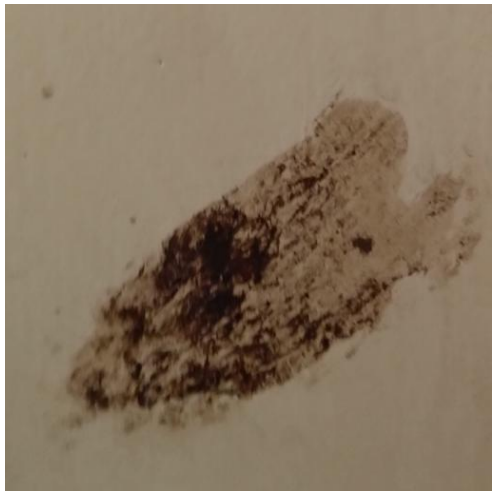
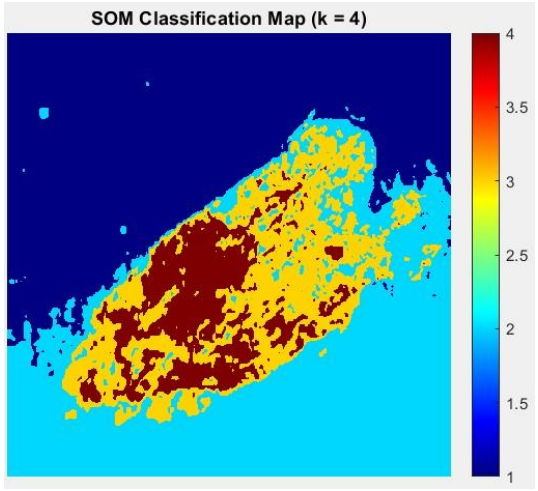
Unsupervised Detection and Intra-Defect Analysis of Surface Stains

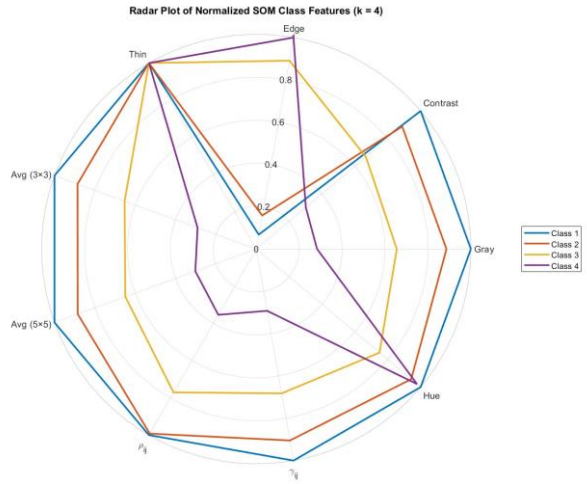
Applicable to surface contamination detection and source identification in building envelopes



Original RGB image of surface stain on wall coating



SOM classification map (k=4) segmenting stain from clean wall surface and revealing internal variations



Feature attribution plot for stain classes — showing differences in hue, gray intensity, and texture thinness between core and peripheral regions

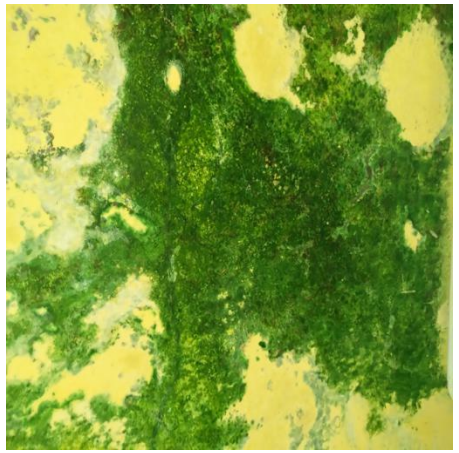
Binary mask of primary stain region extracted without manual labeling

Binary mask of secondary stain pattern (e.g., darker core or moisture concentration) extracted without manual labeling

