Improved Machine Vision Algorithm for Unmanned Aerial Vehicle (UAV) Applications in the Monitoring of Transportation Infrastructure

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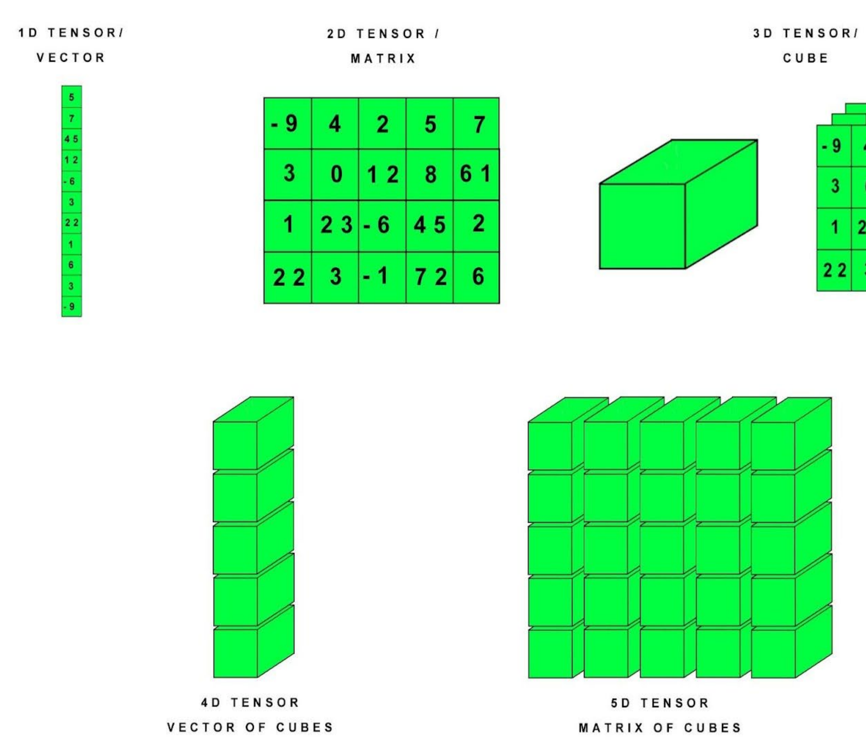
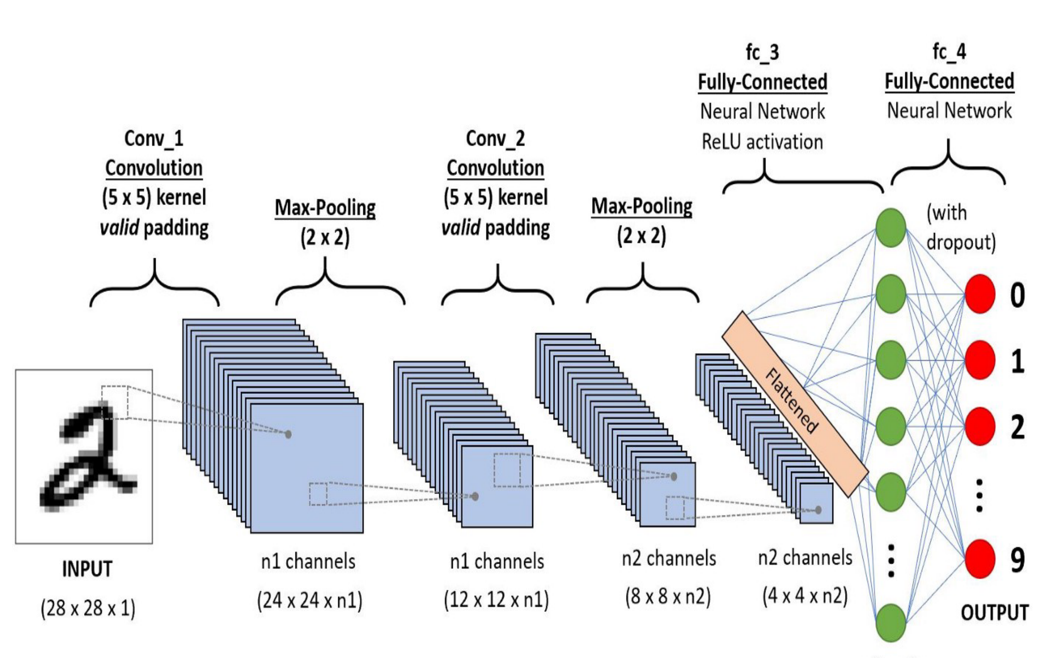
Background Information:

Tensors can be described as an n[th] dimensional array of numbers that correspond to certain data. Tensors, therefore, contain more information and data when compared to a vector.



