Use of Fuzzy Logic and Image Processing Algorithm to Assess Infrastructure Deterioration

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Abstract

With the significant increase in new buildings and rising concerns of structural failure, the safety and serviceability of infrastructures have to be ensured periodically or immediately following a given hazardous event. Determining the extent of concrete deterioration in a given structure is a multivariate decision-making problem with parameters that vary extensively, depending on the structural element involved. The use of digital imaging techniques to identify the deteriorated surfaces of structures is a substantial area of research and aims to investigate a number of unknown parameters, including damage quantification and condition rating. This paper presents a tool to measure the extent of the criticality of the concrete deterioration to help quantify if the deterioration warrants intervention for repair. The tool is essentially based on fuzzy set theory (FST), a well-developed theory used to address uncertainties in decision making. This paper illustrates the integration of previously developed fuzzy logic–based decision-making tools with the developed image processing algorithm to quantify the damage for the condition rating of infrastructures. The proposed integrated framework uses visual specifics of different elements of the infrastructure to perform automated evaluation of structural anomalies like cracks and surface degradation. The developed image processing software is used with proposed fuzzy set framework to measure the damage indices due to various deterioration types like corrosion, alkali aggregate reaction, freeze–thaw attack, sulfate attack, acid attack or loading, fatigue, shrinkage, and honeycombing. The paper also presents case studies of a long-span bridge and a warehouse building for concept validation.

References

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