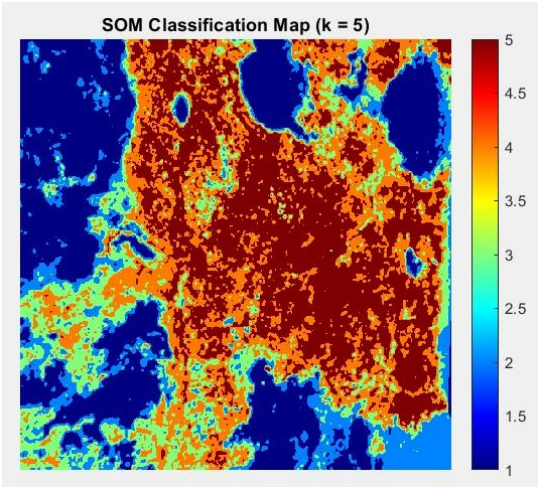
This unsupervised SOM-based pipeline is applicable to building envelope quality control and surface contamination detection, enabling automated identification of wall stains without training data or manual labeling. Intra-defect clustering reveals variations within the stain, such as darker cores or moisture-rich zones, which can help identify contamination sources or water ingress points. Distinct hue, grayscale, and thinness feature profiles differentiate the core and peripheral regions, supporting both defect detection and forensic analysis. The approach can be extended to other contaminant types, including mold growth, efflorescence, and rust streaks.

Unsupervised Detection and Intra-Defect Clustering of Algae Growth

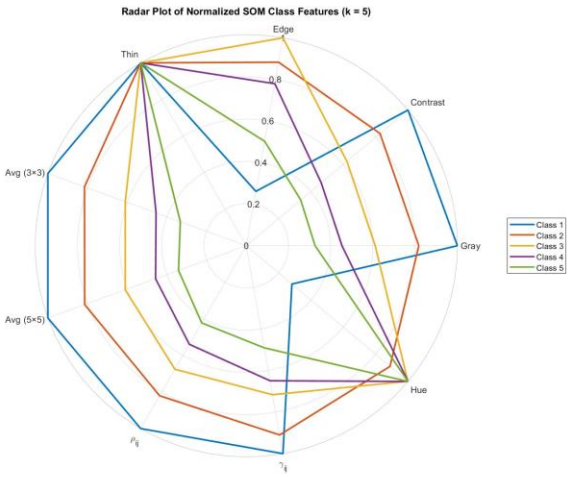
Applicable to surface contamination and biological growth detection in building envelopes



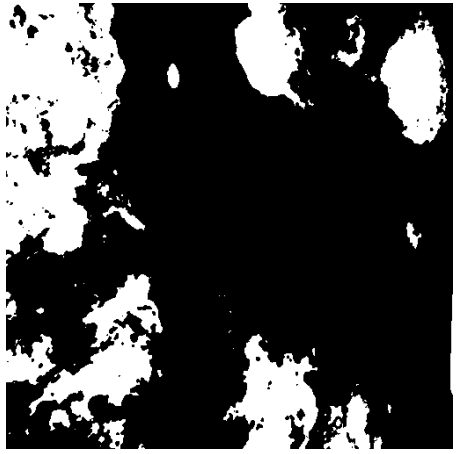
Original RGB image of surface algae growth on wall coating



SOM classification map (k=5) revealing intra-defect texture variations



Feature attribution plot for defect classes — showing differences in edge, hue, contrast, and texture thinness



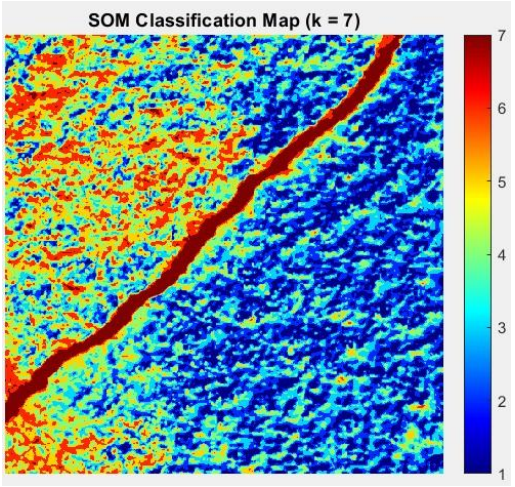
Binary mask of algae growth extracted without manual labeling

This unsupervised SOM-based pipeline is applicable to building envelope quality control and contaminant detection, enabling automated identification of biological surface growth without training data or manual labeling. Intra-defect clustering reveals variations in algae texture and growth stages, providing actionable insights for maintenance prioritization. The same approach can be extended to classify other surface contaminants—such as mold, rust, and chemical deposits—supporting scalable, low-cost inspection in construction and retrofit environments.

