Event-driven diagnostic system for damage tolerant composite components under complex loading conditions

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The increasing demand of advanced composite materials application in critical, complex loaded components requires research efforts towards the development of reliable methodologies for instantaneous diagnosis of damage evolution and component life prediction.

The main task of the PhD work is to develop a methodology for the diagnosis of components made of composite materials with gradual damage behaviour characterised through distinct, physically based events such ply failures and the resulting stress redistribution. The novelty of this method is the attempt to create variable diagnostic procedures based on multi-level models with integrated control algorithms that allow an improved recognition of the occurring damage sequence compared to typical single-stage diagnostic procedures. The diagnostic models should be designed with an assumption that the analysed component is equipped with integrated sensor, actuator and electronic elements, which allow in-situ measurements of diagnostic signals and calculation of their relevant features.

In a first step, the analysis of the damage evolution sequence of selected composite materials is to be undertaken. Moreover, an important factor is the selection of residual processes as sources of diagnostic information. This information can be obtained by acoustic emission technique or vibration measurements. Fast Fourier Transform (FFT) analysis is possible to be used to point out the dominant frequencies, which then will be related to the main failure mechanism. Finally, the development of an event-driven control strategy of the diagnostic process should be built, in order to estimate the residual strength throughout the service life. The diagnostic procedure should be able to detect, localise and quantify the existing damage as well as to estimate its most probable evolution.