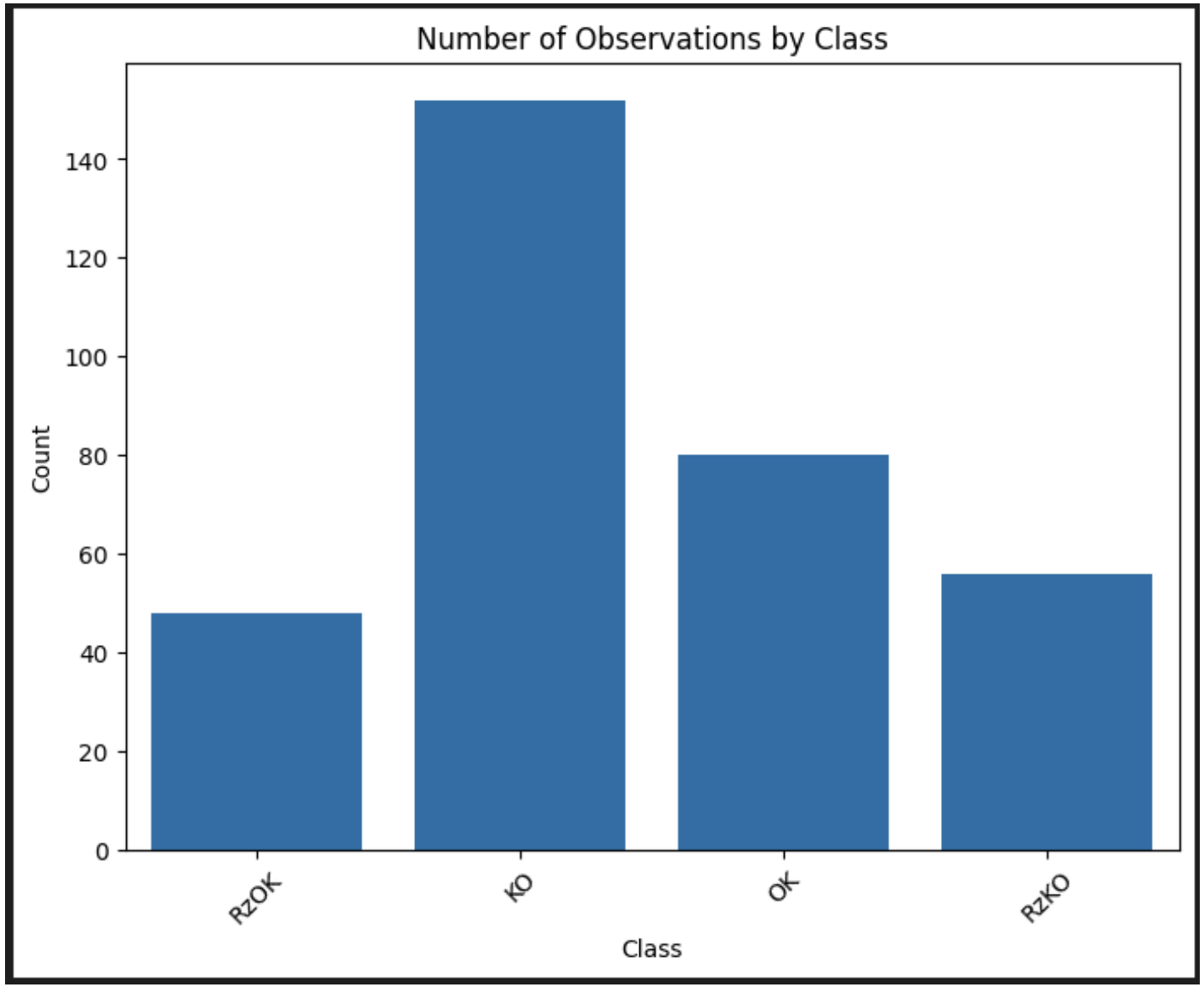
IMPLEMENTATION

November 2024

TRAIN DATASET

- 4 classes
  - KO: 140 samples
  - OK: 80 samples
  - RzKO: 55 samples
  - RzOK: 50 samples

DATASET


Number of Observations by Class
Count
0
20
40
60
80
100
120
140
RzOK
KO
OK
RzKO
Class

TEST DATASET

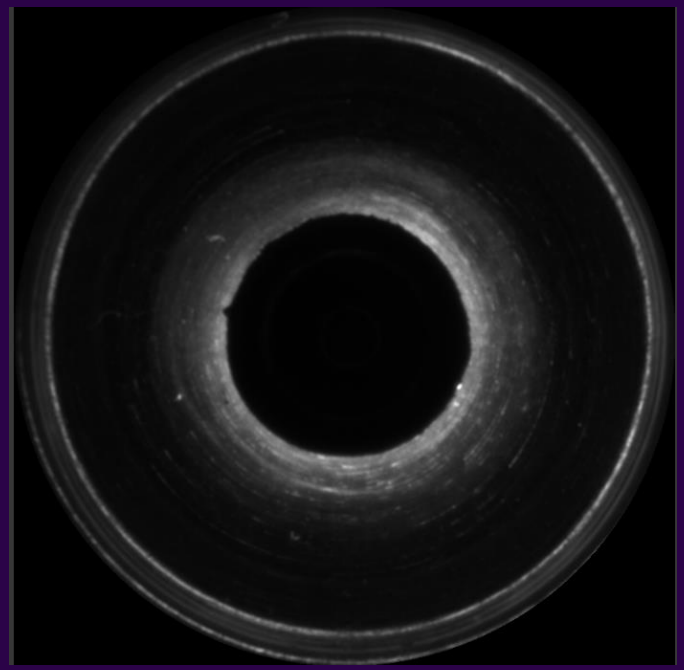
- 4 classes
  - KO: 16 samples
  - OK: 9 samples
  - RzKO: 14 samples
  - RzOK: 16 samples

