the parameters

Training Accuracy: 0.9681818181818181

Testing Accuracy: 0.9578313253012049

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.83 1.00 0.91 30

Axar\_Patel 1.00 0.96 0.98 28

Jasprit\_Bumrah 1.00 0.87 0.93 30

Kuldeep\_Yadav 0.97 1.00 0.98 31

Ravindra\_Jadeja 1.00 0.92 0.96 24

Virat\_Kohli 1.00 1.00 1.00 23

accuracy 0.96 166

macro avg 0.97 0.96 0.96 166

weighted avg 0.96 0.96 0.96 166

A graph of a graph showing the number of steps

Description automatically generated with medium confidence

A graph with blue squares and white text

Description automatically generated

1. RestNet as a feature extractor and KNN and SVM as a classifier(Decision Level Fusion ) with tuning the parameters

Training Accuracy: 0.9681818181818183

Testing Accuracy: 0.9578313253012049

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 1.00 1.00 1.00 30

Axar\_Patel 1.00 1.00 1.00 28

Jasprit\_Bumrah 1.00 1.00 1.00 30

Kuldeep\_Yadav 1.00 1.00 1.00 31

Ravindra\_Jadeja 1.00 0.96 0.98 24

Virat\_Kohli 0.96 1.00 0.98 23

accuracy 0.99 166

macro avg 0.99 0.99 0.99 166

weighted avg 0.99 0.99 0.99 166

A graph with blue squares and white text

Description automatically generated

**RestNet as a feature extractor and KNN & SVM as a classifier(Stacking) with tuning the parameters**

Training Accuracy: 0.9845440494590417

Testing Accuracy: 0.9814814814814815

