CENTER FOR SPACE RESEARCH PROGRAMS

feature technology } *Health monitoring of structure integrity with AE*

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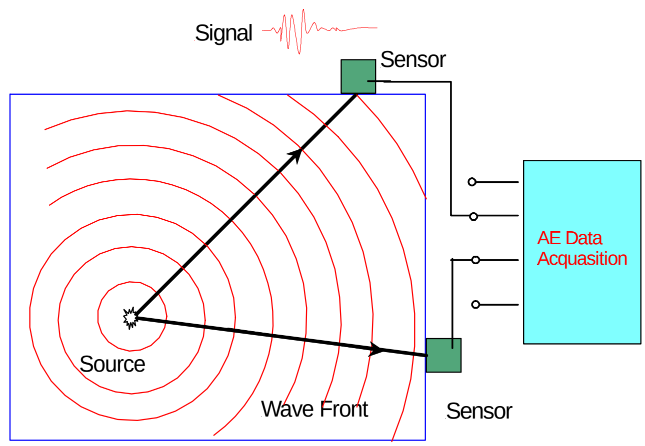
The recent incidents of debris striking of the *International Space Station* and the *Columbia* tragedy highlight the importance of real time–based health-monitoring techniques for large space structures. In addition, the spacecraft that will accomplish NASA's exploration mission require active health monitoring of their structures. A technique that is uniquely suited for this mission need is acoustic emission (AE) monitoring.



The AE monitoring technique uses signals generated by the structure, which may be due to either crack growth under stress or impact force on the surface, to parameterize the fracture/failure process. This unique monitoring mechanism distinguishes the technique from other non-destructive testing methods and makes it the only one capable of real time mapping of fracture/failure processes. In addition to real time source location of the captured AE events, the energy level or "magnitude" of the detected event can be evaluated, which provides immediate evidence of the degree of the damage. A particular engineering advantage of the AE technique is its efficiency for global monitoring in that a large and complex structure can be monitored with a limited number of sensors.

Penn State researchers have developed a number of key techniques for efficient AE monitoring of large and complex structures, which include layout of the monitor sensor array; phase association for identifying arrival types; ray tracing in thin structures and the associated source location algorithms; and reliability analysis of the event location result.

The effectiveness of these techniques was demonstrated by an AE test of a railroad tank car, which was 44 ft long with a diameter of 6.5 ft. A 12-channel system was used, covering about 80% of the 968 ft^2 surface area. The average source location accuracy for 78 calibration events was within 4.35 in (110 mm).

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