DESIGN AND DEVELOPMENT OF AN INTELLIGENT EMERGENCY STATE REPORTING SYSTEM FOR PUERTO RICO

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AI IMAGE CLASSIFICATION

ABSTRACT & INTRODUCTION

Puerto Rico's recurring emergencies generate large amounts of citizen-shared imagery that could support faster situational awareness. This study developed two EfficientNet-B0 models to classify emergency type and estimate damage severity. Model 1 achieved 94.07% best validation accuracy, while Model 2 achieved 79.57%. The results showed that dataset relevance influenced performance more strongly than architectural complexity alone.

OBJECTIVE

Develop and evaluate an AI image-analysis pipeline that:

- Classifies Fire, Flood, Infrastructure Damage, and Road Emergency.
- Estimates Mild Damage or Severe Damage.
- Prepares model outputs for later system integration.

METHODOLOGY

Implemented both CNN models using Python in Visual Studio Code.
Evaluated ResNet-50 and CrisisMMD as the initial baseline.
Selected EfficientNet-B0 with pretrained ImageNet weights.
Engineered a custom Model 1 dataset using six public datasets.
Prepared a modified and supplemented CrisisMMD-based severity dataset.
Trained both models on CPU hardware.
Evaluated performance using accuracy, precision, recall, F1-score, and confusion matrices.

MODEL DEVELOPMENT

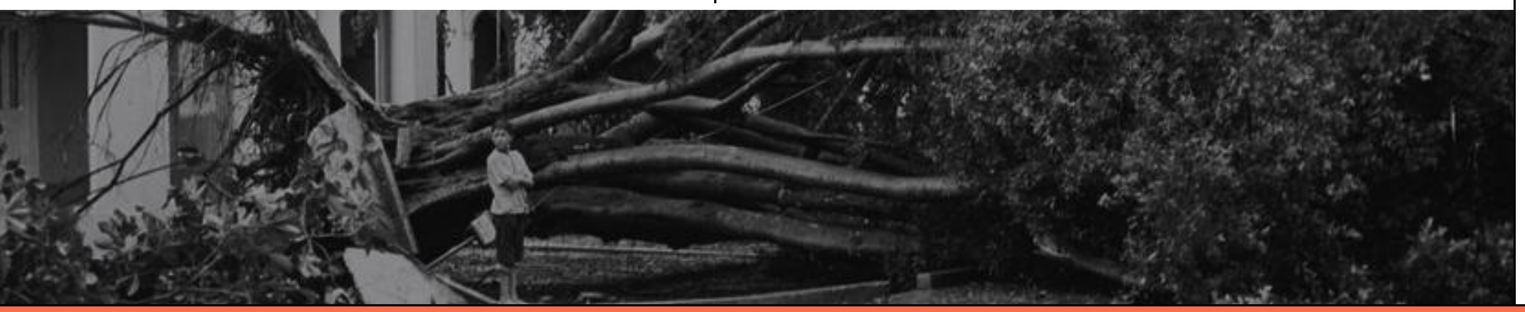
Model 1: Emergency Classifier
1,949 images | 4 classes
EfficientNet-B0 | Frozen feature extractor
Model 2: Severity Estimator
2,847 images | 2 classes
Weighted loss | Staged fine-tuning
Model 3: Authenticity Checker
Proposed to detect AI-generated emergency images.
Not implemented due to the lack of emergency-specific training data.



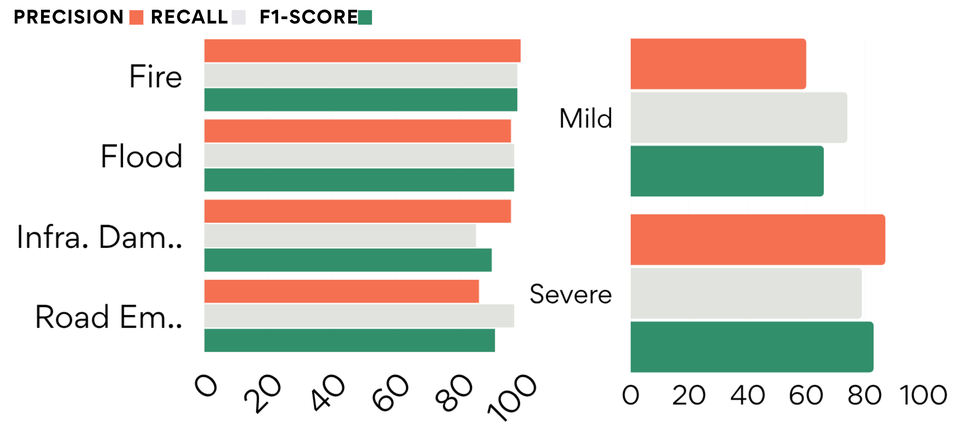
IMAGE EXAMPLE FROM MODEL 1 DATASET (FIRE)



IMAGE EXAMPLE FROM MODEL 2 DATASET (SEVERE DAMAGE)



MODEL PERFORMANCE



Model 1 Class Metrics
Best Validation Accuracy: 94.07%

Model 2 Class Metrics
Best Validation Accuracy: 79.57%

ANALYSIS

Model 1 performed strongly across all four emergency categories, with most errors occurring between Infrastructure Damage and Road Emergency due to similar visual features. Model 2 was more challenging because severity labels were less distinct, the dataset remained imbalanced, and severity is subjective even to humans.

CONCLUSION & FUTURE WORK

The results support the feasibility of using lightweight computer-vision models for emergency-image analysis. Dataset relevance had a greater impact on performance than architectural complexity, while severity estimation requires clearer labels and additional testing. Future work should focus on external testing with Puerto Rico imagery, clearer severity criteria, confidence-based human review, and an emergency-specific authenticity dataset.

Alam, F., Ofli, F., & Imran, M. (2018). CrisisMMD: Multimodal Twitter datasets from natural disasters. Proceedings of the International AAAI Conference on Web and Social Media, 12(1).
Kansal, K., Chandra, T. B., & Singh, A. (2024). ResNet-50 vs. EfficientNet-B0: Multi-centric classification of various lung abnormalities using deep learning. Procedia Computer Science, 235, 70–80.
Mustafa, A. M., Agha, R., Ghazalat, L., & Sha'ban, T. (2024). Natural disasters detection using explainable deep learning. Intelligent Systems with Applications, 23, 200430.