A Versatile Crack Inspection Portable System based on Classifier Ensemble and Controlled Illumination

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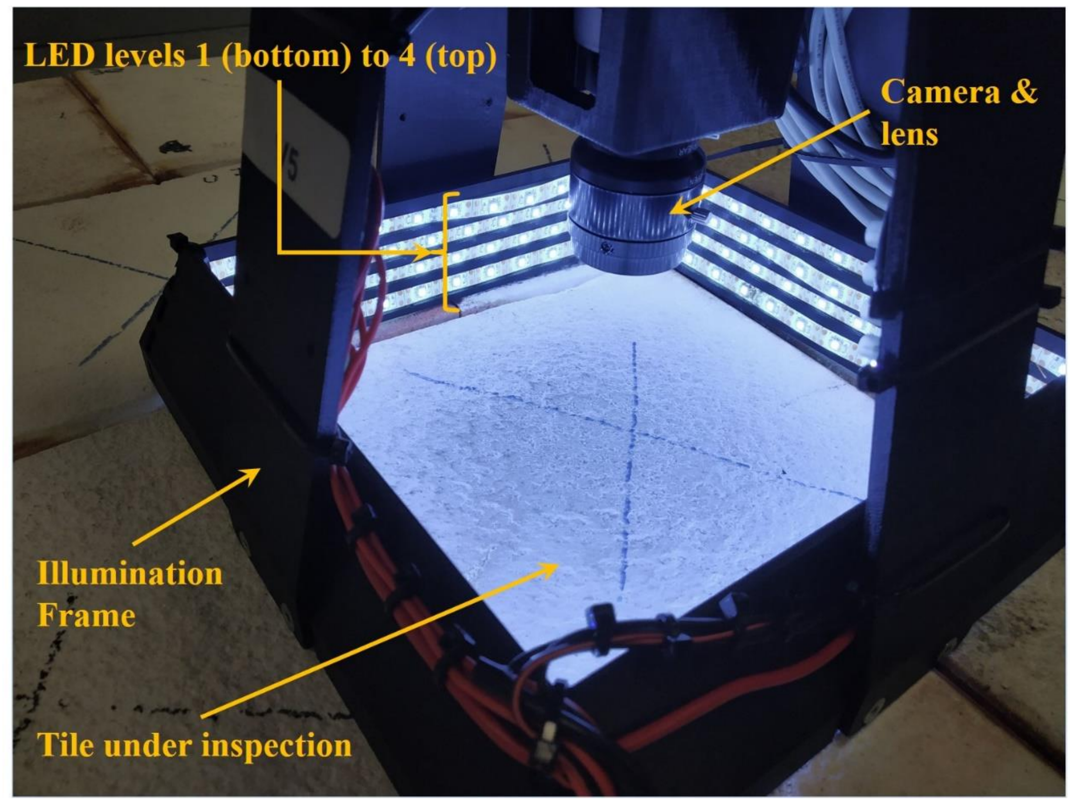
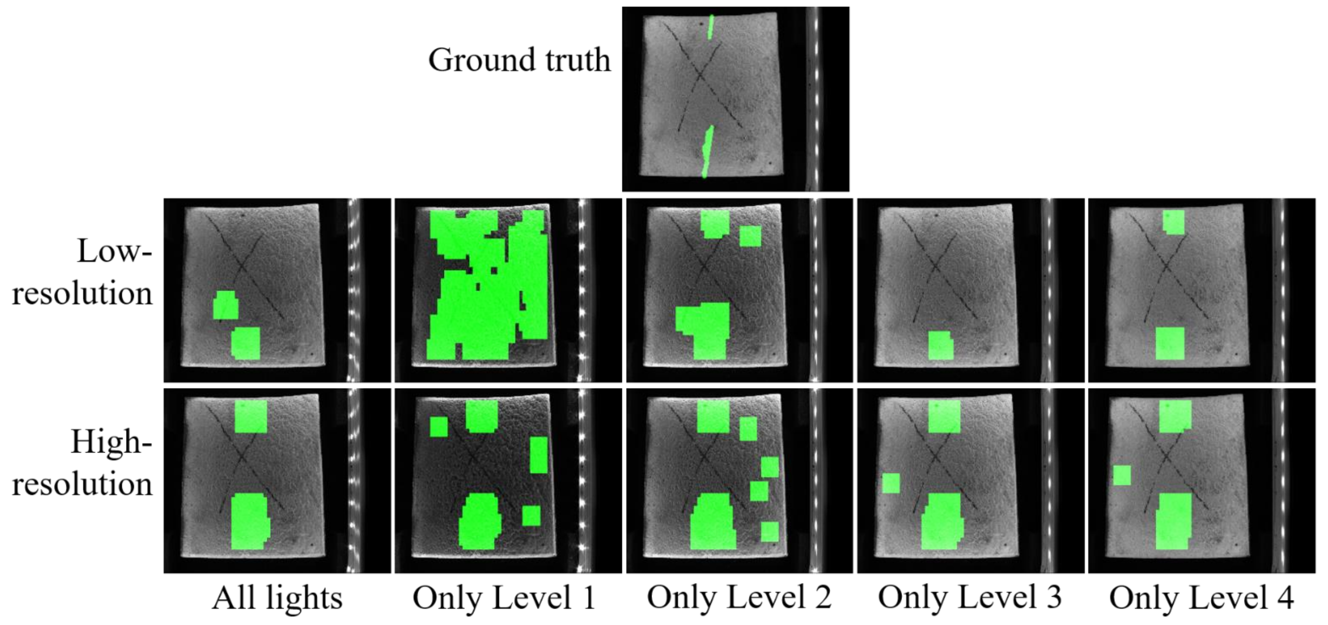
Highlights