MODELS

1. MobileNetV3Large
2. EfficientNet B0
3. Resnet50

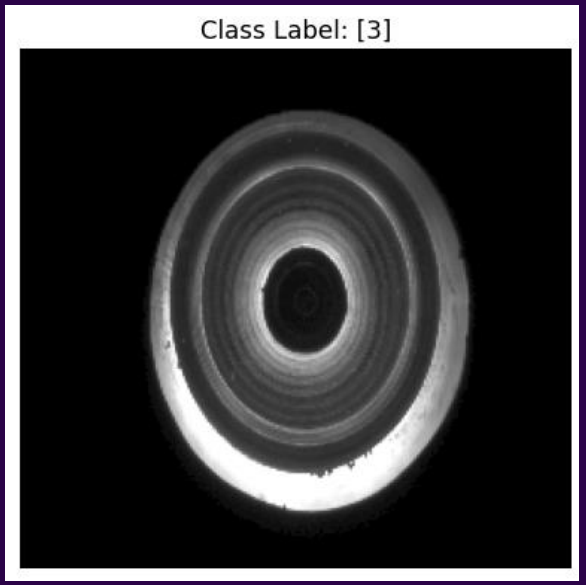
CROP

- crop central part of all images in our dataset to only train model on the part which we expect anomaly



GAMMA TRANSFORM

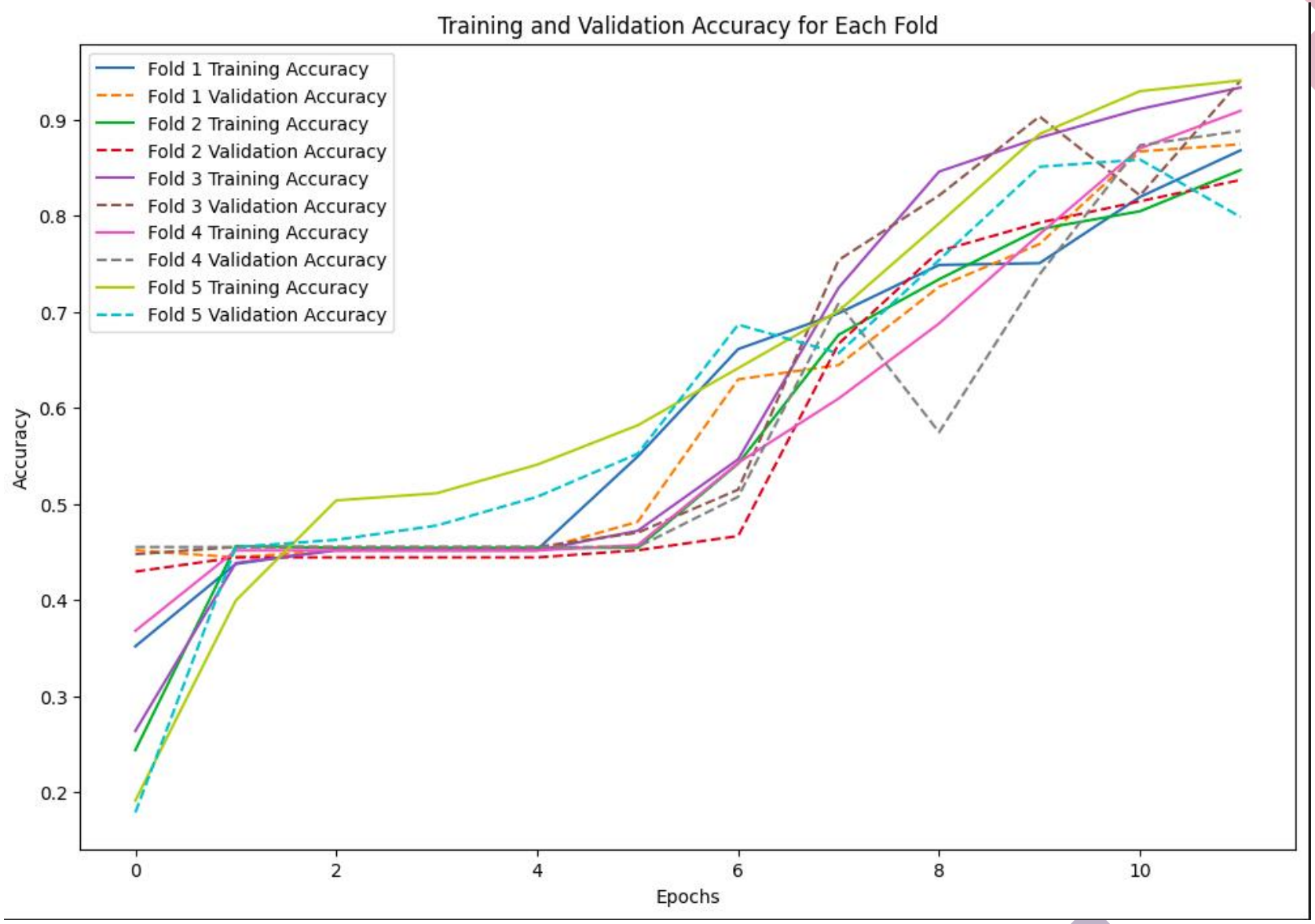
- Apply gamma on all dataset
- add new images to dataset
- Dataset contain normal images + gamma version
- Gamma value = 1.6

