Automatic Crack Detection Using Encoder-Decoder Architecture

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Papers

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Description of the Problem

Several factors, such as stress from heavy loads, water intrusion, wear and tear, and shrinkage over time, can cause concrete cracking. Concrete cracking poses many problems, including tripping hazards, sanitation issues, and other risks. Concrete cracking may lead to uneven surfaces, with one side of the crack being on a higher elevation than the concrete on the other side. These uneven surfaces can result in individuals tripping and injuring themselves or causing damage to vehicles, such as scrapes to the tires and underbelly of the vehicle. If allowed, water can settle in cracks and form mold inside, posing a health risk to humans and other animals. Cracks in concrete can also result in debris falling on areas such as bridges, and cracks in the concrete lead to chunks of concrete falling, which can land on a person or vehicle below. Inside buildings, cracks in concrete can lead to chunks of concrete falling on people. These chunks of falling concrete can result in serious bodily injury or death. Cracks can be prevented with regular maintenance and proper monitoring. However, this is not always possible as many areas cannot afford a necessary level of maintenance and monitoring which will result in concrete in these areas having a considerable amount of cracks and damage. While some local governments will be able to afford these costs, others will not, which can cause the state and federal governments to contribute to funding to these local governments; however, these larger governments will not be able to afford to help all the local governments and require a way to make monitoring and maintenance to be cheaper and more efficient.

Approach

Our approach to fixing this problem is implementing the proposed algorithm, U-Hierarchical Dilated Network (U-HDN), which utilizes an encoder-decoder algorithm to perform crack detection. The U-HDN algorithm consists of three components: a U-net architecture to extract the features and restore the image, a multi-dilation module to get more information about the features, and a hierarchical feature learning module to obtain multi-scale features. We will take multiple images of road pavement, where some have cracks while others do not, and split them into training, validation, and testing groups before feeding them into the network. The model will be trained on parts of the dataset, and when tested by inputting images, it will state whether there are cracks or not. To evaluate the model's performance, we will use the validation data to see how accurate the model is at determining whether or not the concrete surface has cracks. We will also implement different algorithms, such as a simple Convolutional Neural Network and VGG16, to detect cracks in the dataset. Using these results, we will compare the performances of these networks with the performance we got from training and testing the U-HDN algorithm.

Data

The data we will use for this project will be images of concrete surfaces, some with cracks and some without cracks. The dataset splits the images into two folders: Positive and Negative. The Positive data folder contains images of concrete surfaces with cracks, and the Negative data folder contains images of concrete surfaces without cracks. The Positive and Negative data folders each have 20,000 images for 40,000 images total. The dataset is from: https://www.kaggle.com/datasets/arunrk7/surface-crack-detection.

References

Hardrock. (2021, April 8). Beware of floor cracks: The dangers concrete cracks can cause. Hard Rock Concrete Coatings | Utah Concrete Coating Contractor. Retrieved March 25, 2023, from https://www.hardrockconcretecoatings.com/beware-of-floor-cracks-the-dangers-concrete cracks-can-cause/#:~:text=Mold%2D%20if%20water%20is%20able,a%20source%20o %20potential%20injury.

Team Member Responsibilities

Nathan: Data Extraction; Split Data into Training, Validation, Testing subsets; Creating U-Hierarchical Dilated Network
Nikolaus: Implementing alternative networks such as VGG16 and Convolutional Neural Network, Training the models, Evaluating the models, Comparing the different models performances