Description for the general public

In the present fast-paced life the comfort and the utility of the engineering structures is taken for granted. The unavailability of the structure due to failure or emergency maintenance actions causes large losses in terms of time, money and in extreme cases is a threat to life. So it is imperative to know the condition of the structure in order to avoid such severe situations. The assessment of the condition of the structure through the use of sensors is called structural health monitoring (SHM).

Typically the SHM is carried out through the use of vibration based techniques. These techniques are sensitive to large levels of damage. This although useful in some applications, such as bridges which have a high tolerance in their design, is not good enough for composites structures such as in aircrafts which have low damage tolerance. The guided waves based technique and the electromechanical impedance based technique is very sensitive to even small changes in the structure and is commonly used for composite structures. One of the challenges for these methods is the sensitivity to ambient conditions such as loading, temperature etc. These factors are also significant for the vibration based damage detection. In order to overcome these effects the use of numerical models is necessary. The numerical models may allow us to separate the effects of the ambient loads and those due to damage and hence allow more reliable damage detection.

Unfortunately the development of a numerical model which accurately imitates the response of the structure is very difficult and time consuming. So new techniques for improving the accuracy and efficiency of the numerical models is needed. This task will be done in parallel by the teams in Switzerland and Poland. The team in Poland specializes in the technique called Spectral Element Method (SEM) which is computationally more efficient than the finite element method. The performance may be improved further by using parallel computing which is another upcoming field. The SEM method will be developed further to improve the modelling of damage scenarios in order to imitate the behavior of the structure. Similar efforts making use of the XFEM technique will be carried out by the Swiss team. The use of SEM and reduced order modelling will improve the computational efficiency and generate data which can be combined with the measurement data from the sensors.

Firstly the data driven approaches making use of the experimental data only will be investigated. The recent developments in the areas of artificial intelligence will be used for this purpose. This approach will provide an initial assessment of the condition of the structure such as the existence of damage and its location. In order to determine the extent of the damage the physics based approaches which make use of the numerical data and the experimental data will be explored.

The measurements will be carried out on simple composite samples for the validation of developed models. Next, the developed methodology will be applied to small-scale wind turbine blades. A wide range of sensors and measurement techniques will be employed for the study such as use of fibre optic sensors, laser Doppler vibrometer, piezoelectric sensors for point-wise measurements and the electro-mechanical impedance measurements.