- A novel setup for automatic visual inspection of cracks in ceramic tiles. This setup can produce height varying illumination conditions with the intuition that cracks can be better visualized under specific lighting conditions than others. Our setup is designed for field work with constraints in its maximum dimensions.
- To the best of our knowledge, it is the first study that demonstrates the effects of state-of-the-art classifiers and height-varying illumination for crack detection. Here, we evaluate the performance both at patch as well as image-level.
- Also, it provides insights about which illumination configuration can help in detecting cracks in a challenging real-world industrial environment.

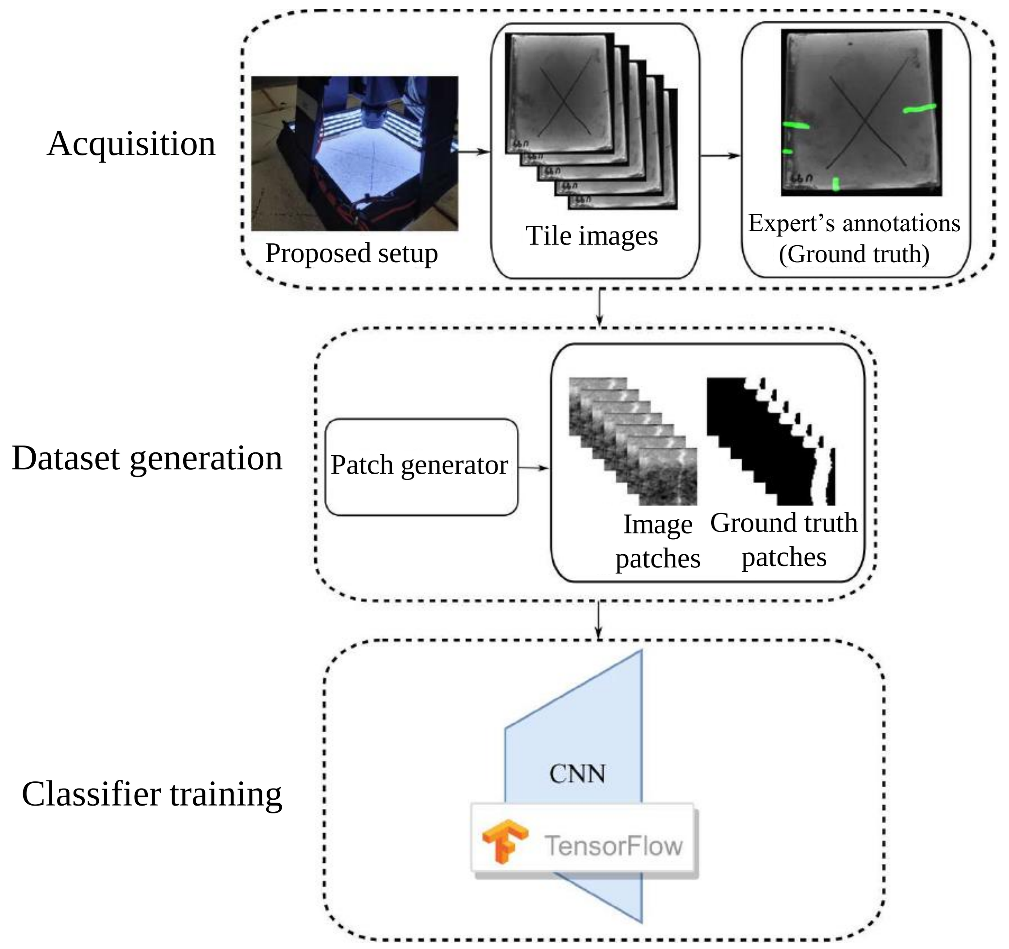
Proposed Setup



Crack Detection Example



Experimental Pipeline



Classification Architectures Used

- 6 state-of-the-art classifiers [1, 2, 3, 4, 5,.6]
- 2 custom architectures (TileNet6 and TileNet7)

Metrics for evaluation

Patch-level

- Accuracy

$$\frac{TP + TN}{TP + FP + FN + TN}$$

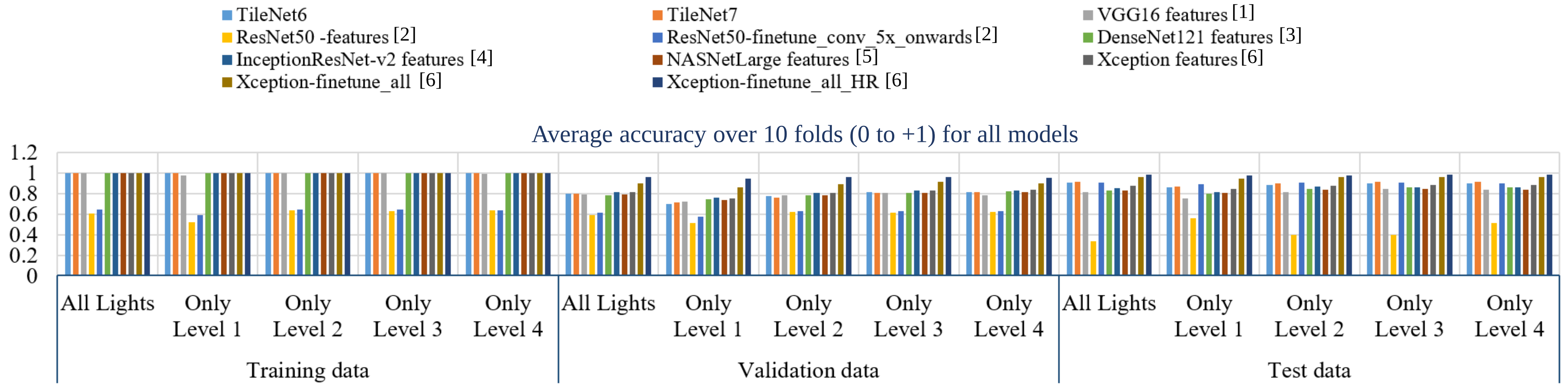
- Matthew's Correlation Coefficient

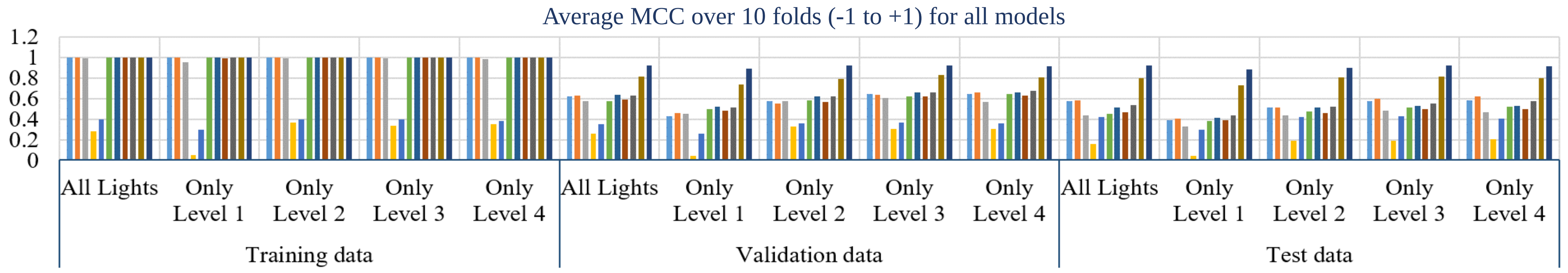
$$MCC = \frac{TP * TN - FP * FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$