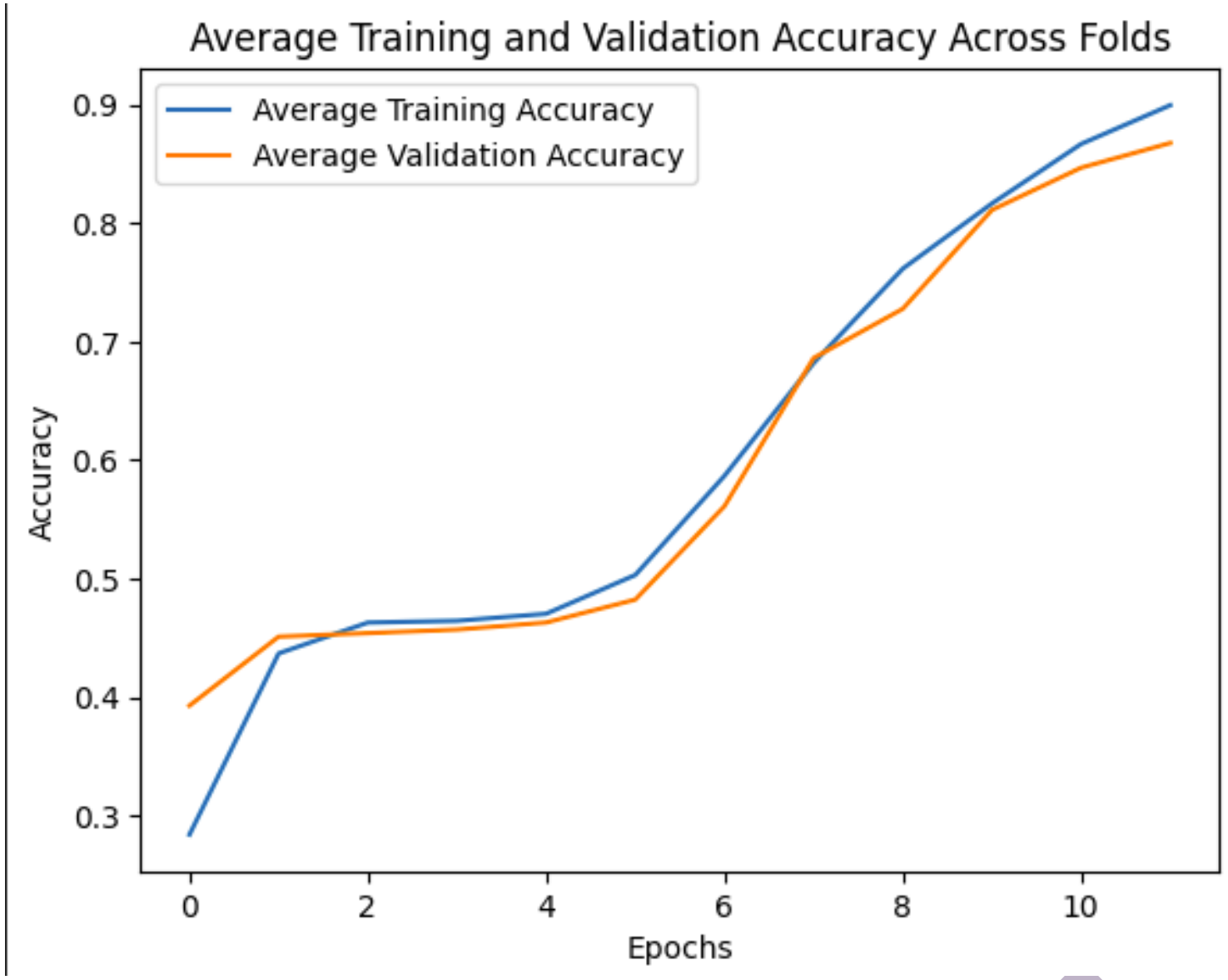


CROSS VALIDATION

- Use StratifiedKFold
- 5 FOLDS
- Save weights of best cross-validation
- ResNet50 classifier
- Loss function: sparse categorical crossentropy
- Optimizer: SGD
- Learning rate: Cosine Decay with Warm-Up
  - weight_decay=5e-4,
  - momentum=0.9
- Train for 13 epochs
- Input image: (224,224)
- BATCH SIZE = 32

RESULT FOR CROSS VALIDATION


Training and Validation Accuracy for Each Fold
Fold 1 Training Accuracy
Fold 1 Validation Accuracy
Fold 2 Training Accuracy
Fold 2 Validation Accuracy
Fold 3 Training Accuracy
Fold 3 Validation Accuracy
Fold 4 Training Accuracy
Fold 4 Validation Accuracy
Fold 5 Training Accuracy
Fold 5 Validation Accuracy
Accuracy
Epochs
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
2
4
6
8
10

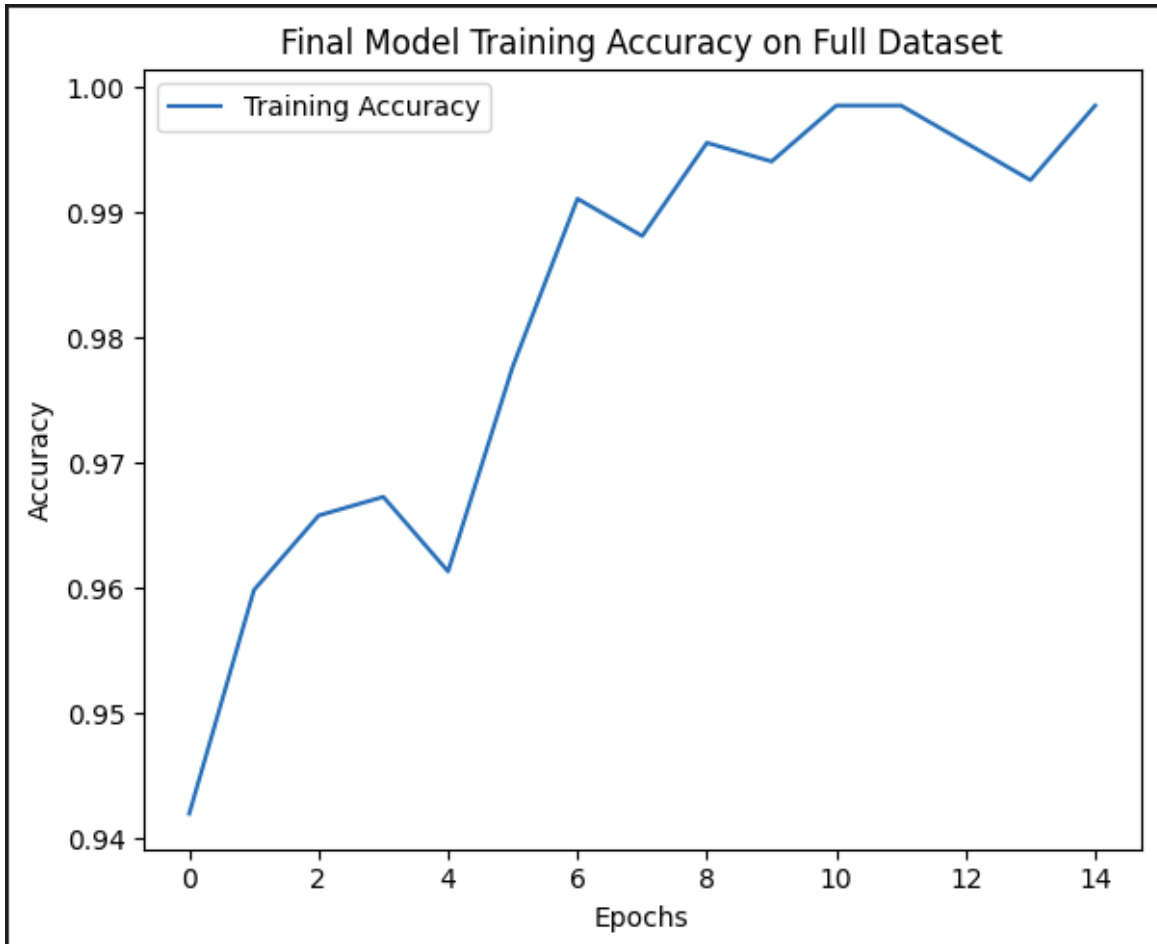

Average Training and Validation Accuracy Across Folds
Average Training Accuracy
Average Validation Accuracy
Accuracy
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
2
4
6
8
10
Epochs

