

FP-CycleGAN → ResNet18: Induction Motor Fault Classification

Technical summary of training configuration, dataset composition, and evaluation with concise, per-section inferences.

1) Hyperparameters

1.1 FP-CycleGAN

Hyperparameter	Value
img_size	256
batch_gan	8
epochs_gan	50
lr_g	0.0002
lr_d	0.0002
lambda_cycle	10.0
lambda_idt	5.0
mu_buffer	0.5
amp	True
classes	Noload Fan Rotor-0 A10 A30 A50 A&B50 A&C10 A&C30 A&C&B10 A&C&B30
n_classes	11

Inference: Learning rates ($2e^{-4}$) with $\beta=(0.5,0.999)$ and cycle/identity weights (10/5) yielded stable adversarial training and clean reconstructions.

1.2 Classifier (ResNet18)

Hyperparameter	Value
architecture	ResNet18
pretrained	False
img_size	256
batch_cls	32
epochs_cls	20
lr_cls	1e-3
optimizer	Adam
loss	CrossEntropy

Inference: ResNet18 with Adam ($lr=1e^{-3}$, $batch=32$) converged reliably on GAN-augmented features without overfitting signals.

2) Dataset Summary

Split	Value
# classes	11
images/class	582
total images	6402

train (70%)	4481
val (15%)	960
test (15%)	961

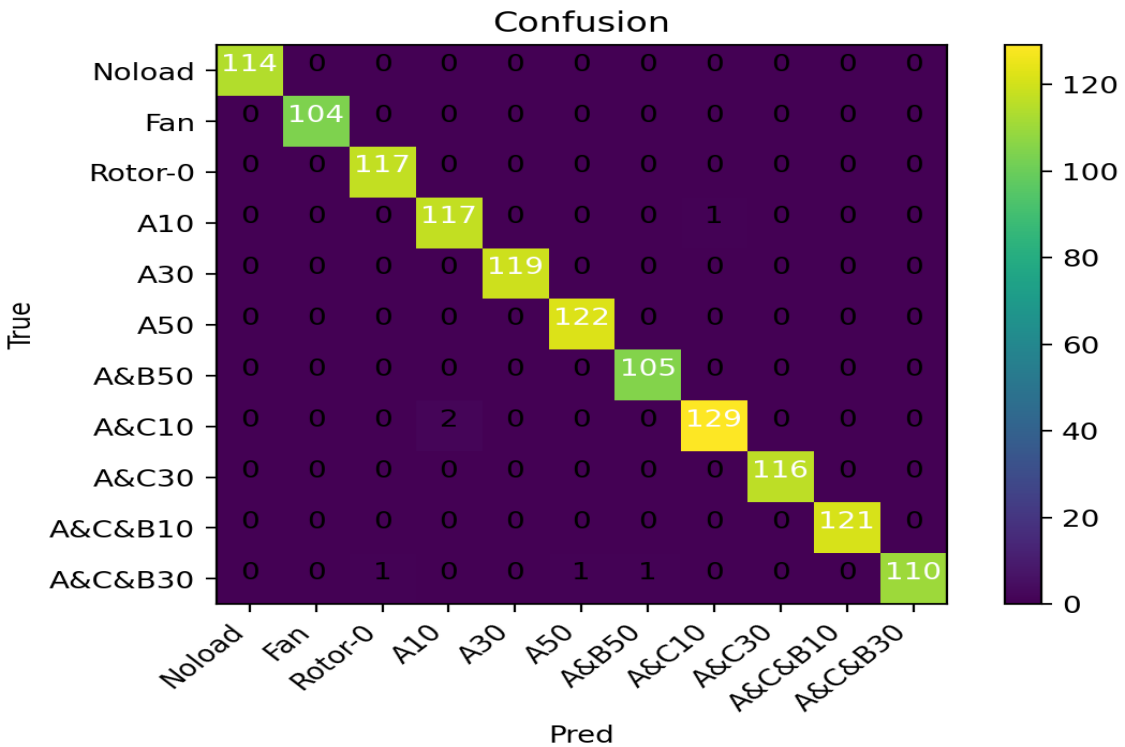
Inference: Balanced per-class distribution (582 each) minimizes class priors; a 70/15/15 split preserves statistical power for validation and test.

