3D FULL FIELD DEFORMATION MEASUREMENT USING DIGITAL IMAGE CORRELATION

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3D deformation and strain are crucial parameters in engineering design and construction. Precise 3D full-field measurement is useful in identifying the response of the structure under a given loading condition. Digital Image Correlation (DIC) is a non-contact optic-based technique that may prove to be ideal for full-field deformation applications. It has the potential to become an inexpensive, simple, and accurate solution for deformation measurement. All DIC measuring systems now available consist of expensive software packages and experimental facilities which are difficult to access. Therefore, a cost-effective method must be developed to use in the local context efficiently.

This research mainly focuses on the development and validation of the cost-effective precise non-contact-based deformation measurement technique. In the proposed method, 3D full-field deformation of the deforming object is measured using two digital cameras and an image processing toolbox available in the MATLAB commercial package. Further, the proposed method efficiency is enhanced by developing it as a standalone application, which can be installed and used by any technician conveniently and utilized for various laboratory Civil Engineering applications. Enhancing the proposed DIC algorithm to improve resolution in 3D applications and extending to phase-changing materials and developing Graphical User Interface (GUI) and general guidelines to be used by a technician were defined as objectives of this research.

The proposed measuring system consists of two digital cameras mounted on a rigid frame as it is targeted to capture the specimen and connected to a computer. A random speckle pattern must be applied on the specimen's surface to track the deformation. The proposed image processing algorithm was developed in MATLAB by using a computer vision toolbox. Later Graphical User Interface was developed using MATLAB App Designer. The developed system was used to obtain the results and validated for rigid body motion tests of concrete cube and cylinder, compression test of concrete, uni-axial tensile test of a dog bone aluminium specimen and shrinkage cracks of mortar experiments.

In conclusion, a cost-effective and reliable measurement system was developed by using DIC techniques and MATLAB computer vision toolbox, with its performance validated experimentally by assessment of measurements of the in-plane strain of materials. Even though it has some limitations, the developed algorithm and application can be effectively used for laboratory-scale Civil Engineering related experiments. Also, the application that was developed can be handled by technicians who do not have much knowledge nor understanding of programming languages. The Graphical User Interface that was developed is easy to use and saves considerable time. The performance of the system that has been developed can be assessed and improved for greater precision.

Keywords: Digital Image Correlation; 3D Reconstruction; full-field Measurements; computer vision

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