UNIVERSITY OF CAMBRIDGE
Department of Engineering

CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

A Digital Methodology for Dimensional Inspection of Reinforcement Cages from Point Cloud Data with the Aid of an As-designed BIM Model

Reinforcement Steelfixing is a skilled, manually intensive construction trade that has seen no improvement in productivity over many decades, this is against the demands of the industry which is calling for lower cost delivery of heavily reinforced major infrastructure, increased use of complex DfMA and 3D reinforcement detailing catalysing more intricate designs. This thesis seeks to demonstrate a digital methodology for the benefit of quality and productivity of steelfixing and inspection, by bringing together two emerging technologies – 'mixed (augmented) reality' and automated as-built modelling.

Computationally efficient algorithms are developed for the recognition of reinforcement from a point cloud, enabling the dimensional checks required by project specifications and national standards to be automatically conducted and recorded. Traditional scan-vs-BIM techniques are not appropriate for this purpose as it is shown that semantic understanding of reinforcement is required in order to inspect it. Having achieved this, the in/out of tolerance results on each rebar are displayed back to the user via 'mixed reality', in theory allowing the accurate placement of reinforcement to be carried out 'in-process', reducing the risk of rework and creating as-built reinforcement models for remote inspection and posterity. A registered point cloud and reinforcement BIM model are taken as inputs to the algorithms presented, with the BIM model serving dual purpose; it carries geometric information which is used in a novel way to aid reinforcement recognition and secondly textual and numeric parameters carried on the model objects are used as the nominal basis for inspection.

At the time of writing, mixed reality technology - capable of both augmentation and interaction with the real world - is in its first incarnation and the meshes generated are sparse, intended only for mapping large surfaces. In this work reinforcement is automatically modelled from Terrestrial Laser Scanner data before then being 'digitally inspected' and the results consumed in mixed reality. However, it is posited that the greatest opportunity arises when mixed reality technology has developed to the point that the point clouds they generate have increased in density and accuracy such that data-capture, processing and feedback of results may be achieved in near real time on the device.

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