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Quantification of subsurface defects in reinforced concrete of bridges by unsupervised segmentation of IR images

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ABSTRACT

This paper presents segmentation analysis of Infrared (IR images of reinforced concrete (RC blocks for characterisation and quantification of corrosion defects using unsupervised clustering. The IR images used in this study were collected during cool down process of RC slabs to laboratory environment temperature through convection heat exchange. The RC slabs were cast from a normal strength mix, typical for bridge construction in the UK and Ireland. The slabs had two steel rebars with protruding ends that were used for accelerated corrosion setups. Unsupervised clustering was conducted on IR images by applying k-means clustering method on normalised temperature readings in a region of interest. In this paper, the performance of clustering method to distinguish between environmental or surface effects and true bridge anomalies is studied, and the corrosion-affected concrete is quantified. Variation of thermal contrast and quantity of defective concrete during the experiments as well as discussion of the results in context provides a basis for improved implementation of IRT for RC structures and contributes to wider objectives of structural health monitoring (SHM.

Keywords: Reinforced Concrete (RC, Rebar corrosion, Unsupervised clustering, Infrared Thermography (IRT), Structural Health Monitoring (SHM)

1 INTRODUCTION

Degradation of concrete because of corrosion of rebars in aggressive operational and environmental conditions is a major reason for damage in the reinforced concrete (RC elements of bridges such as deck, girders, soffit, and foundation [1, 2]. The progress of the rebar corrosion causes accumulation of iron oxide at the interface between the rebar and concrete which has higher volume than the steel which subsequently weakens their adhesion and can cause cracking of the concrete [3]. Therefore, it is required to monitor the condition of structure to recognise the onset of corrosion propagation and detect damages at earliest possible stage, preferably by non-destructive techniques and before they progress severely, incur costly rehabilitation and maintenance, endanger lives and cause traffic disruption [1, 4, 5].

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