Impact Damage Detection in Fiberglass Composites Using Low Acoustic Impedance-Based PZT Transducers

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Abstract

The objective of this work is to evaluate the feasibility of detecting damages caused by impacts in fiberglass-epoxy composites using lead-zirconate-titanate (PZT) transducers. Impacts were created by a hammer (unquantified energy) and an automatic impact system (quantified energy) in multiple composite sheets. The mechanism of the damage detection relies on the impedance measurement by a low acoustic impedance (LAI) transducer, which resonates in the radial mode rather than the regular thickness mode. The effect of surface roughness was investigated by using specimens with different quantified surface roughness values. It was shown that the final results are heavily affected by the rough surface and hard boundary conditions. Mainly, we aimed to evaluate the efficiency of low acoustic impedance technique in the damage detection of composites. The tests were carried out in the energy ranges of 10 to 54 joules. The surface of each specimen was gridded with a step size of 5 mm, and the impedance was measured for each location. The final results were normalized using a no-load condition as the reference point. It was shown that the proposed portable and easy-to-use LAI setup could detect the damages qualitatively. The normalized measured impedance was variable, but it showed a significant increase, in some cases as high as 100%, on the impact's region.

Keywords: robotics, IoT, internet, teleoperation, robot remote control, delay time, virtual private network, VPN

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