Wireless Monitoring of Blade Impacts

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Many rotary systems today utilize composite blades because they are light-weight and stiff. However, composites can be easily damaged without any visible surface damages. With the advanced sensors, one can now detect these damages from impacts on the blades. These sensors can detect the location of the impact and possibly the amount of damage inflicted. This allows people to be more quickly informed about the structural integrity and damages of the blade which could be potentially devastating. Impact testing was conducted on carbon fiber and fiberglass rotor blades instrumented with low cost piezo-electric films sensor. Unique wave signatures were generated by impacting the various locations on the rotor blades. Experiments were designed to prove that these unique signatures were attributed to surface anti-symmetrical lamb wave propagation. Further impact testing was conducted on a section of a full-scale helicopter rotor blade with a composite skin. Test results reaffirmed the generation of anti-symmetrical lamb waves during impact testing. Wireless detection and recording of various blade impacts was demonstrated using a multi-channel high speed data acquisition system. The demonstrations suggest that is it possible to remotely detect and locate the impact events on the full-scale blade. In addition, efforts were made to analyze the received wave signatures in the frequency domain on blades with and without damages. The results indicated that regardless of impact location, the frequency spectrum shows the same resonance. It was also noticed that the amplitude of the first resonance was reduced in damaged blades. The anti-symmetrical lamb propagation is useful for both impact location and damage detection.