Tensor Model Representation [1]

Convolution neural networks are machine vision neural networks that pass an edge filter over the input image tensor to convolve the input image tensor to a high feature tensor that is then flattened/vectorized to then pass to an output classification layer that is used to determine the model's accuracy [2].

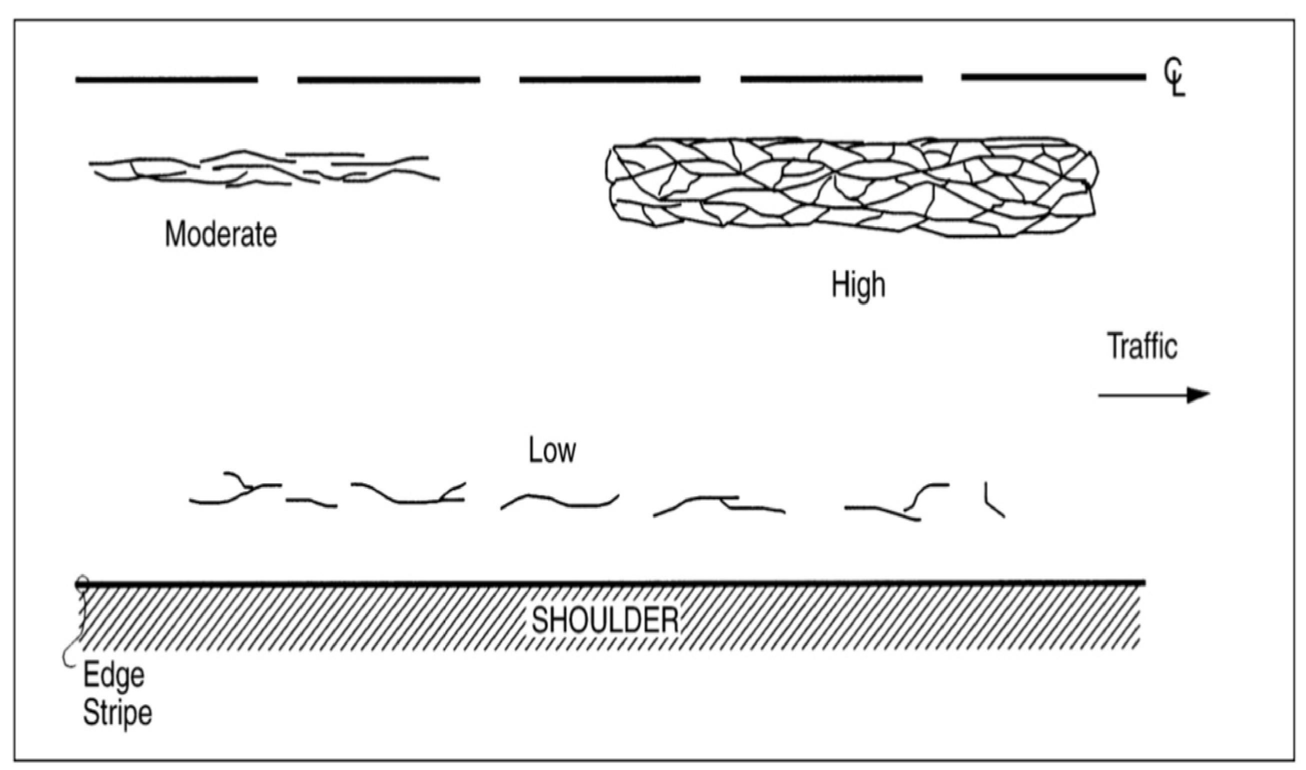


CNN Model Representation [3]

Introduction:

Due to constant dynamic loading on transportation surfaces such as bridges and roads, fatigue cracks form on the transportation infrastructure. If unattended to, these cracks can then cause the infrastructure to fail which increases the risks of traffic accidents. It is important that these cracks and failures be identified so that they can be repaired to reduce the risk of traffic accidents.

