On-site inspection of wind turbine blades using shearography with a robotic deployment system

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Wind energy is a fast growing industrial sector. As wind turbines are expected to work 90% of the time during a typical lifetime of 20 years, structural flaws are of great concern, particularly for blades. Repairing or replacing a blade is always difficult, especially for large wind turbines. The downtime of a wind turbine installation due to a blade failure usually lasts 4-6 days, longer than that due to electrical or mechanical failure within the nacelle. Cracks in the blades sometimes appear soon after manufacture. Defects also can be produced during transportation. Current inspection of wind turbine blade is mainly reliant on sending an engineer via rope access.

An ideal solution to this problem is to utilize a compact robot that can reach the blade and implement faster inspections on site. Shearography has long been recognised as a powerful inspection technique, and has found wide application in a range of industries including aerospace, automotive and shipbuilding sectors. However, conventional shearography still needs a relatively stable environment, thus it is difficult to use for on-site WTB inspections.

In this paper we report our latest work to achieve on-site inspection of WTB using shearography. A robotic platform which is able to climb along the wind tower is developed. A vacuum suction based end-effector is also developed which sits on top of the platform and which enables the shearography system to be deployed on the WTB surface during inspection. Two successful field trials were performed in this year in CRES wind form in Greece. The first trial was carried out on April 20, 2019, a second trial was performed. During the test, the weather was changing from low wind speed (3-5m/s) to above 10m/s, which is the up limit for wind turbine maintenance and inspection. Nevertheless, we managed to reach the position and recorded a few speckle pattern video clips in half an hour. Afterwards, we had to stop the test and retract the robotic platform. After post-processing of the recorded video clips, we were able to see shearographic fringe patterns. To the authors' knowledge, this was the first time in the world that shearography fringe pattern was obtained from an on-site inspection on a wind turbine tower. It demonstrated that our overall approach of using shearography with a robotic system for WTB inspection is working. The second field trials occurred in May 13-14, where we were able to collect more speckle pattern videos of the WTB after thermal stressing by a heat gun, and more shearography fringe patterns were obtained. This further demonstrated that shearography can be used for on-site WTB inspection.