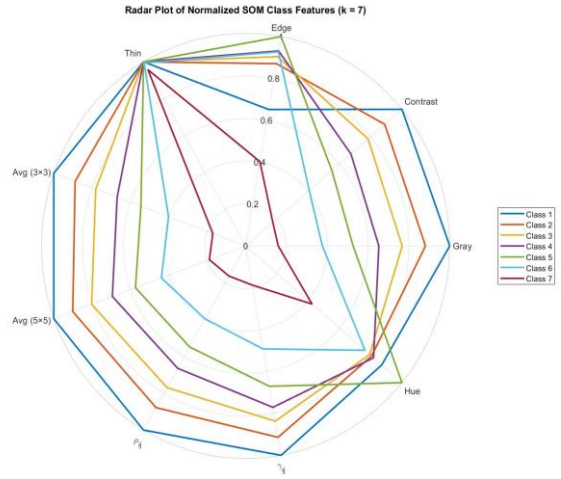
Unsupervised Detection and Feature Attribution of Major Structural Cracks

Applicable to structural defect detection and severity assessment in building envelopes

Original RGB image of a major crack on exterior wall surface



SOM classification map (k=7) isolating crack regions from textured background



Feature attribution plot for crack class — highlighting strong edge, contrast, and grayscale intensity

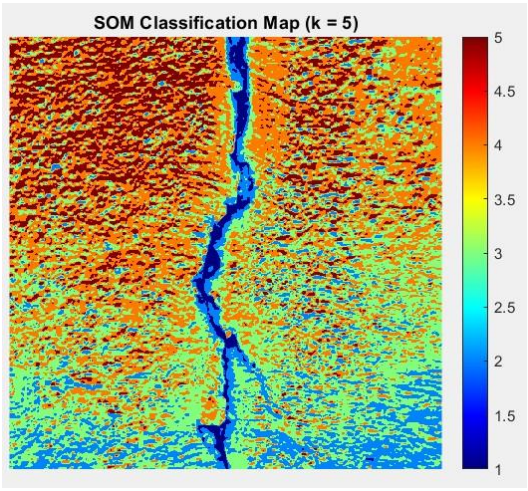
Binary mask of major crack extracted without manual labeling

This unsupervised SOM-based pipeline is applicable to building envelope quality control and structural defect severity assessment, enabling precise detection of major cracks without training data or manual labeling. High edge and contrast feature values characterize the crack class, supporting interpretable and explainable diagnostics. Such capability aids in prioritizing repairs, preventing further structural degradation, and can be extended to detect other critical defects such as deep spalling or joint failures.

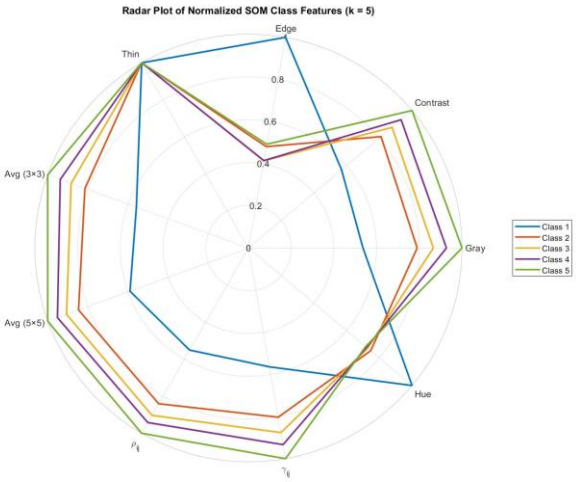
Unsupervised Detection and Feature Attribution of Minor Structural Cracks

Applicable to structural defect detection and severity assessment in building envelopes

Original RGB image of a minor crack on exterior wall surface



SOM classification map (k=5) isolating crack regions from textured background



Feature attribution plot for crack class — showing moderate edge and contrast values compared to major cracks

