**Project Title: Structural crack detection using efficientnet model**

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**Introduction**

The structural integrity of buildings is essential for public safety, especially in older infrastructures where unnoticed fissures may result in catastrophic failures. Conventional techniques for surveying structures, particularly those built with ashlar masonry, have predominantly depended on visual assessment and manual record-keeping. This method, although historically common, is labour-intensive, time-consuming, and susceptible to subjective interpretation, frequently reliant on the competence of individual inspectors. In edifices comprising substantial quantities of masonry components, such as old castles or public buildings, the labelling and assessment of each unit's state presents significant logistical and budgetary difficulties.

Recent advancements in digital technology and computer vision have facilitated the development of more objective, scalable, and efficient approaches. Methods such as terrestrial laser scanning and image-based machine learning are revolutionizing the identification and classification of faults such as fractures. Previous studies have shown the use of supervised learning to identify degradation patterns in ashlar masonry, particularly in culturally important locations such as the Chapel Royal at Stirling Castle (Millard et al., 2018). This research enhances the existing framework by utilizing sophisticated image preprocessing techniques—CLAHE and Hessian filtering integrated with the EfficientNet deep learning model to augment the precision and efficiency of automated crack detection, facilitating more reliable and economical condition evaluations in constructed environments.

**Aim of the project**

This project aims to create an automated method for identifying structural faults in masonry structures via deep learning techniques. The system seeks to maximize accuracy and minimize subjectivity in defect identification by integrating modern image preprocessing methods—CLAHE for local contrast enhancement and Hessian-based filtering for emphasizing crack-like structures with the EfficientNet convolutional neural network. The objective is to develop a scalable and dependable approach for expedited condition evaluation of structures, facilitating improved maintenance decisions and conservation strategies.

**Research questions**

* What is the efficacy of the EfficientNet model in precisely identifying structural fractures from photos in comparison to conventional visual inspection techniques?
* Can modern image preprocessing approaches, such as CLAHE and Hessian-based filtering, enhance the performance of crack detection models regarding precision, recall, and computing efficiency?

**Dataset Overview**

The dataset utilized in this study is SDNET2018: Structural Defects Network Concrete Crack Images, accessible on Kaggle. It consists of more than 56,000 high-resolution photographs of concrete surfaces, including bridge decks, walls, and pavements, taken under real-world settings. Each picture is a 256x256 pixel tile, categorized as either “cracked” or “non-cracked,” facilitating binary classification tasks. The dataset encompasses a wide spectrum of crack widths, ranging from 0.06 mm to 25 mm, and captures real-world intricacies such surface roughness, shadows, stains, debris, and fluctuating lighting conditions.

This dataset was chosen for numerous critical reasons. The extensive scale and diversity offer a robust basis for training deep learning models such as EfficientNet, facilitating improved generalization across various structural types. Secondly, the incorporation of natural noise and impediments renders it very appropriate for practical deployment situations where ideal imaging circumstances are few. Third, SDNET2018 is esteemed among academic and industry research circles, establishing it as a benchmark dataset for evaluating model performance. This has been utilized to evaluate diverse computer vision and deep learning methodologies, providing a benchmark for verifying innovative pipelines such as the one presented in this study.

The objective is to strengthen minor fracture characteristics and improve detection accuracy by utilizing this dataset alongside CLAHE and Hessian-based preprocessing. In summary, SDNET2018 effectively corresponds with the project's objectives of creating a scalable, objective, and precise crack detection system suitable for real-world infrastructure.

Link to download:

* <https://digitalcommons.usu.edu/all_datasets/48/>
* <https://www.kaggle.com/datasets/aniruddhsharma/structural-defects-network-concrete-crack-images>