

Assessment and Monitoring of Civil Infrastructure through Contactless Imaging Technology

Synopsis

Structural health monitoring (SHM) of ageing concrete bridges and tunnels is traditionally performed with sensor networks or Digital Image Correlation (DIC). Conventional DIC, however, demands a pristine reference image taken before any damage occurs, a prerequisite rarely satisfied for existing assets, limiting field deployment and necessitating costly traffic closures and instrumentation.

In an earlier step of this project (*Structural Reuse funded by COWIfonden*), we successfully proved that our DIC approach is feasible and established a workflow from the speckle pattern application until the mapping of the strain field and displacement across concrete prisms in loading and unloading scenarios.

This project will establish an intermediate-stage DIC procedure that designates the first image captured immediately after a moving load has cleared the field of view as an apparent reference. Sequential high-resolution images recorded during the loading–unloading cycle will be correlated to deliver full-field displacement and strain maps, allowing the identification of microcracks or damaged locations without recourse to a baseline photograph.

This project will focus on (1) the optimization of speckle patterns, lighting and camera parameters to minimize measurement uncertainty; (2) undertake DIC using a structural element under a simulated moving load and gain insight on strain localization under more realistic boundary conditions; (3) laboratory validation on a reinforced-concrete beam equipped with actuators, strain gauges and/or LVDTs, and (4) find out the interrelation between the field of view, camera distance, moving load, and identified (micro)cracks.

The anticipated outcome is a validated, reference-free DIC tool that can generate stress heatmaps of bridge decks in minutes, enabling early detection of micro-crack initiation and irreversible deformation. Adopting this DIC approach will allow engineers to schedule targeted maintenance, extend service life, and reduce CO₂-intensive rebuilds, thereby supporting the European Green Deal and COWIfonden's focus on digital asset management.

Achieving these research goals would mark a major advance toward real-world deployment, and by leveraging on unmanned aerial vehicles (UAVs) technology, real-time structural monitoring will be possible giving owners and operators a significant edge on planning maintenance at an optimal time.

The two-year program runs from July 2025 to July 2027. Experimental work will be undertaken between DTU Sustain, Denmark, and MNIT Jaipur, India