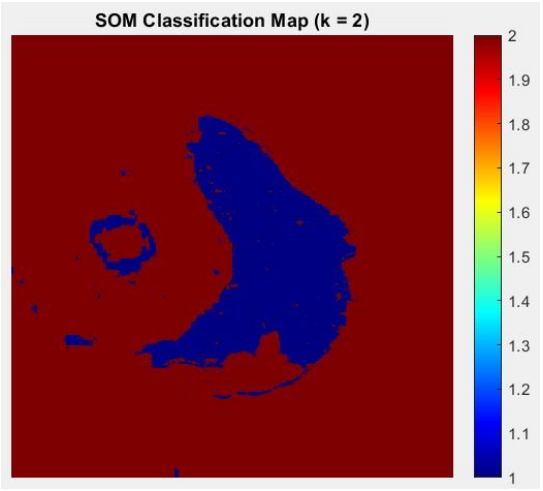
Binary mask of minor crack extracted without manual labeling

This unsupervised SOM-based pipeline is applicable to building envelope quality control and structural defect severity assessment, enabling accurate detection of minor cracks without training data or manual labeling. Compared to major cracks, the feature profile shows moderate edge and contrast values, supporting interpretable severity differentiation. This capability allows inspectors to distinguish between critical and non-critical defects, optimize maintenance schedules, and extend the approach to other subtle surface anomalies such as hairline fractures or joint separations.

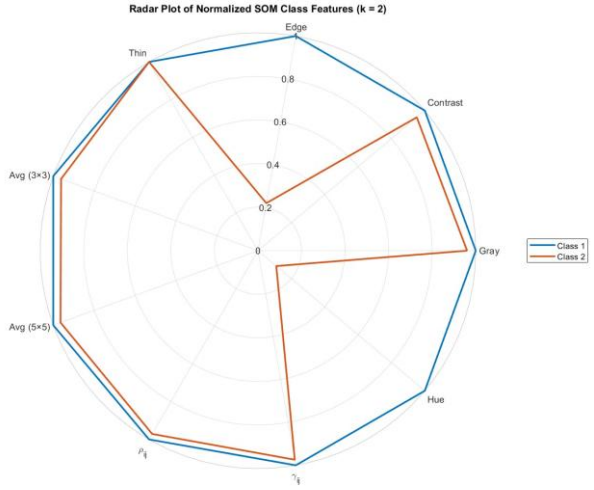
Unsupervised Detection and Feature Attribution of Surface Peeling

Applicable to coating failure detection and maintenance planning in building envelopes

Original RGB image of surface coating peeling on wall panel



SOM classification map (k=2) separating peeling region from intact wall surface



Feature attribution plot for peeling class — highlighting differences in edge sharpness, hue, and grayscale contrast

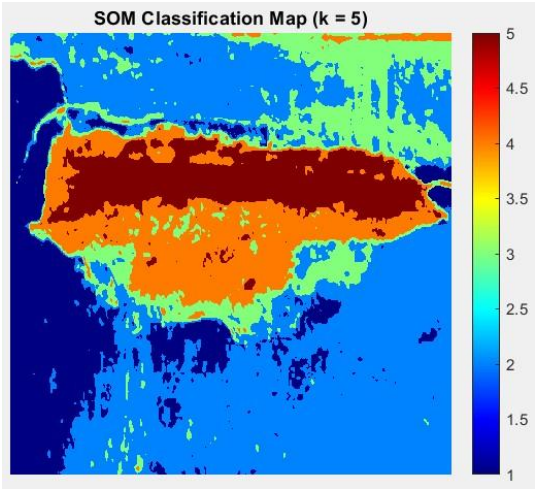
Binary mask of peeling defect extracted without manual labeling

This unsupervised SOM-based pipeline is applicable to building envelope quality control and maintenance planning, enabling automated detection of surface coating peeling without training data or manual labeling. The peeling class shows high edge sharpness and contrast, with distinct hue and grayscale patterns compared to the intact wall surface. Such capability supports proactive intervention, preventing further coating degradation, and can be extended to detect other surface failures such as blistering, flaking, or delamination.