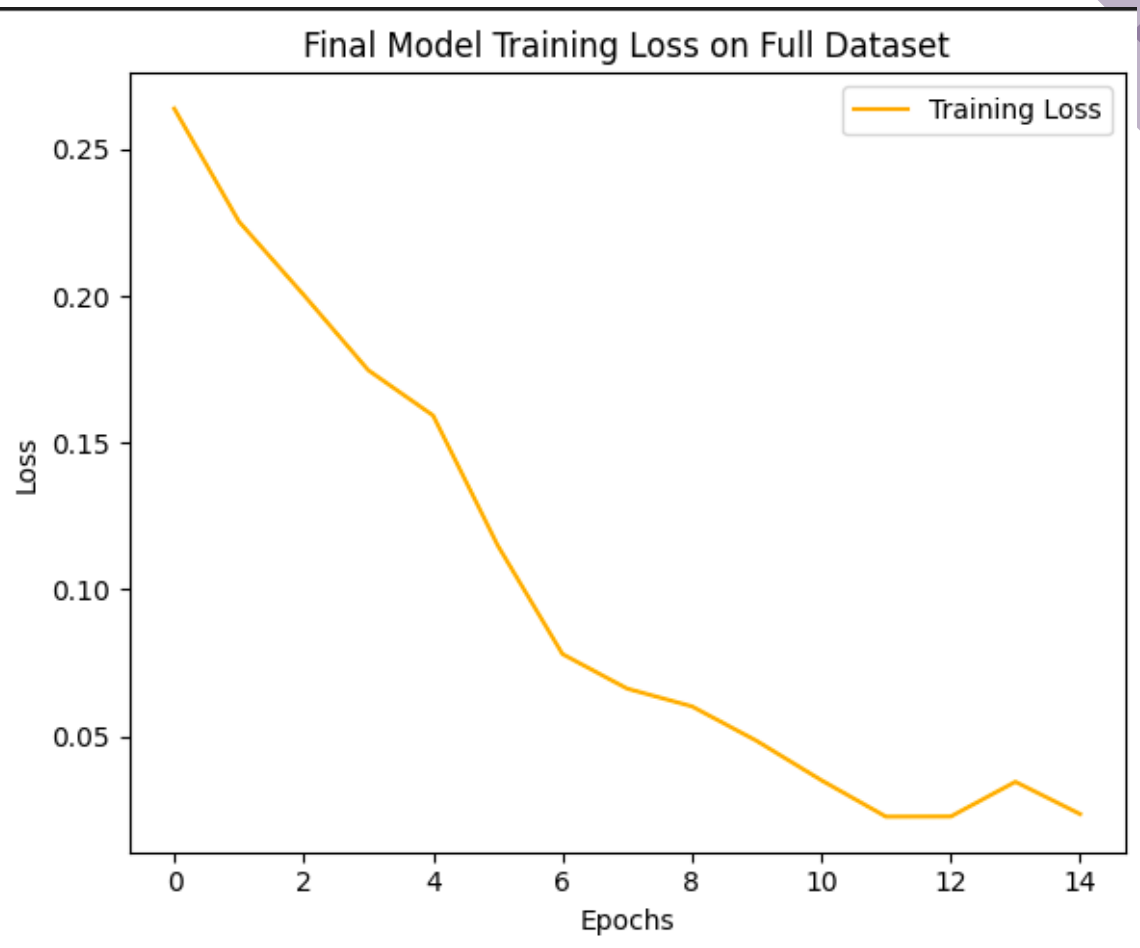
MAIN MODEL

- Load best weights from cross-validation
- Use whole dataset for train
- Loss function: sparse categorical crossentropy
- Optimizer: SGD
- Learning rate: Cosine Decay with Warm-Up
  - weight_decay=5e-4
  - momentum=0.9
- Train for 15 epochs

