Pulsed Eddy Current Inspection at Aluminum Fasteners in Aircraft

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Damage tolerant design of aircraft requires periodic inspection of the structure around fasteners to detect and size any cracks that might be present. Currently this is done with bolt-hole eddy current (BHEC), which requires removal of the fasteners. This paper investigates a technique to detect such cracks, without fastener removal, for two layer structures held together with universal head aluminum rivets. Probes and samples were constructed to investigate cracks about 1/8" and 3/16" rivets. The probes were based on the same basic design, a central driver with 4 pick-up coils at 90 degrees to each other arranged around the driver and connected differentially. The probe responses were reduced to a few scores using a modified principal components analysis. The scores, in turn, were analyzed using a cluster analysis technique. Since the vast bulk of sites are not expected to contain any defects, it was expected that their scores should form a cluster. Fasteners with associated defects would then be expected to appear as outliers to this cluster. Robust statistical techniques allow these outliers to be detected blindly. The results were extremely encouraging with only a few misses that were all second layer notches smaller than the head size. A comparison with conventional eddy current was made, which clearly demonstrated the superiority of the pulsed eddy current approach over low frequency eddy current for crack detection. Much of this improvement had to do with the ability to segregate irrelevant variation (i.e. due to fastener position relative to an edge) to specific scores, which could then be discarded fro the analysis.