

ABSTRACT

Structural damage detection, such as concrete cracks, is a crucial step in the maintenance of physical infrastructure. The use of Deep Learning algorithms like Convolutional Neural Networks (CNN) has proven reliable for image classification tasks. However, in the domain of infrastructure safety, the model's failure to detect actual cracks (False Negatives) can pose fatal hazards. This study aims to implement a Transfer Learning-based MobileNetV2 architecture, conduct an effectiveness comparative analysis of False Negative handling, and empirically prove the independent effects of Batch Size and Learning Rate hyperparameters on learning curve dynamics. The experiment was conducted using a dataset of 40,000 images divided into 4 main scenarios: Baseline, Cost-Sensitive Learning (class penalty weighting), Custom Decision Threshold, and a Hybrid approach. Additionally, learning curve dynamics were evaluated through the One Factor at A Time (OFAT) hyperparameter isolation method on Batch Size and Learning Rate variations. The curve testing results showed that the combination of Batch Size 32 and Learning Rate 0,001 is the most stable baseline parameter. In the False Negative handling test, the Hybrid approach proved to be less effective as it triggered an excessive surge in False Positives (over-penalized). The application of single interventions proved to be more superior, where both Cost-Sensitive Learning and Custom Threshold successfully reduced False Negatives to 0 images and kept False Positives at 13. This optimal performance yielded a Precision of 99,57%, Recall of 100,00%, and F1-Score of 99,78%, while recording the fastest training time efficiency (21 minutes 10 seconds). This study proves that appropriate class handling interventions, accompanied by empirical hyperparameter evaluation, can produce a highly sensitive, stable, and computationally reliable classification system.

Keywords: Batch Size, Concrete Crack Detection, False Negative, Learning Rate, MobileNetV2.