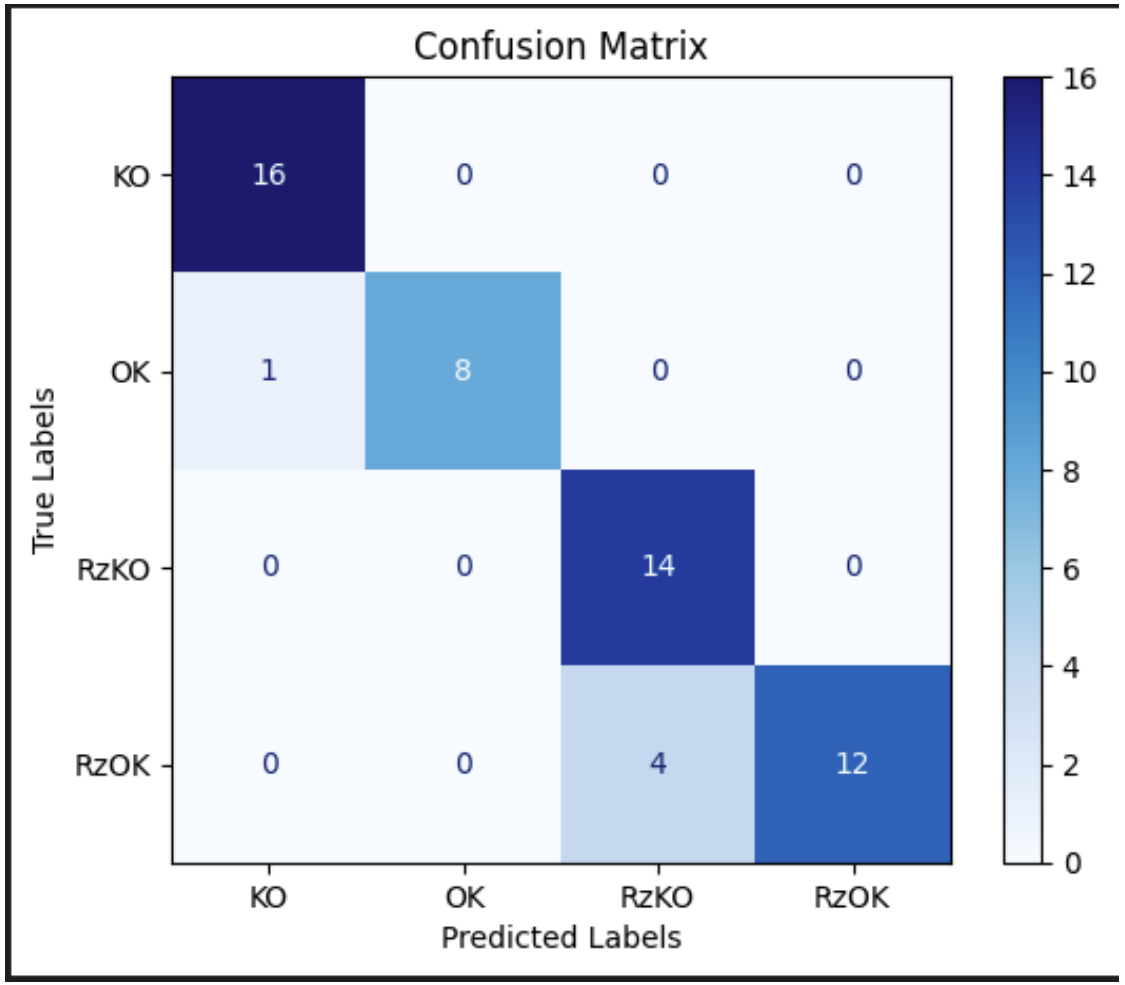
TRAINING FINAL MODEL

```
Epoch 1/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 35s 881ms/step - accuracy: 0.9365 - loss: 0.2882
Epoch 2/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 21s 392ms/step - accuracy: 0.9642 - loss: 0.2439
Epoch 3/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 256ms/step - accuracy: 0.9761 - loss: 0.2015
Epoch 4/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 260ms/step - accuracy: 0.9643 - loss: 0.1888
Epoch 5/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 263ms/step - accuracy: 0.9631 - loss: 0.1649
Epoch 6/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 11s 499ms/step - accuracy: 0.9721 - loss: 0.1314
Epoch 7/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 260ms/step - accuracy: 0.9941 - loss: 0.0847
Epoch 8/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 260ms/step - accuracy: 0.9948 - loss: 0.0668
Epoch 9/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 258ms/step - accuracy: 0.9963 - loss: 0.0669
Epoch 10/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 257ms/step - accuracy: 0.9963 - loss: 0.0510
Epoch 11/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 257ms/step - accuracy: 0.9969 - loss: 0.0439
Epoch 12/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 256ms/step - accuracy: 0.9990 - loss: 0.0237
Epoch 13/15
...
Epoch 14/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 255ms/step - accuracy: 0.9926 - loss: 0.0358
Epoch 15/15
21/21 ━━━━━━━━━━━━━━━━━━━━ 6s 255ms/step - accuracy: 0.9997 - loss: 0.0236
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...
```


Final Model Training Accuracy on Full Dataset
Training Accuracy
Accuracy
Epochs
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0
2
4
6
8
10
12
14

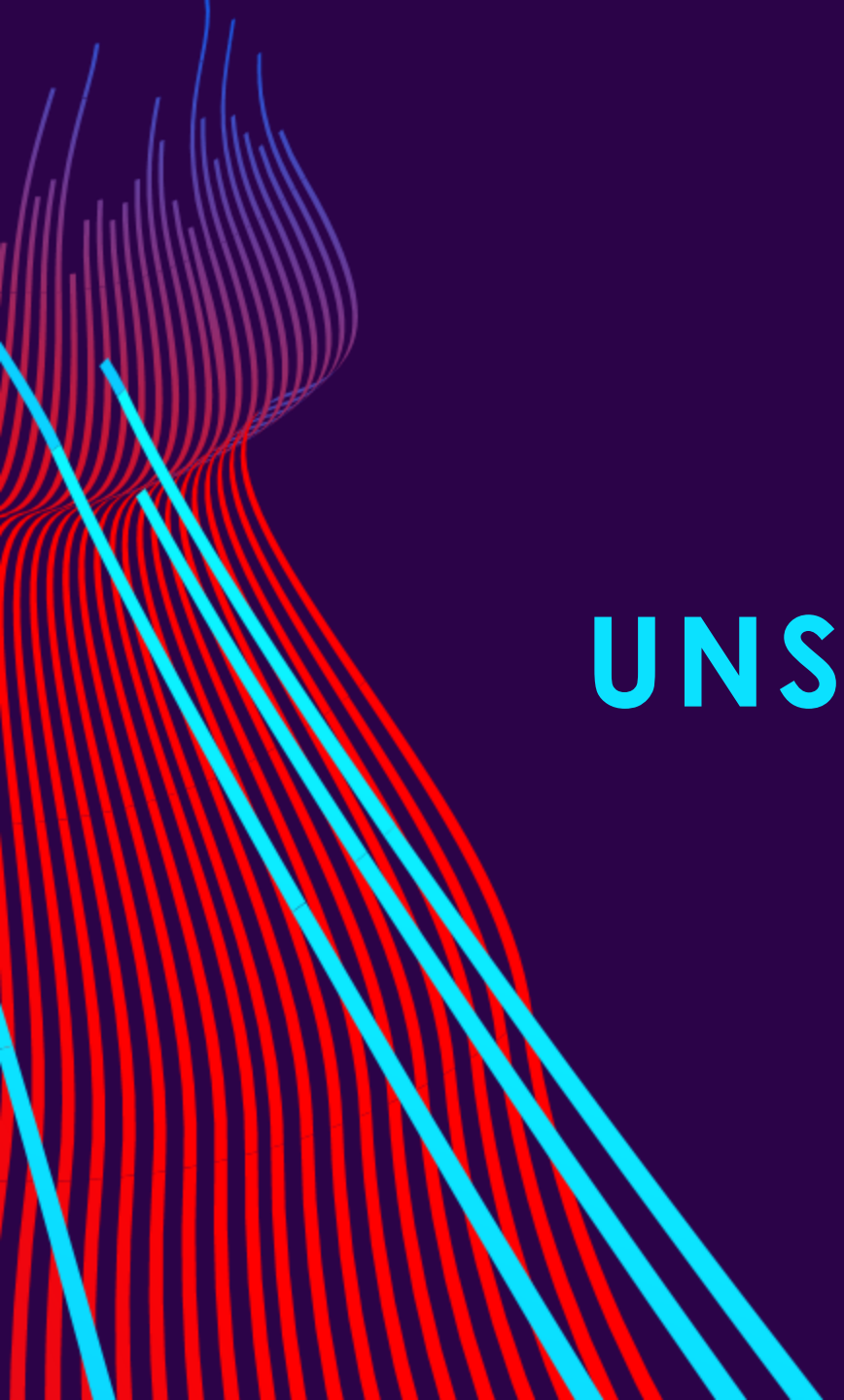

Final Model Training Loss on Full Dataset
Training Loss
Loss
Epochs
0.25
0.20
0.15
0.10
0.05
0
2
4
6
8
10
12
14

