Impacts Deconvolution

In this work we present a deconvolution technique based on adaptive filters for estimating impacts generated by the collision of two rigid bodies. The interest in measure and analysing impacts arise from applications in different areas of science and engineering. Studying the behaviour of car collisions, the impacts on aircrafts on landing, testing the condition of structures and composite materials, determining material properties, impact wear of turbines, earth composition, earthquakes processes, soil analysis and bones fractures due to impact falls are just a few examples.

Generally, impacts are registered by indirect measurements because it is not always possible to instrument the impactor or the impact does not develop on the sensor. This means that signals reach the transducer after crossing a propagation media, a channel, which produces distortions. In order to recover the original excitation signal, it is necessary to apply a deconvolution processes.

Several deconvolution methods have been developed in different fields, and choosing the correct one is critical. Selection depends on signals properties and applications. In the case of impacts, their non-stationary characteristics reduce the options to a small group.

A proposal method, based on adaptive filters, is considered as an alternative deconvolution process. These kinds of filters are a flexible tool, their simple structure allows easy implementations and fast processes. Also, the possibility to change the order of the filter provides a way to change their performance. The particularity of these filters is that they need to be trained to adapt their behaviour. Also, after the training, it is necessary to test their performance to other signals before using them in a real operation.

Adaptive filters have been applied on a cantilever beam model, as seen in Fig. 1., which has been subjected to impacts from two different diameter steel-balls, which are well characterized and have responses similar to a half-sine. Signals generated from the small-ball were used for training, and the rest were used for validation, as shown on Fig. 2. In order to test performance, three different adaptive filters, with different order (7, 12 and 50), were used to test the method. Results are shown on Fig. 3. It is clear that a small order leads to an erratic result, as can be see on Fig. 3 (top). The middle one shows a reasonable deconvolution result, with a signal similar to a half-sine and no ripples. The bottom figure shows a distorted signal. As the order increases, filters response deteriorates. In this case, a reasonable order would be between 12 and 50. Adaptive filters have been tested and showed good performance. Further tests are expected in futures experiments, applying the method to other systems and materials.

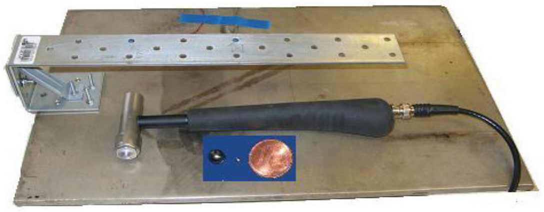

Fig.1 Cantilever Beam and steel-balls

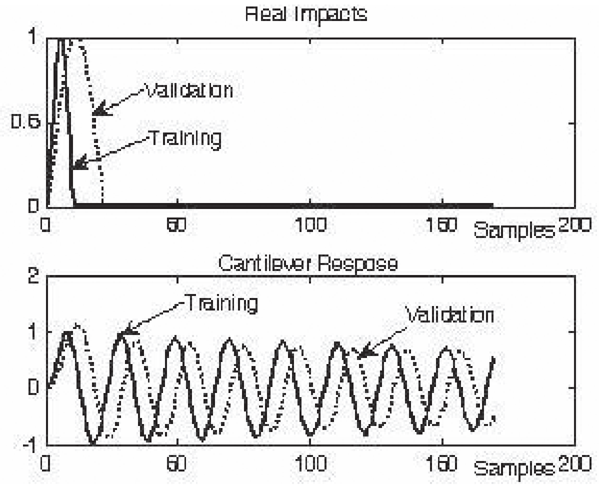

Fig. 2. Top: Impacts for training and validation. Bottom: Cantilever response when signal showed on top were applied.

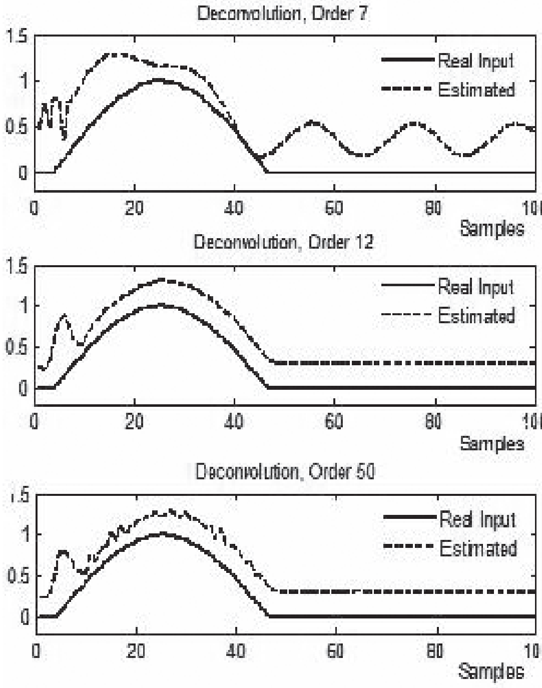

Fig. 3. Deconvolution results for different Adaptive Filter order (N=7, N=12, N=50) using the same validation signal.