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.97 1.00 0.98 29

Axar\_Patel 1.00 0.89 0.94 19

Jasprit\_Bumrah 1.00 1.00 1.00 28

Kuldeep\_Yadav 1.00 1.00 1.00 33

Ravindra\_Jadeja 0.96 0.96 0.96 26

Virat\_Kohli 0.96 1.00 0.98 27

accuracy 0.98 162

macro avg 0.98 0.98 0.98 162

weighted avg 0.98 0.98 0.98 162

A graph of a number of red and green lines

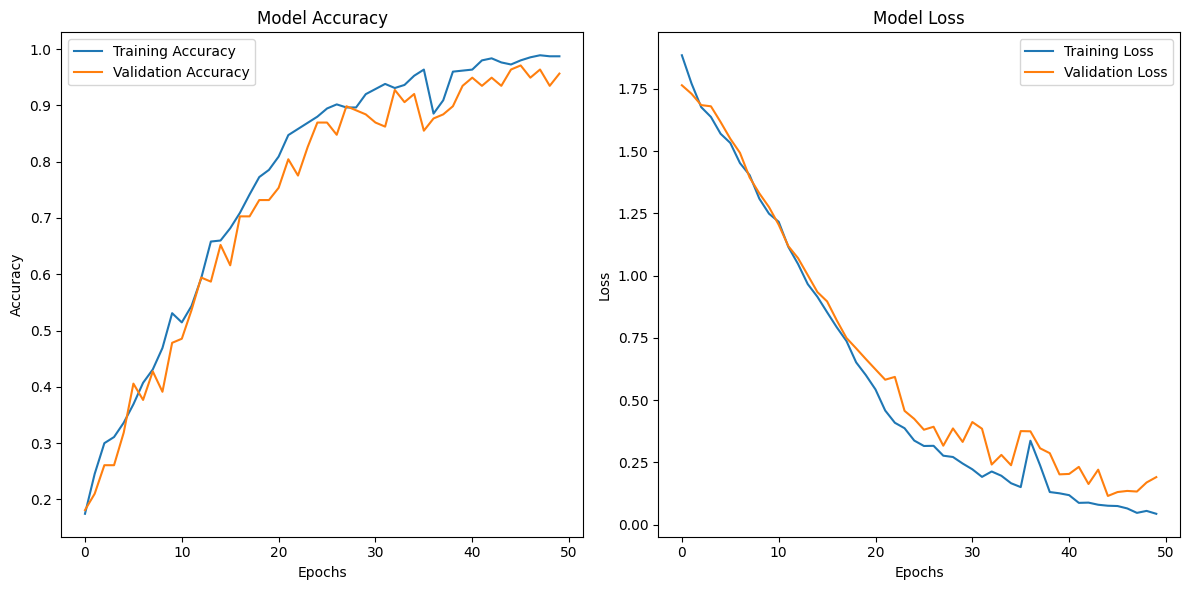
Description automatically generated

A graph with blue squares and white text

Description automatically generated

**TEMPORAL MODEL**

1. LSTM with the features step length, joint velocities, joint angles



Train accuracy: 1.0

Test accuracy: 0.95652174949646

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.90 0.97 0.93 29

Axar\_Patel 1.00 1.00 1.00 14

Jasprit\_Bumrah 0.82 1.00 0.90 9

Kuldeep\_Yadav 1.00 1.00 1.00 33

Ravindra\_Jadeja 1.00 0.93 0.96 28

Virat\_Kohli 0.96 0.88 0.92 25

accuracy 0.96 138

macro avg 0.95 0.96 0.95 138

weighted avg 0.96 0.96 0.96 138

A graph with blue squares and white text

Description automatically generated

1. LSTM with the features step length, joint velocities, joint angles (adjusted dropout)

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

Description automatically generated

Train accuracy: 0.9745454788208008

Test accuracy: 0.9420289993286133

