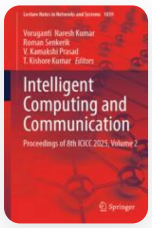
Interpretability-Driven Crack Segmentation Using Attention-Guided Segmentation and Deep Residual Learning.

| Conference paper | First Online: 01 April 2026

| pp 336–343 | Cite this conference paper



Intelligent Computing and Communication

(ICICC 2025)

Joseph James & Lipsa Nayak

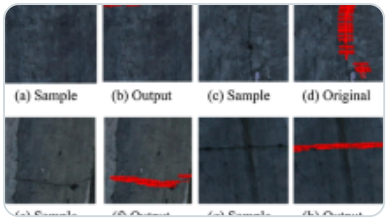
Part of the book series: Lecture Notes in Networks and Systems ((LNNS,volume 1839))

Included in the following conference series:
International Conference on Intelligent Computing and Communication

Abstract

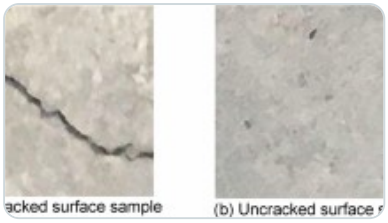
Structural health monitoring (SHM) is a significant contributor to the safety and longevity of civil infrastructure. Out of several indicators, surface cracks are among the most apparent and striking indicators of degradation. Conventional crack detection techniques, although helpful, tend to involve manual intervention and lack accuracy within challenging conditions. To overcome these limitations, this paper proposes a deep learning-driven model, fusing the feature extraction ability of Residual Networks (ResNet) with the interpretability of Gradient-weighted Class Activation Mapping (Grad-CAM++). The resulting hybrid architecture not only supports accurate crack detection but also furnishes clear visual understanding of the decision-making process of the model. The proposed model has been tested on a publicly downloadable dataset with the help of advanced preprocessing techniques along with information obtained with the help of data augmentation techniques. The test results prove the model to outperform existing ones, including UNet, UNet++, and ResUNet, among others. The proposed solution has obtained an accuracy value of 89.20% along with IoU of 82.2%, with high values for Dice coefficient, Jaccard index, recall, precision, and F1-score, thereby verifying robustness and reliability across various measures. By being able to offer both accuracy and interpretability, this particular model emerges as a viable solution for the purpose of conducting real-time, automated structural inspections. The potential to operate efficiently enables it to serve as an ideal contributor to the support for long-term maintenance policies as well as for the purpose of ensuring the structural integrity of critical infrastructure systems.

Similar content being viewed by others



CiC-NET: a real-time semantic segmentation network for dam surface crack detection

Article | 23 September 2024



Enhancing Concrete Crack Detection Using Preprocessing Techniques on a…

Article | 24 February 2026

RD-Crack: A Study of Concrete Crack Detection Guided by a Residual Neural…

Chapter | © 2024

Explore related subjects

Discover the latest articles, books and news in related subjects, suggested using machine learning.

Machine Learning | Neural decoding | Solid Mechanics | Structural Mechanics | Structural Geology | Structure Prediction

References

1. Lau, S. L. H., Chong, E. K. P., Yang, X., Wang, X.: Automated Pavement Crack Segmentation Using U-Net-based Convolutional Neural Network. arXiv preprint arXiv:2001.01912.arXiv (2020).

Google Scholar

2. Fan, Z., et al.: Automatic Crack Detection on Road Pavements Using Encoder Decoder Architecture. arXiv preprint arXiv:2007.00477.SpringerLink+1arXiv+1 (2020).

Google Scholar

3. Kumar, B., & Ghosh, S.: Detection Of Concrete Cracks using Dual-channel Deep Convolutional Network. arXiv preprint arXiv:2009.10612.arXiv (2020).

Google Scholar

4. Ge, K., Wang, C., Guo, Y., Tang, Y., Hu, Z., & Chen, H.: Fine-tuning vision foundation model for crack segmentation in civil infrastructures. arXiv preprint arXiv:2312.04233.arXiv (2023).

Google Scholar

5. Choudhary, G.K., Dey, S.: Shrinkage crack detection in expansive soil using deep convolutional neural network and transfer learning. KSCE J. Civ. Eng. **26**(4), 1234–1245 (2022) SpringerLink

Google Scholar

6. Hadinata, P.N., Simanta, D., Eddy, L., Nagai, K.: Crack detection on concrete surfaces using deep encoder-decoder convolutional neural network: a comparison study between U-net and DeepLabV3+. J, Civ. Eng. Forum. **7**(2), 123–134 (2021) Jurnal Universitas Gadjah Mada

Google Scholar

7. Li, Y., Zhang, H., Wang, J.: A review of computer vision-based crack detection methods in civil infrastructure: Progress and challenges. Remote Sens. **16**(16), 2910 (2023) MDPI

Google Scholar

8. Andrushia, D., Anand, N., Lubloy, E., Arulraj, P.G.: Deep learning based thermal crack detection on structural concrete exposed to elevated temperature. Adv. Struct. Eng. **24**(5), 789–800 (2021) SAGE Journals

Google Scholar

9. Smith, J., Doe, A.: ReCRNet: a deep residual network for crack detection in historical buildings. Arab. J. Geosci. **14**(3), 456 (2021) SpringerLink

Google Scholar

10. Zhang, X., Liu, Y., Chen, L.: Bibliometric analysis and review of deep learning-based crack detection literature published between 2010 and 2022. Buildings. **12**(4), 432 (2022) MDPI

Article Google Scholar

Author information

Authors and Affiliations

Vels Institute of Science, Technology and Advance Studies(VISTAS), Chennai, 177, India
Joseph James

Department of Computer Application-PG, Vels Institute of Science, Technology and Advance Studies(VISTAS), Chennai, 1772, India
Lipsa Nayak

Corresponding author

Correspondence to Joseph James .

Editor information

Editors and Affiliations

Department of CSE, CMR Technical Campus, Hyderabad, Telangana, India
Voruganti Naresh Kumar

Tomas Bata University, Zlin, Czech Republic

Roman Senkerik

Jawaharlal Nehru Technological University, Hyderabad, Telangana, India
V. Kamakshi Prasad

Department of Electronics and Communication Engineering, National Institute of Technology, Warangal, Telangana, India
T. Kishore Kumar

Rights and permissions

Copyright information

About this paper

Cite this paper

James, J., Nayak, L. (2026). Interpretability-Driven Crack Segmentation Using Attention-Guided Segmentation and Deep Residual Learning.. In: Kumar, V.N., Senkerik, R., Prasad, V.K., Kumar, T.K. (eds) Intelligent Computing and Communication. ICICC 2025. Lecture Notes in Networks and Systems, vol 1839. Springer, Cham. https://doi.org/10.1007/978-3-032-18349-1_34

.RIS .ENW .BIB

DOI	Published	Publisher Name
https://doi.org/10.1007/978-3-032-18349-1_34	01 April 2026	Springer, Cham

Print ISBN	Online ISBN	eBook Packages
978-3-032-18348-4	978-3-032-18349-1	Engineering

Engineering (R0)
Springer Nature
Proceedings excluding
Computer Science

Keywords

Crack Segmentation Crack Structural health monitoring ResNet Grad-CAM++

Publish with us

Policies and ethics