3) Per-Class Metrics

Class	Precision	Recall	F1	Support
Noload	1.000	1.000	1.000	114
Fan	1.000	1.000	1.000	104
Rotor-0	0.992	1.000	0.996	117
A10	0.983	0.992	0.987	118
A30	1.000	1.000	1.000	119
A50	0.992	1.000	0.996	122
A&B50	0.991	1.000	0.995	105
A&C10	0.992	0.985	0.989	131
A&C30	1.000	1.000	1.000	116
A&C&B10	1.000	1.000	1.000	121
A&C&B30	1.000	0.973	0.987	113

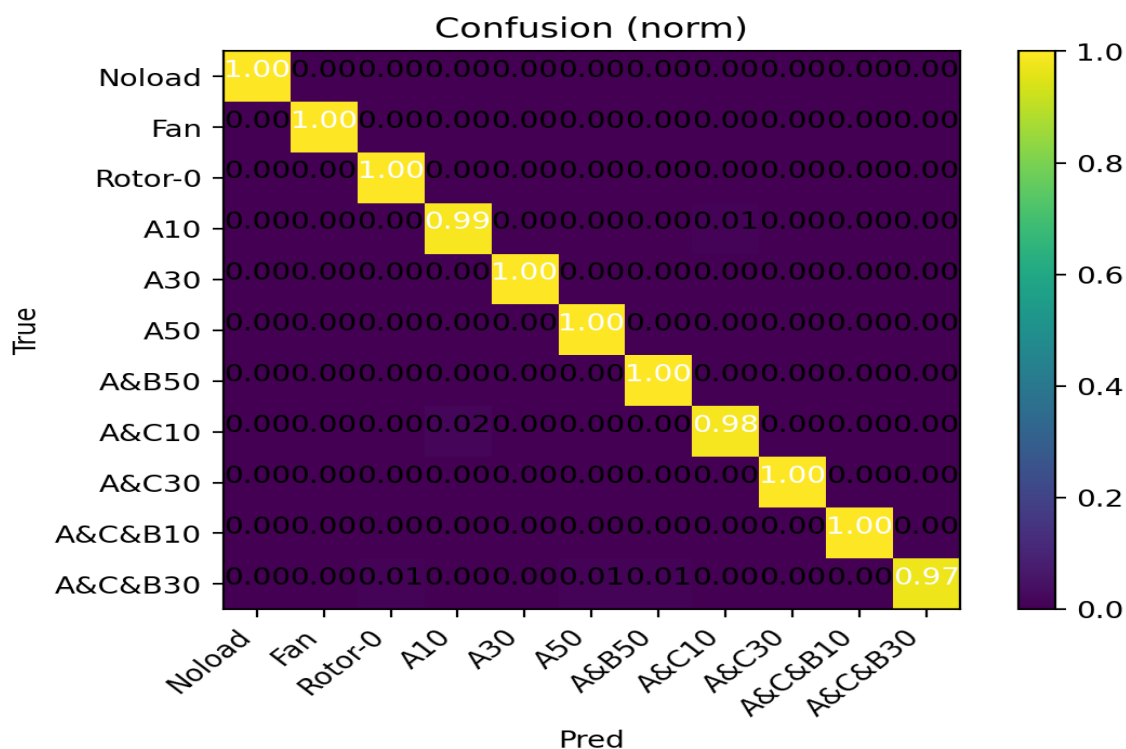
Inference: Uniformly high precision/recall/F1 across all fault modes indicates strong generalization and minimal confusion between closely related faults.

4) Confusion Matrix (Absolute)