RESULT FOR FINAL MODEL




```
Found 55 files belonging to 4 classes.
Class names: ['KO', 'OK', 'RzKO', 'RzOK']
2/2 ━━━━━━━━━━━━━━━━━━━━ 1s 238ms/step - accuracy: 0.8977 - loss: 0.3074

Test Loss: 0.28312137722969055
Test Accuracy: 0.9090908765792847
1/1 ━━━━━━━━━━━━━━━━━━━━ 2s 2s/step
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 1s/step
```



UNSUCCESSFUL ATTEMPT

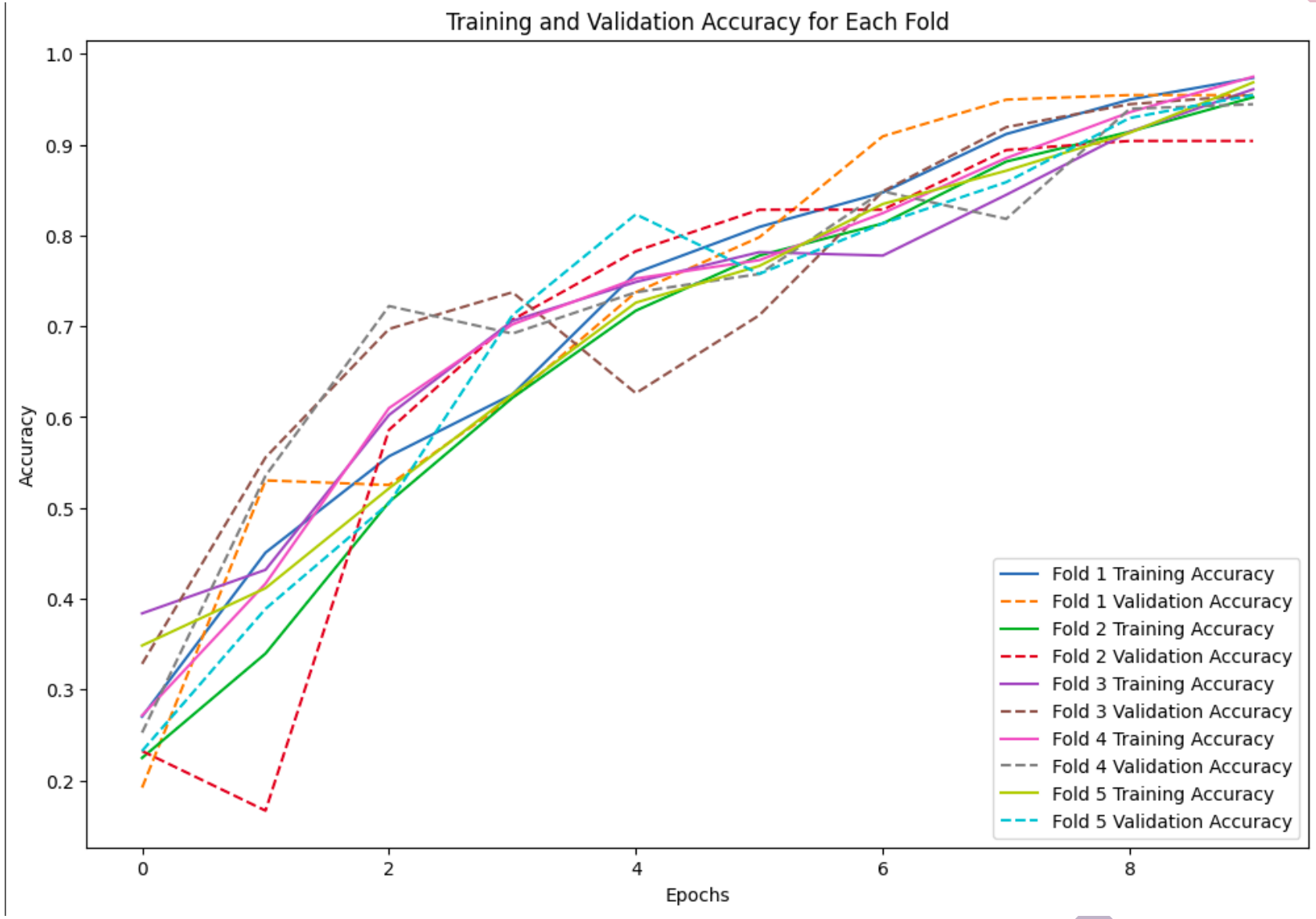
GAMMA + CROP

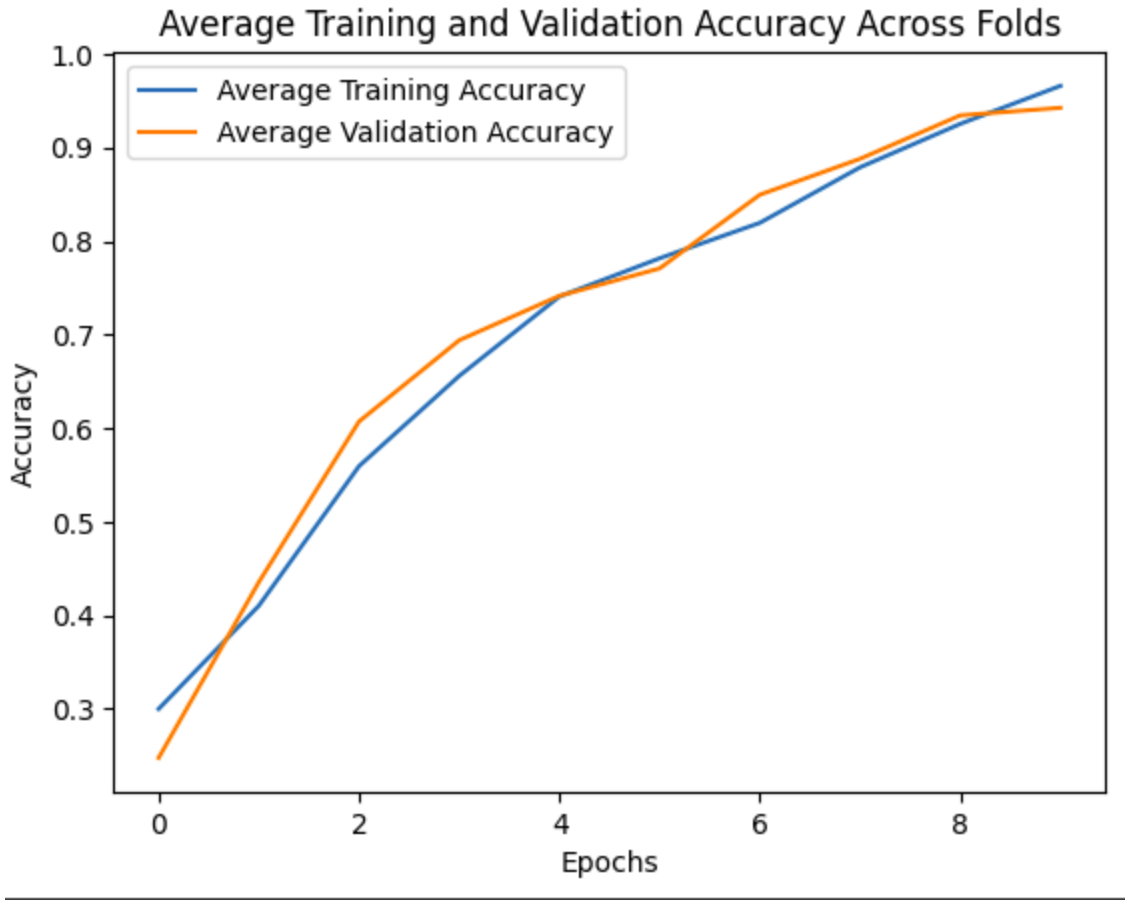
- Add gamma version to dataset
- Add crop version to dataset
- Dataset size reach to 990

- Add weight to classes
  - class_weights = {0: 1.0, 1: 1.75, 2: 2.55, 3: 2.80}
  - Class names: ['KO', 'OK', 'RzKO', 'RzOK']

RESULT FOR CROSS VALIDATION

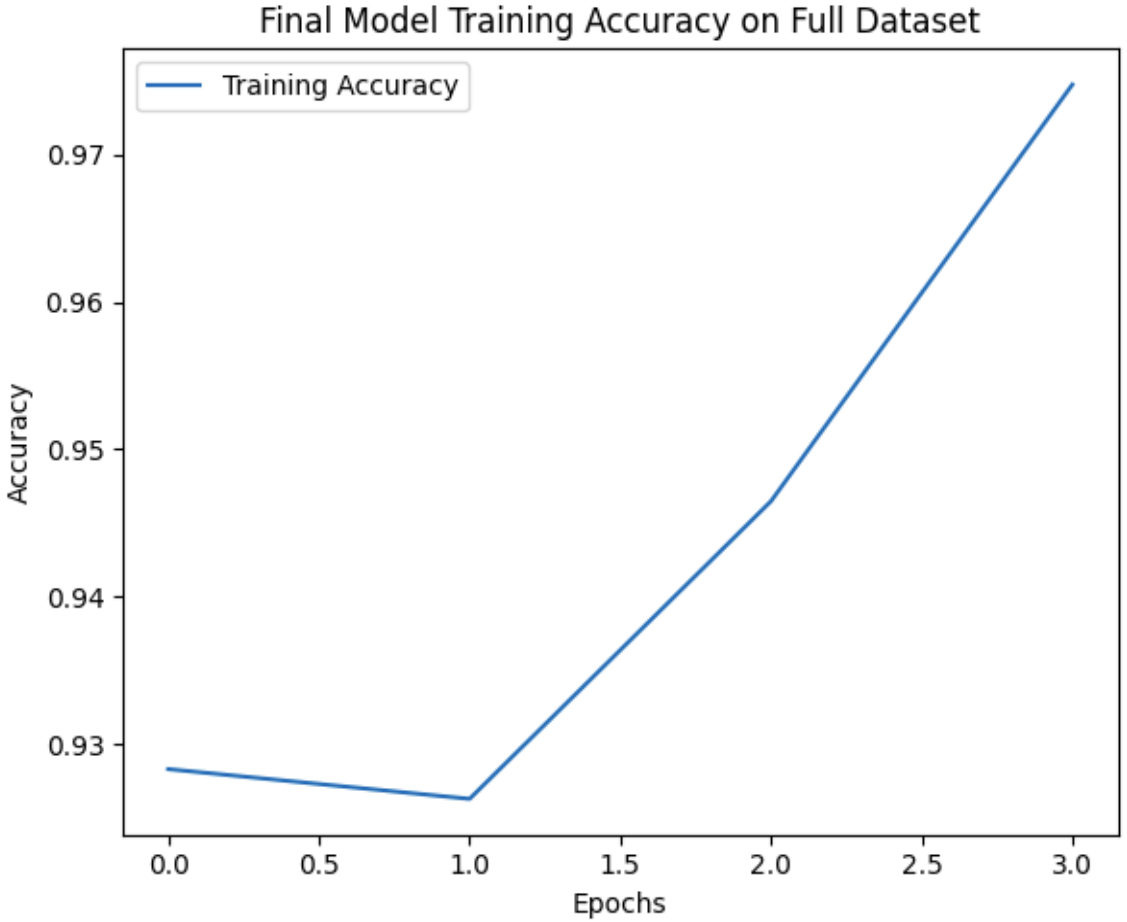
```
Training fold 3...
Epoch 1/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 62s 2s/step - accuracy: 0.3592 - loss: 2.2841 - val_accuracy: 0.3283 - val_loss: 1.3665
Epoch 2/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 21s 297ms/step - accuracy: 0.3691 - loss: 2.2312 - val_accuracy: 0.5556 - val_loss: 1.2656
Epoch 3/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 11s 434ms/step - accuracy: 0.5972 - loss: 1.9360 - val_accuracy: 0.6970 - val_loss: 0.9284
Epoch 4/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 11s 432ms/step - accuracy: 0.7018 - loss: 1.4144 - val_accuracy: 0.7374 - val_loss: 0.6721
Epoch 5/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 11s 433ms/step - accuracy: 0.7553 - loss: 1.1218 - val_accuracy: 0.6263 - val_loss: 0.9845
Epoch 6/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 11s 433ms/step - accuracy: 0.7697 - loss: 1.0002 - val_accuracy: 0.7121 - val_loss: 0.7411
Epoch 7/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 7s 280ms/step - accuracy: 0.7662 - loss: 0.9195 - val_accuracy: 0.8485 - val_loss: 0.4469
Epoch 8/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 7s 281ms/step - accuracy: 0.8227 - loss: 0.7386 - val_accuracy: 0.9192 - val_loss: 0.2675
Epoch 9/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 11s 433ms/step - accuracy: 0.8932 - loss: 0.5375 - val_accuracy: 0.9444 - val_loss: 0.2191
Epoch 10/10
25/25 ━━━━━━━━━━━━━━━━━━━━ 7s 285ms/step - accuracy: 0.9543 - loss: 0.3723 - val_accuracy: 0.9545 - val_loss: 0.1977
Fold 3 - Validation Accuracy: 0.9545454382896423
```


