# Identification of the Place and Materials of Knocking Objects in Flow Induced Vibration

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Many industrial systems contain pipes with fluid flow in it, either for transmitting materials or for cooling purposes. If some parts of the system detached or loosened it may go to either chaotic or deterministic motion due to forces gained from the flow energy. This motion is called flow induced vibration. If loose part knocks on the inner surface of the tube (or other compartment) then audible knock is generated. These are surface waves on the metal surfaces. The place of the knocks and the knocking material are crucial from the point of view of the fate of the given industrial objects. Therefore identification of the event, finding its place and identification of knocking material have primary importance form the point of view of the safety and maintenance of the system.

We investigated the improvement of the identification of the event recognition using autoregressive modeling based filtering [1] and sequential probability ratio test. While some parts of this technique had been elaborated earlier, the realization of those algorithms in LABVIEW and its integration into an embedded system are brand new developments.

For the localization of the place of the event, we investigated basically the time delay estimation methods. Time delays were estimated using cross-correlation technique and impulse response estimation. From the estimated time delays using linear measures of the piping system one can conclude the place of the knocks. However, besides the direct effect, i.e. besides the shortest route of the sound there are several other routes, reflections in the system, which in the case of repeated knocks can overlap with the arriving new front of the subsequent knocks. Selection of the arriving front were based on the physical nature of different fronts, however, this required an intelligent programming technique.

To give a hint on the material of the knocking objects we estimate the auto power spectral density function by dividing the frequency band into high frequency part and low frequency part. It was shown, that the ratio of these partial RMS values are different for knocking object of different materials. We present the first results of division of the APSD into four parts. It can be clearly seen, that this may improve the identification.

Finally, we discuss the possibility of introduction of neural network techniques into the process of identification of the place and material of knocking objects.

### References

[1] George E. P. BOX, Gwilym M. Jenkins: TIME SERIES ANALISIS forecasting and control, Holden-Day, 1976