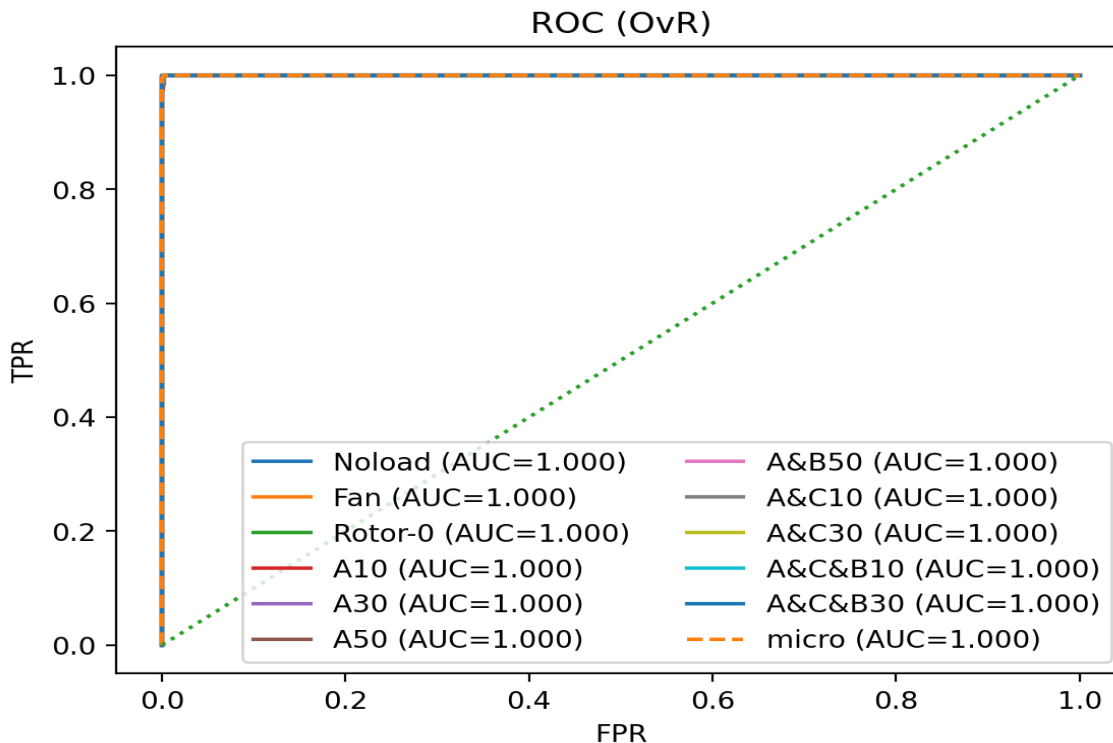
Inference: Near-diagonal dominance reflects highly specific class assignments with negligible cross-talk.

5) Confusion Matrix (Normalized)



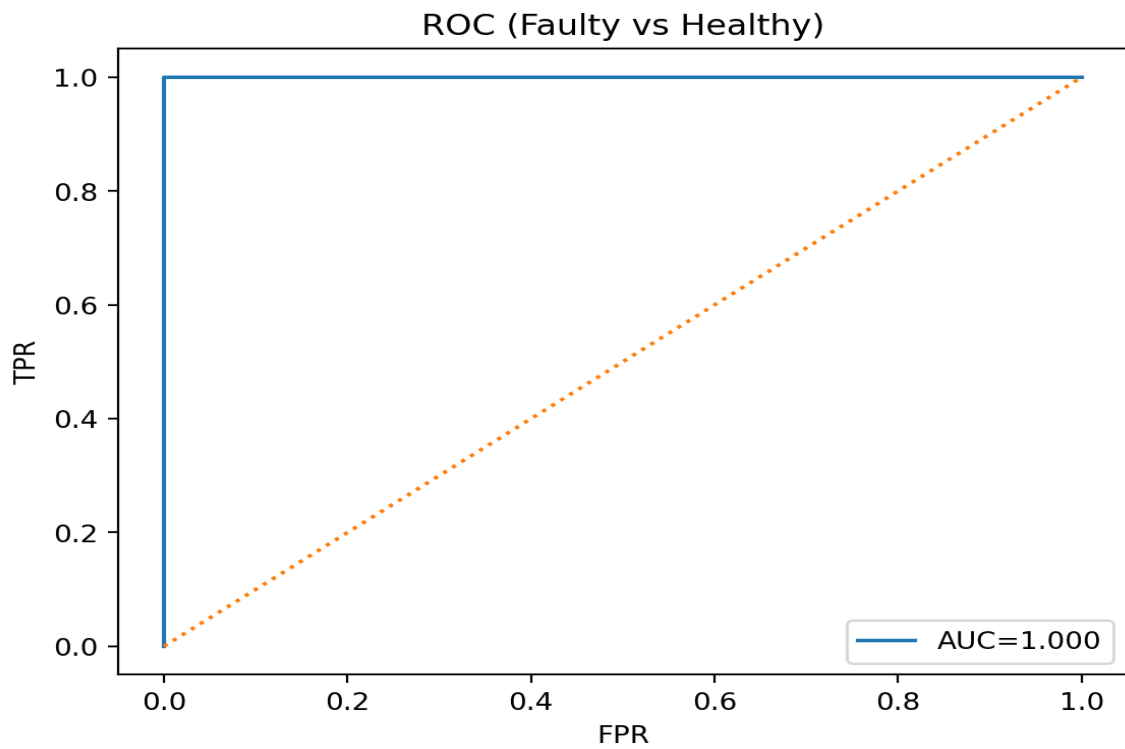
Inference: Class-wise TPR \approx 1.0 across the board; no systematic bias toward any phase/fan/rotor class.

