MAKÜ
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Efficient Glitch Classification in Gravitational-Wave Detector Data Using Deep Learning and Machine Learning

Deep visual features + lightweight machine learning

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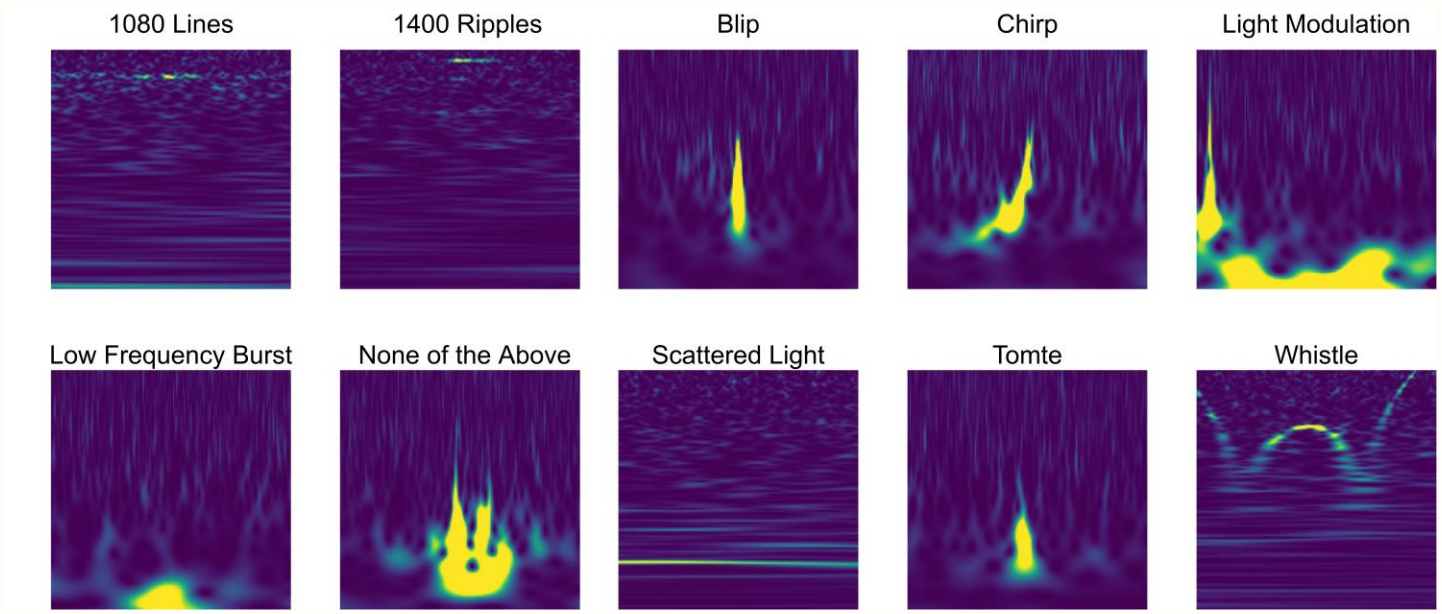


Representative time–frequency morphologies from the ten-class dataset

Motivation: retrain quickly as detector conditions and glitch populations evolve.

WHY GLITCHES MATTER

- Short, non-Gaussian detector transients
- Can resemble signal-like structures
- Degrade data quality and event validation