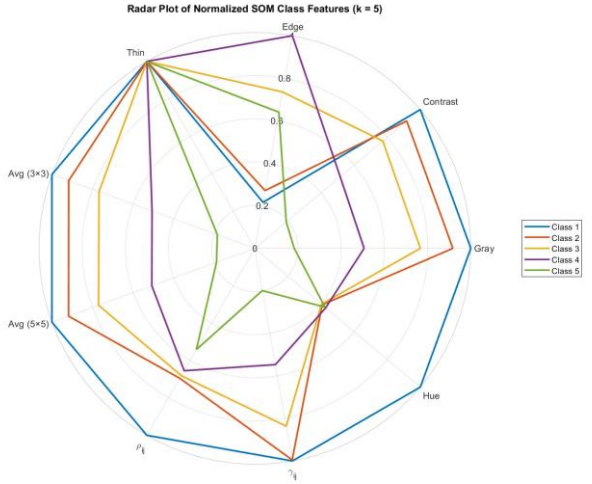
Unsupervised Detection and Layered Analysis of Concrete Spalling

Applicable to structural safety assessment and repair prioritization in building envelopes

Original RGB image of concrete spalling with exposed reinforcement



SOM classification map (k=5) identifying both surface and deep spalling regions



Feature attribution plot for spalling classes — showing high edge and contrast values for deep spalling, distinct hue and texture features for surface-level spalling

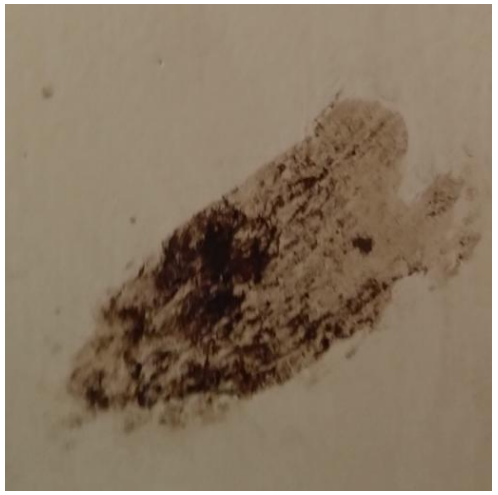
Binary mask of surface-level spalling (4th class) extracted without manual labeling

Binary mask of deep spalling with rebar exposure (5th class) extracted without manual labeling

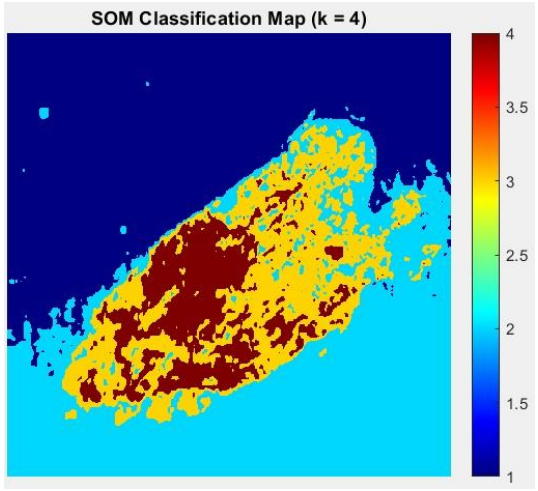
This unsupervised SOM-based pipeline is applicable to building envelope quality control and structural safety assessment, enabling automated detection of concrete spalling without training data or manual labeling. By differentiating surface-level and deep spalling, the method supports layered defect analysis, which is critical for repair prioritization and cost estimation. High edge, contrast, and grayscale feature values characterize deep spalling with reinforcement exposure, while surface-level spalling shows distinct hue and texture patterns. The approach can be extended to other layered defects such as corrosion progression, coating delamination, and multi-stage material degradation.

Unsupervised Detection and Intra-Defect Analysis of Surface Stains

Applicable to surface contamination detection and source identification in building envelopes



Original RGB image of surface stain on wall coating



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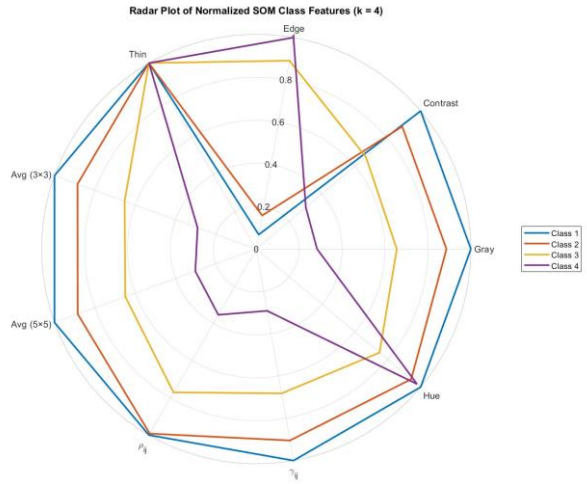

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