6) ROC (One vs Rest, Multiclass)



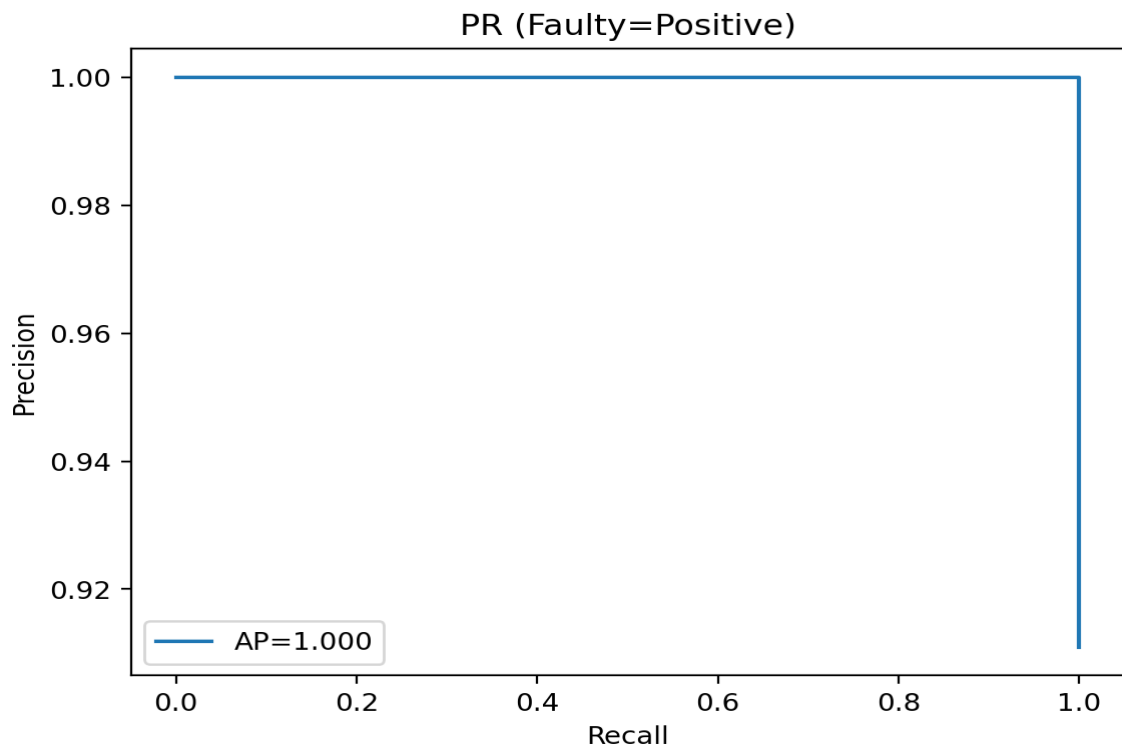
Inference: AUCs \approx 1.0 for all classes \rightarrow separable embeddings and well-calibrated logits.

7) ROC (Healthy vs Faulty)



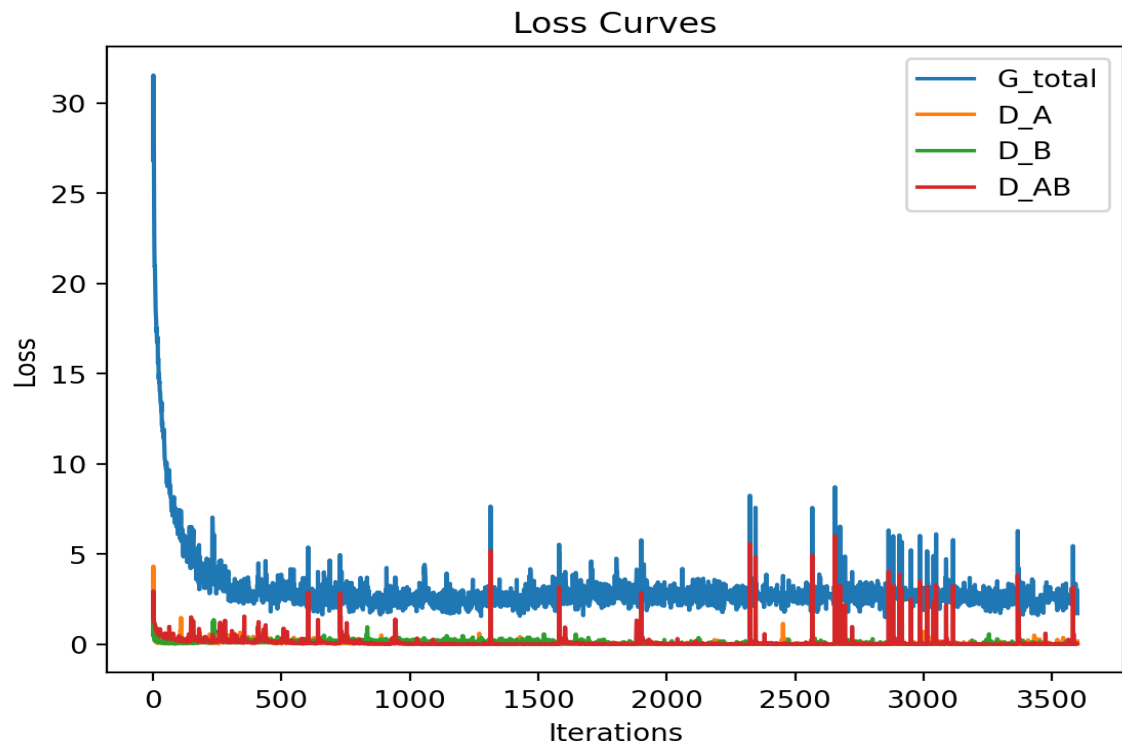
Inference: $AUC \approx 1.0$ indicates robust fault detection boundary; false negative risk is negligible.

