DESCRIPTION FOR THE GENERAL PUBLIC

Structural Health Monitoring (SHM) is no longer a luxury but a necessity. Several SHM strategies have been proposed that make use of different parameters like vibration in the structure, strain in the structure, propagation of waves in the structure (guided waves) etc. Each method has its own set of advantages and hence some methods are suitable for some kind of applications while the others for some other. Guided waves have been found to be very effective for plate like structures and have been used extensively in plate-like structures especially in aerospace industry.

In the aerospace industry there is a large emphasis on reducing the weight of the structure. As a result composite materials which have a high strength to weight ratio are finding wide spread applications. Composites are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The properties of the material can be tailored to requirements by adjusting the composition, method of manufacturing and adding some additives. They can be designed to withstand harsh environments. On the downside, composite structures are often anisotropic, and the wave propagation through the composite samples is direction dependent which makes use of guided waves for SHM a challenge. Also, the range of the propagation of the guided waves is much lower than in metallic structures. As a result for the same coverage on the structure more sensors are required. The need for more sensors increases the cost of equipment, also as mentioned before, the extra weight is a major concern in some applications. Hence, there is a need to reduce the number of sensors without compromising the quality of the monitoring which can be achieved through optimization of sensor placement. Another way of ensuring optimal use of the sensors is by using the same Piezo-electric transducers for better SHM. This can be achieved by the dual use of PZT actuators for the guided waves as transducers for the Electromechanical Impedance (EMI) measurements. The dual SHM strategy improves the quality of SHM without increasing the number of sensors.

There has been some research work in the area about optimizing the sensor placement but these studies have been limited to isotropic materials. Also the influence of the structural components is not taken into consideration while optimizing the sensor network. The treatment of the optimization problem too has been limited to analytical approaches. The analytical approach makes several simplifying assumptions for modelling the wave propagation through the composites, this makes the optimization imprecise. The other shortcoming in the literature is lack of methodology for EMI based damage detection at the network array level as well as the development of the dual SHM strategy.

Thus, the research proposes a methodology for determining the optimal sensor placement for guided waves measurement. The study will be undertaken taking into consideration the interaction of the wave with the anisotropic material, the boundaries of the structure as well as other structural components like rivets, stiffeners etc. The study will be based on numerical simulations as well as experiments. By using the experimental and numerical approach the systematic errors due to simplifying assumptions for the interaction of the material and waves will be eliminated. Also the optimized sensor network performance will be compared through the use of metrics with physical significance like the probability of detection, coverage etc.