Algorithms for Prognostication of Electronics Failures in Hybrid and Electric Vehicles

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Electronics is being widely used in cars. Applications include – lane departure warning systems, collision avoidance systems, antilock braking systems, and adaptive cruise control. Electric vehicles use electronics for battery system management, drive and propulsion systems. Improvement in the reliability of electronics in vehicles necessitates the development of the ability to identify imminent failures. Currently, on-board diagnostics are used to detect the occurrence of failure and do not provide insight into the damage state of the system and the remaining useful life. In this paper the hypothesis that changes in the spectral behavior can be used to identify imminent failure in electronic assemblies has been tested. In order to test the hypothesis, the natural frequencies of the board assemblies have been measured using an electro-dynamic shaker. Then the board assemblies were subjected to repetitive shock events, and three parameters were measured: deformation, strain, and continuity of the board assembly. The fast Fourier transform of the strain pulses was computed to identify the spectral content of board motion during the drop test, which evolved with time after the first impact. The joint time frequency analysis was then used to study the evolution in the spectral content with time after impact. Damage was found to accrue in the solder joints of the board assemblies, die attach of the components, silicon chip inside the components, and wirebonds between the chip and the substrate. Finally, a neural network was developed and trained to identify faulty assemblies by feeding it with training signal of pristine assemblies.

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