Autonomous dynamic line-scan with Terahertz and long-wave IR for culture heritage evaluation using a novel unsupervised data fusion strategy

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The structural health evaluation is one of the most essential tasks on cultural heritage conservation. It is commonly carried on by adapting non-destructive inspection techniques. However, due to the particularity of cultural heritage samples, conventional contact-type detection methods such as ultrasonic testing could not be applied to this task. Considering of the non-contact property, optical and related techniques have been employed for the non-invasive investigation of cultural heritage. In this study, an autonomous dynamic line-scan system with continuous wave terahertz imaging and long-wave IR thermography is proposed for the structural health evaluation on culture heritage. The line-scan continuous wave terahertz imaging in transmission mode is aimed at producing clear maps for wooden structure of cultural heritage samples whereas the line-scan long-wave IR thermography is used for inspection on surface and sub-surface flaws on samples. Due to the limitation on the shape of terahertz source, terahertz wave with sufficient intensity could only be collected in a constrained region on cultural heritage samples which are in large size. An unsupervised data fusion strategy designed in encoder-decoder deep learning structure with dense blocks is adapted for multi-focus data fusion. Experiments conducted on cultural heritage samples including wooden panel paint, paint on canvas and an ancient book cover have shown promising results which certify that the proposed approach is effective for cultural heritage evaluation task.