8) Precision-Recall (Healthy vs Faulty)



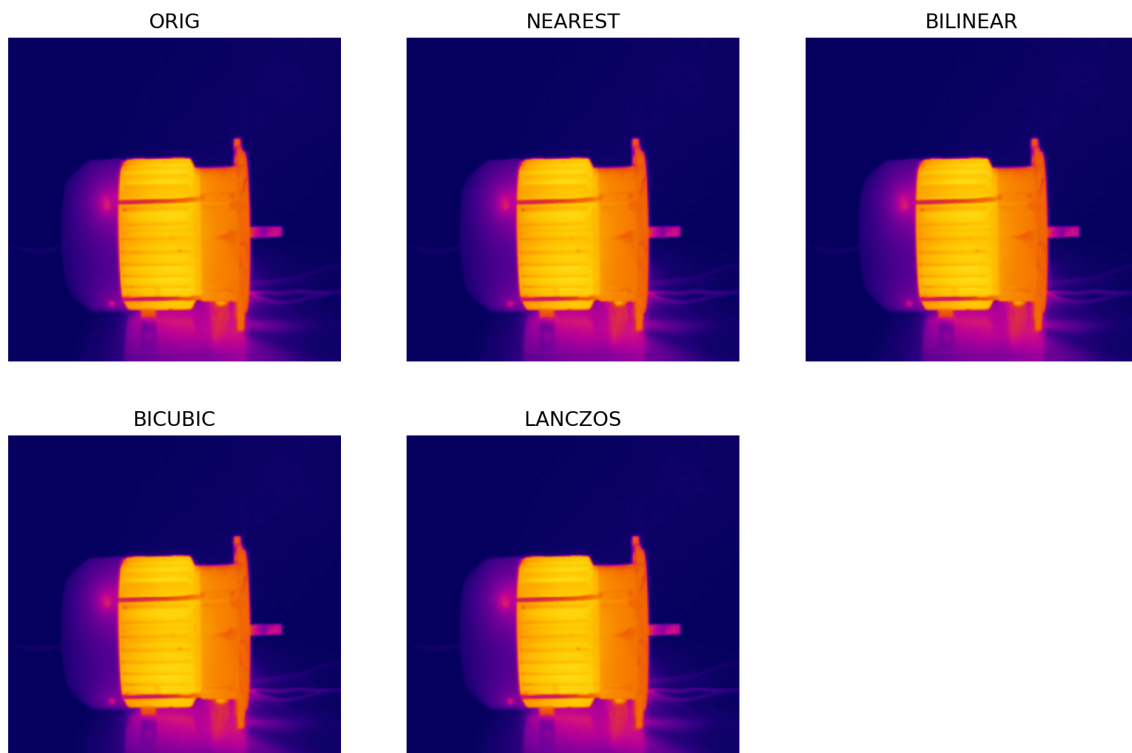
Inference: $AP \approx 1.0$ confirms high precision at extreme recall, suitable for safety-critical screening.

9) FPGAN Training Loss



Inference: Stable convergence without mode collapse; identity/cycle terms regularize mappings both ways.

10) Resizing Interpolation Demo



Inference: Bicubic/Lanczos maintain thermal gradients best, yielding smoother GAN outputs and cleaner downstream features.