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.91 1.00 0.95 29

Axar\_Patel 0.92 0.86 0.89 14

Jasprit\_Bumrah 0.90 1.00 0.95 9

Kuldeep\_Yadav 0.97 0.91 0.94 33

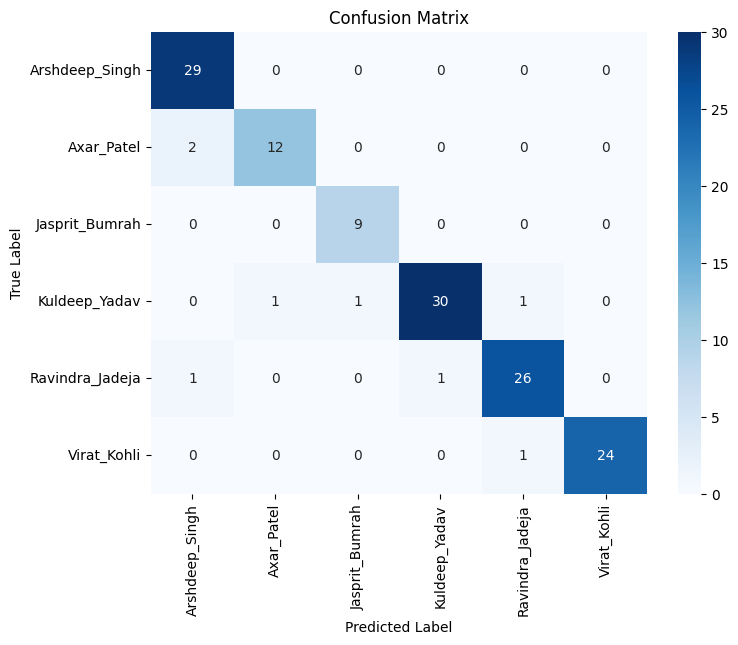
Ravindra\_Jadeja 0.93 0.93 0.93 28

Virat\_Kohli 1.00 0.96 0.98 25

accuracy 0.94 138

macro avg 0.94 0.94 0.94 138

weighted avg 0.94 0.94 0.94 138



1. GRU with the features step length, joint velocities, joint angles

Train accuracy: 1.0

Test accuracy: 0.9555555582046509

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.86 1.00 0.93 32

Axar\_Patel 1.00 0.92 0.96 12

Jasprit\_Bumrah 1.00 1.00 1.00 15

Kuldeep\_Yadav 1.00 0.96 0.98 23

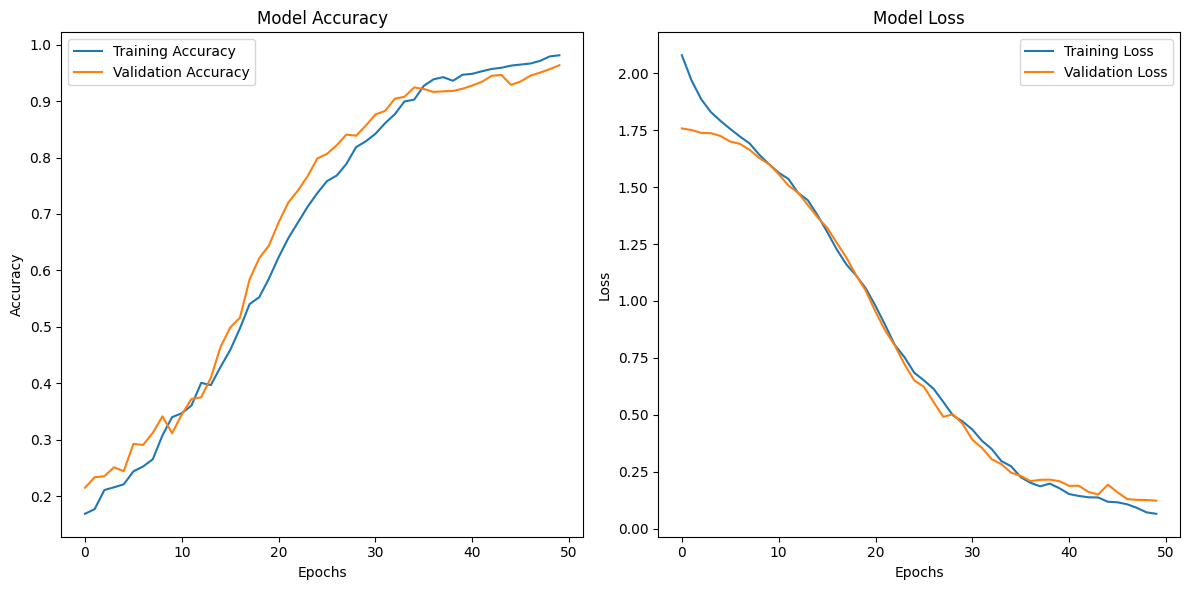
Ravindra\_Jadeja 0.96 0.92 0.94 24

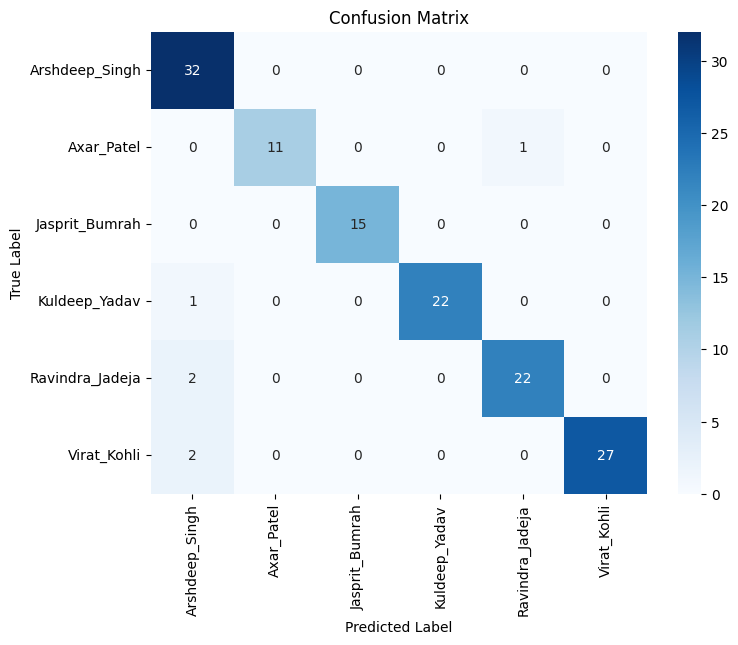
Virat\_Kohli 1.00 0.93 0.96 29

accuracy 0.96 135

macro avg 0.97 0.95 0.96 135

weighted avg 0.96 0.96 0.96 135





1. GRU with the features step length, joint velocities, joint angles with regularization and adjusted dropouts

Train accuracy: 0.9981481432914734

Test accuracy: 0.9555555582046509

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.94 0.97 0.95 32

Axar\_Patel 0.92 1.00 0.96 12

Jasprit\_Bumrah 0.94 1.00 0.97 15

Kuldeep\_Yadav 0.96 0.96 0.96 23

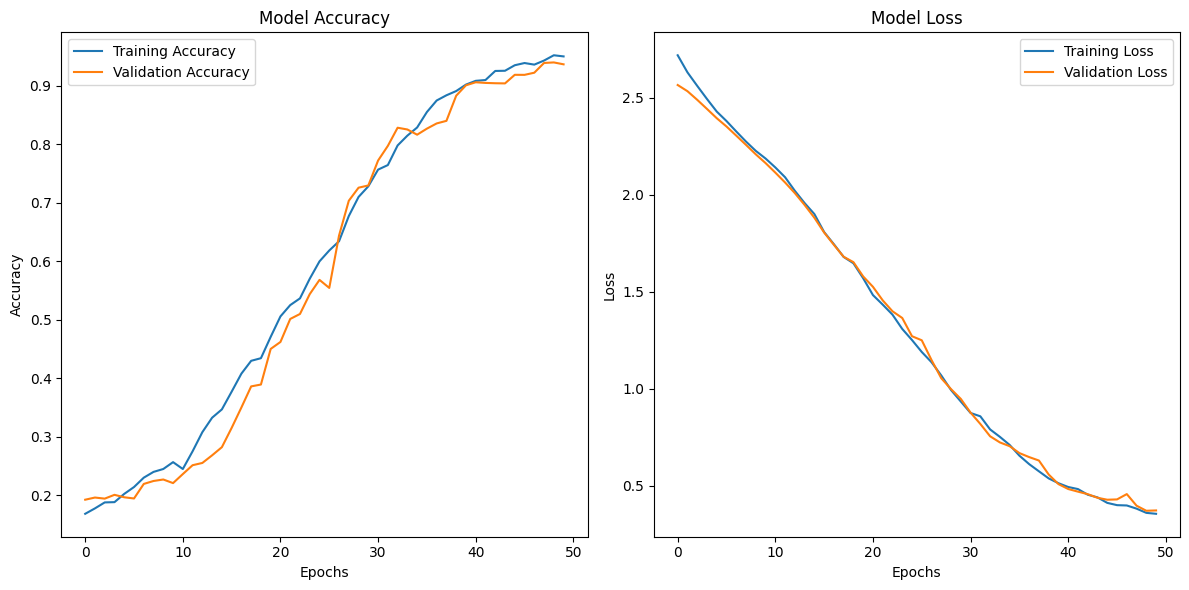
Ravindra\_Jadeja 1.00 0.88 0.93 24

Virat\_Kohli 0.97 0.97 0.97 29

accuracy 0.96 135

macro avg 0.95 0.96 0.96 135