4,318 Gravity Spy samples

10 glitch classes

224x224 RGB Q-transforms

Research question

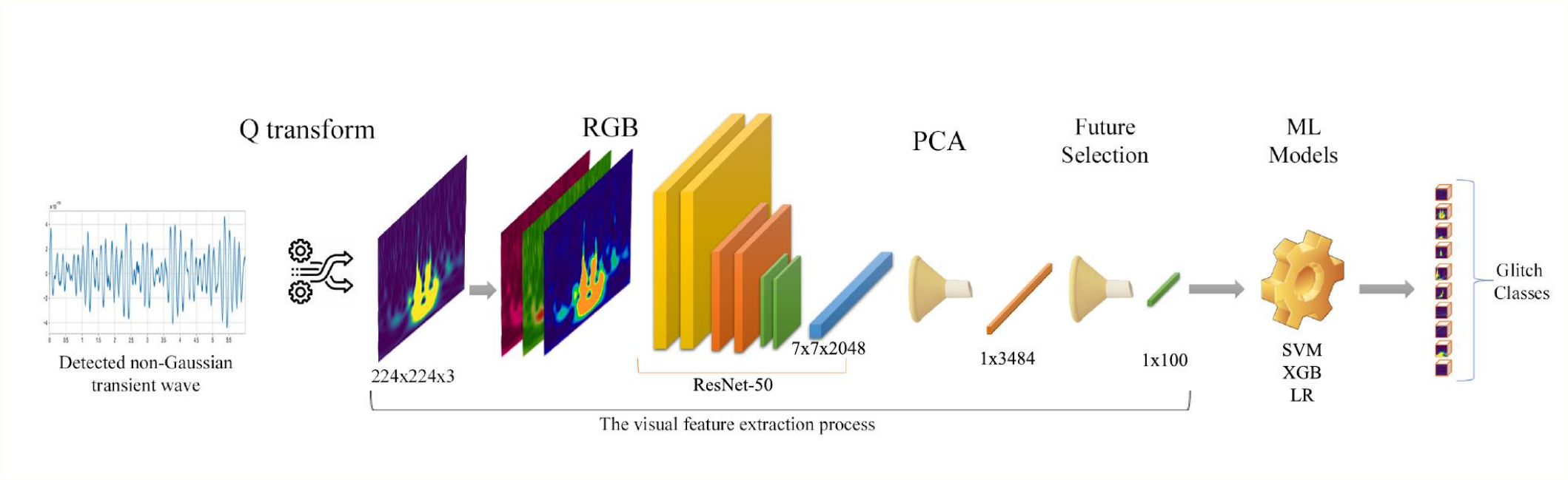
Can we retain high accuracy without repeatedly retraining the entire deep network?

STUDY DESIGN

70% train / 10% validation / 20% test
Five random realizations · no resampling

TWO-STAGE METHODOLOGY

Freeze the backbone; retrain only the classifier



Fine-tuning baseline: up to 100 epochs · patience 10 · learning rate 10^{-4}

DEEP VISUAL ENCODERS

Inception-v3

5 × 5 × 2,048 → 51,200 features

ResNet-50

7 × 7 × 2,048 → 100,352 features

ImageNet pretrained · convolutional weights fixed

COMPRESSION

51,200 / 100,352

↓

3,454 PCA components

↓

100 selected features

LIGHTWEIGHT CLASSIFIERS

LR · SVM · XGBoost

Only the downstream classifier is retrained

Optuna optimization
70% / 10% / 20% split
Five random realizations · no resampling

MAIN RESULT

Near-fine-tuned accuracy with 31.7× faster training

93.98%	37.6 s	F1 = 0.9111	31.7×
test accuracy	measured training time	selected frozen pipeline	faster than fine-tuning

INCEPTION-v3: ACCURACY–TIME TRADE-OFF

Frozen features + PCA + FS + LR	93.98%	37.6 s
Comparable fine-tuned pipeline	95.72%	1,191.8 s

Measured training-time scale

Trade-off: −1.74 percentage points accuracy · 31.7× faster training

THE TREND HOLDS BEYOND ONE SETTING

ResNet-50 frozen path

92.13% · 42.3 s · 23.9× faster

20-class scaling test

89.95% accuracy · F1 = 0.7983

Highest class-level F1

Scattered Light 0.9759
Blip 0.9713 · Chirp 0.9630

Hardest: None of the Above · F1 0.7097

Frozen deep features offer a practical accuracy–retraining-time trade-off.

Visit the poster for full class results, PCA sensitivity, and sample-scaling tests.

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