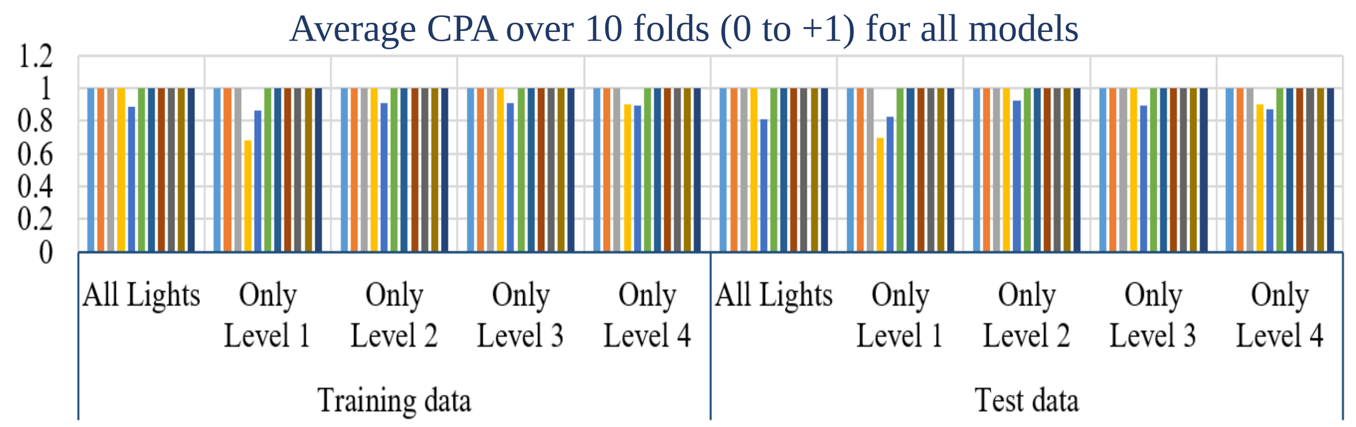
Image-level

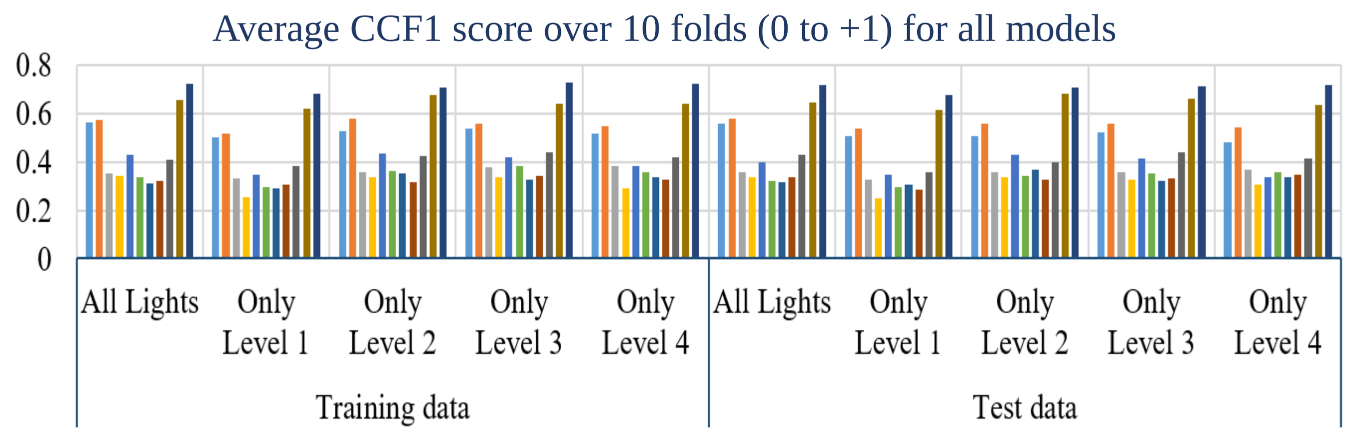
- Crack Presence Accuracy (CPA)
  Average accuracy of detecting presence or absence of cracks in the entire image
- Crack Count F1 Score (CCF1):
  Average F1 score for correctly predicting the number of cracks present in the entire image

Results









Conclusions

Lights

- All lights configuration provides the best results
- Lights placed at greater heights more effective than those placed near the tile's surface

Architecture

- Increasing depth of the network improves the results
- Fine-tuning pre-trained weights of the Xception architecture provided the best results

Spatial resolution

- Use of high-resolution patches improves the results compared to low-resolution
- Study should help in deciding the resolution versus performance trade-off for field use

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