1.5.10. QUANTIFICATION OF DAMAGE PROCESSESES AT SURFACES AND INTERFACES OF BUILDING STRUCTURES USING OPTICAL METHODS AND ACTIVE THERMOGRAPHY

Krankenhagen R., Röllig M., Maierhofer Ch., BAM Federal Institute for Materials Research and Testing, Berlin, Germany;
Mecke R., Hofmann M., Schiller M., Fraunhofer Institute for Factory Operation and Automation IFF, Magdeburg, Germany;
Kalisch U., Meinhardt-Degen J., Institute for Diagnosis and Conservation on Monuments in Saxony and Saxony-Anhalt (IDK), Halle, Germany

A large amount of damage of building structures induced by environmental influences like sun radiation, air pollution, moisture, freeze thaw alterations, vibration and settlements are either starting or appearing first on the surface of the building structure. The aim of the presented research is the development and qualification of an efficient strategy for early digital detection, spatial recording and quantification of damage at and close to the surface by using innovative automated electronic methods. With these methods, structural changes can also be observed for longer periods and appropriate measures and repair can be applied at an early stage. Beyond that the effectiveness and sustainability of protective measures can be analysed.

This strategy is based on the optimisation and combination of the following methods:

– Light section method by using a laser scanner and robotic pivot arm for recording the geometry, topology of the surface and geometric alterations (e.g. cracks, bulging, deformations);

– Active thermography by using different heat sources and an infrared (IR) camera for detecting of inhomogeneities in the surface near area, which are not directly visible at the surface (e.g. delaminations, masonry structure behind plaster, cracks, voids, moisture).

In this presentation, the specifications, advantages and limits of both methods will be presented.

With the light section method, a very precise determination of position of all six envelopes is possible. Arbitrary surfaces can be surveyed with an accuracy of about 0.1 mm. A concatenating to 2D photos is possible. The disadvantages are the complexity of the experimental set-up as well as the data analysis. Latter will be further developed in this project.

With active thermography, inhomogeneities below the surface can be detected up to a depth of about 10 cm. A maximum spatial resolution of 0.3 mm is possible, but can be enhanced by using a close-up lense. Here, two different IR cameras being sensitive at different wavelengths have been applied:

– Variocam hr from Infratec (7.5 to 14 μm, 640×480 pixels, uncooled microbolometer array, 50 Hz frame rate);

– SC 1000 from Inframetrics (3 to 5 μm, 248×239 pixels, stirling cooled Pt/PtSi array).

For recording of congruent mappings of the object under investigation, first the internal aberrations of the IR cameras have been corrected (internal camera calibration) by using a freeware matlab toolbox. This calibration shows considerable distortions up to 5% at the boundaries, which cannot be neglected for datafusion.

Fig. 1. Frame with digital camera and IR camera for adjusting of images

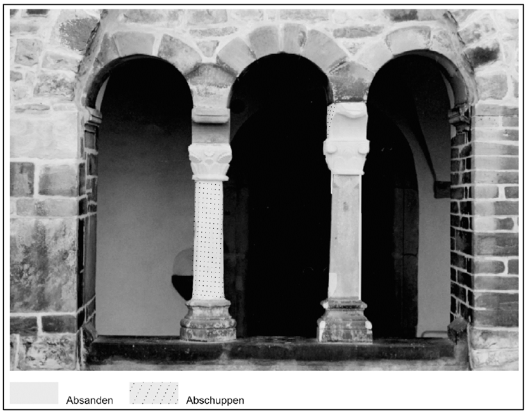

Fig. 2. Damage at two columns in a cloister
(Unser Lieben Frauen, Magdeburg)

For facilitating the fusion to the 3D data, parallel to the capturing of thermograms digital photos are taken from the measurement area. For this, IR camera and digital camera were both mounted into a common frame structure enabling a reproducible relative position (see fig. 1).

Experimental data will be shown on the application of both methods to different damage and structures of historic buildings. One of these case studies is shown in fig. 2. Here, two columns have been investigated showing delaminations and loss of material.

Algorithms have been developed for data fusion enabling multi-layer 3D representations with all complementary and subsidiary information.