weighted avg 0.96 0.96 0.96 135



A graph with blue squares and white text

Description automatically generated

1. GRU with the features step length, joint velocities, joint angles with regularization and adjusted dropouts and adjusted sequence length

Train accuracy: 0.9941860437393188

Test accuracy: 0.9844961166381836

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 0.94 1.00 0.97 30

Axar\_Patel 1.00 1.00 1.00 7

Jasprit\_Bumrah 1.00 1.00 1.00 19

Kuldeep\_Yadav 1.00 0.91 0.95 22

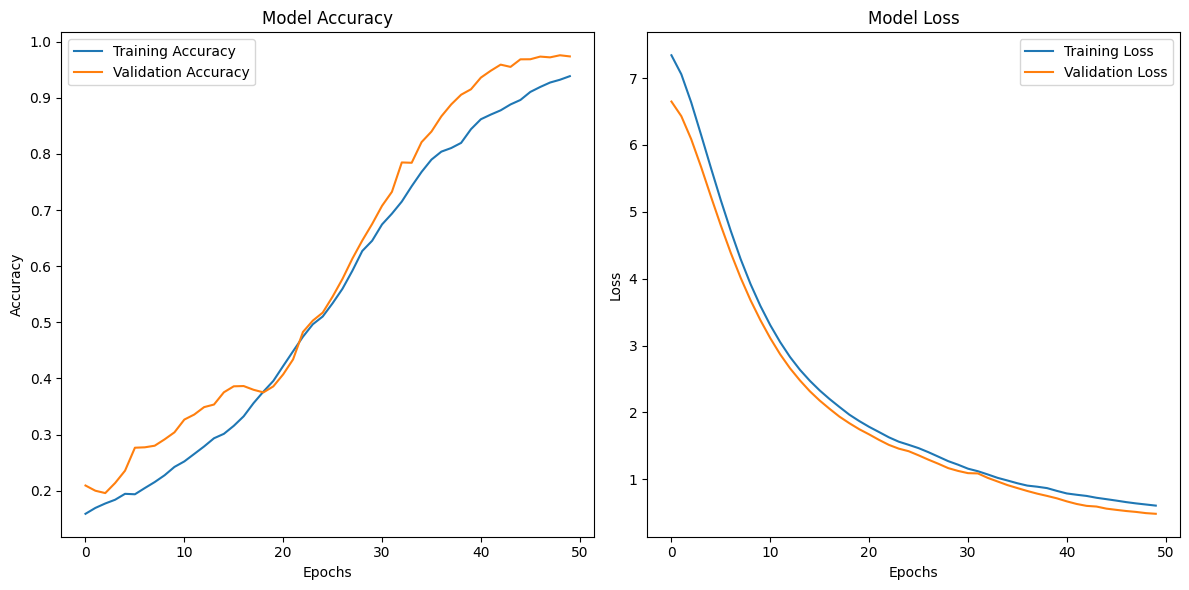
Ravindra\_Jadeja 1.00 1.00 1.00 25

Virat\_Kohli 1.00 1.00 1.00 26

accuracy 0.98 129

macro avg 0.99 0.98 0.99 129

weighted avg 0.99 0.98 0.98 129



A graph with blue squares and white text

Description automatically generated

1. GRU with the features step length, joint velocities, joint angles, joint acceleration and angular acceleration with regularization and adjusted dropouts and adjusted sequence length (added data to axar)

Train accuracy: 1.0

Test accuracy: 1.0

Classification Report:

precision recall f1-score support

Arshdeep\_Singh 1.00 1.00 1.00 32

Axar\_Patel 1.00 1.00 1.00 20

Jasprit\_Bumrah 1.00 1.00 1.00 12

Kuldeep\_Yadav 1.00 1.00 1.00 26

Ravindra\_Jadeja 1.00 1.00 1.00 21

Virat\_Kohli 1.00 1.00 1.00 24

accuracy 1.00 135

macro avg 1.00 1.00 1.00 135

weighted avg 1.00 1.00 1.00 135