Training and Validation Accuracy for Each Fold
Accuracy
Epochs
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
2
4
6
8
Fold 1 Training Accuracy
Fold 1 Validation Accuracy
Fold 2 Training Accuracy
Fold 2 Validation Accuracy
Fold 3 Training Accuracy
Fold 3 Validation Accuracy
Fold 4 Training Accuracy
Fold 4 Validation Accuracy
Fold 5 Training Accuracy
Fold 5 Validation Accuracy


Average Training and Validation Accuracy Across Folds
Average Training Accuracy
Average Validation Accuracy
Accuracy
Epochs
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
2
4
6
8

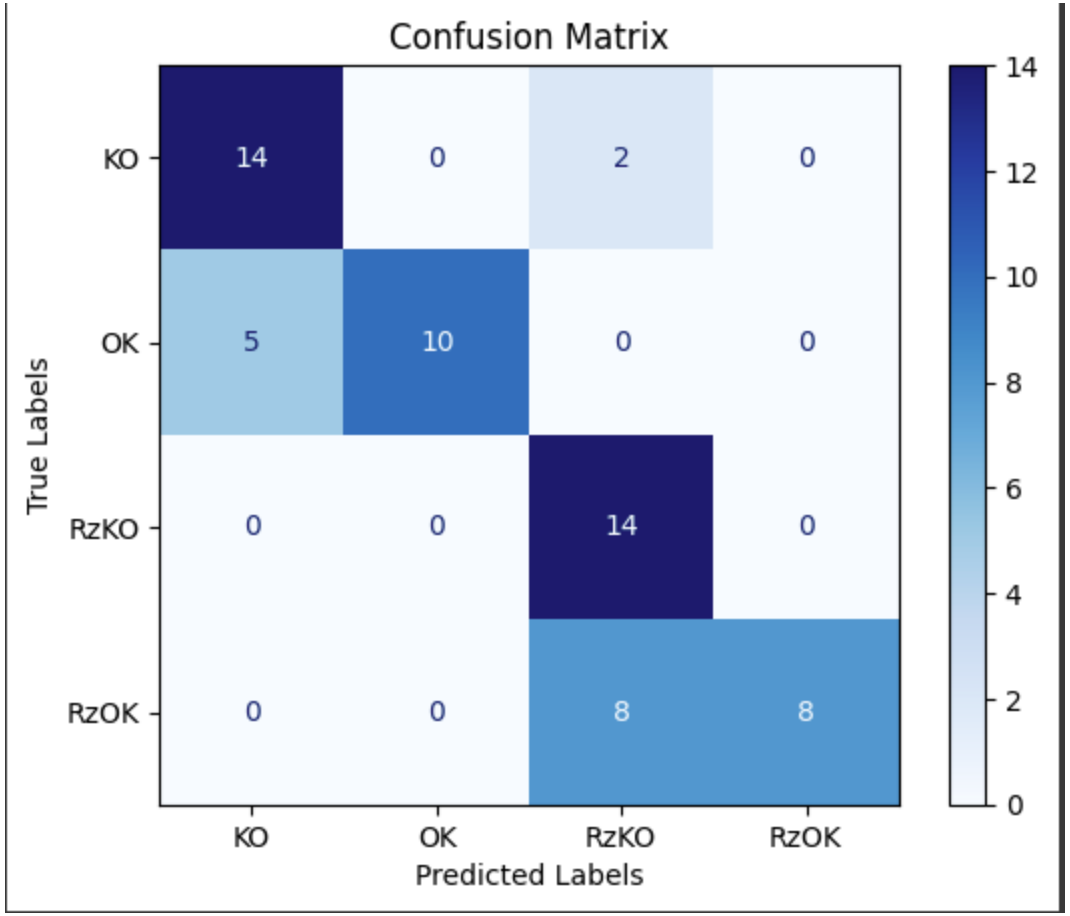
TRAINING FINAL MODEL

```
Epoch 1/4
31/31 ━━━━━━━━━━━━━━━━━━━━ 65s 1s/step - accuracy: 0.9308 - loss: 0.2097
Epoch 2/4
31/31 ━━━━━━━━━━━━━━━━━━━━ 41s 819ms/step - accuracy: 0.9287 - loss: 0.1914
Epoch 3/4
31/31 ━━━━━━━━━━━━━━━━━━━━ 11s 333ms/step - accuracy: 0.9475 - loss: 0.1465
Epoch 4/4
31/31 ━━━━━━━━━━━━━━━━━━━━ 8s 246ms/step - accuracy: 0.9682 - loss: 0.1078
```


Final Model Training Accuracy on Full Dataset
Training Accuracy
Accuracy
0.97
0.96
0.95
0.94
0.93
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Epochs

Final Model Training Loss on Full Dataset
Training Loss
Loss
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Epochs

RESULT FOR FINAL MODEL




```
Found 61 files belonging to 4 classes.
Class names: ['KO', 'OK', 'RzKO', 'RzOK']
2/2 ━━━━━━━━━━━━━━━━━━━━ 8s 3s/step - accuracy: 0.7423 - loss: 0.5689

Test Loss: 0.5514926314353943
Test Accuracy: 0.7540984153747559
1/1 ━━━━━━━━━━━━━━━━━━━━ 2s 2s/step
1/1 ━━━━━━━━━━━━━━━━━━━━ 2s 2s/step
```