Note: An area of short closely spaced (< 0.3 m) transverse cracks in the wheel path should be recorded as fatigue cracking.



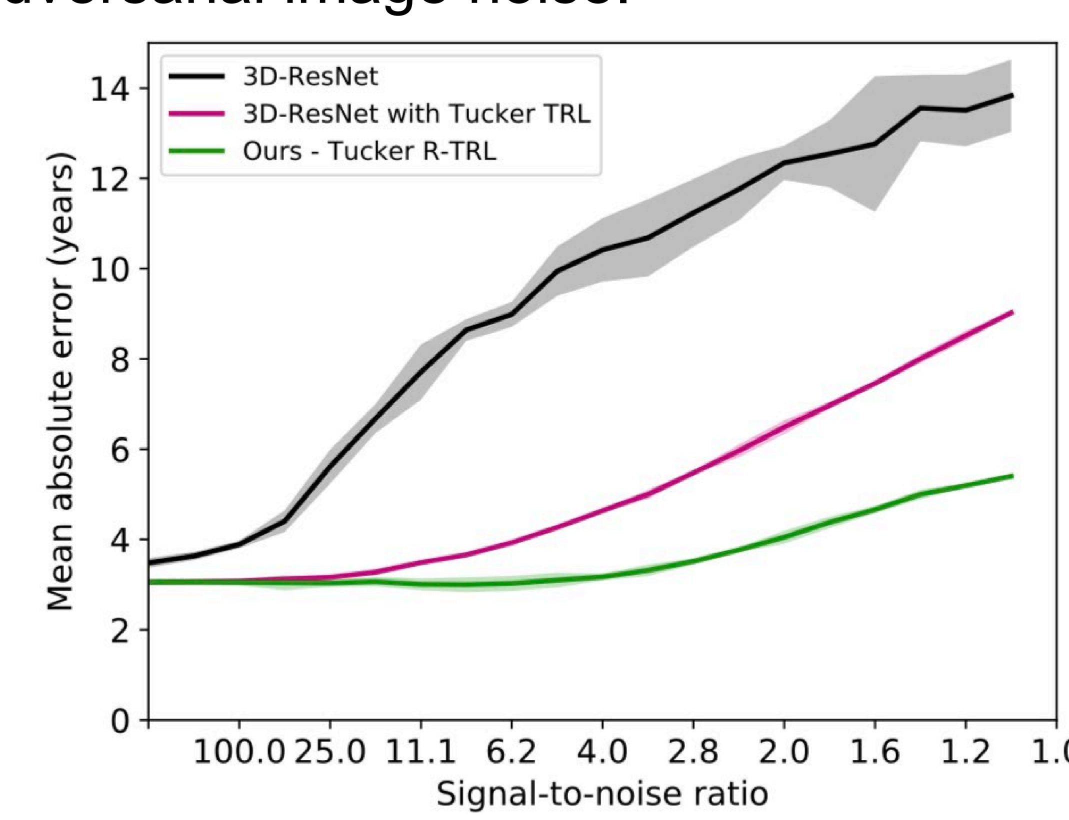
Distress Type ACP 1 - Fatigue Cracking [4]

Procedure:

To help aid in the identification of potential cracks and other defects in our transportation infrastructure, unmanned aerial vehicles equipped with cameras and other sensors along with machine vision algorithms have been deployed. Current machine vision algorithms use a variation of the you only look once (YOLO) machine vision algorithm. The accuracy of YOLO tested in the identification of Air-crafts is 99.3% accurate [5].

Artificial Intelligence Pier Crack Detection [6]

It may be possible to improve the YOLO algorithm's accuracy through the use of Tensor Regression Layers (TRL) and subsequent TRL dropout. In "Tensor Dropout for Robust Learning," [7]. TRL were proven to improve the robustness of other machine vision algorithms used for object detection such as ResNet18. To achieve robustness the TRL uses CP_decomposition, similar to single value decomposition for matrices, but applied to a tensor. The addition of TRL to YOLO may improve the model's performance and help make the model more robust to adversarial image noise.



Age prediction error on the MRI test set as a function of increased added Gaussian noise [7]

Conclusion:

With the possible improvements to the YOLO machine vision algorithm through the addition of TRL, the UAV can better help identify possible cracks and other defects on the transportation infrastructure. The machine vision algorithm paired with the UAV will help in the monitoring and maintenance of the transportation infrastructure.

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