Evaluation of thickness estimation methods for mechanical parts by analysis of ultrasonic signals A-scan, B-scan, C-scan

Abstract

Evident currently has its own non-destructive testing devices. They generate a 100V signal which requires a large battery. These devices are therefore heavy and bulky. Evident is looking to develop a new type of device, one that is lighter, less bulky and more energy efficient to facilitate the work of the operators. The aim of our project is to explore different methods of thickness estimation to make this possible.

Working Environment

Non-destructive testing (NDT) is a method of assessing the properties of a material, component or system without causing damage. NDT techniques are used in many sectors, including aerospace, automotive and manufacturing, to inspect defects, determine material properties and verify structural integrity.

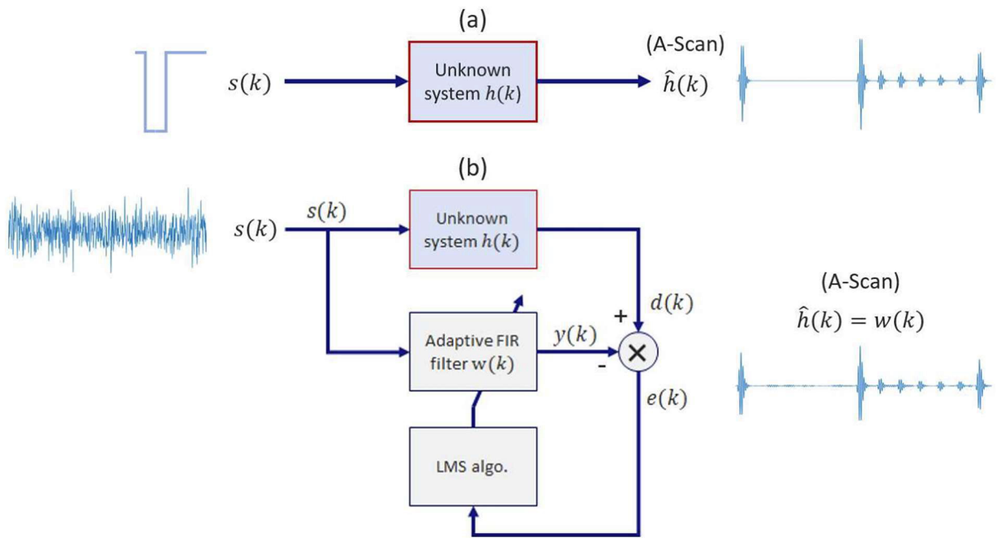
For our project it works by sending a pulse of ultrasonic waves through the subject and measuring the time it takes for the waves to travel through the different materials and return to the surface. Then it is possible to calculate the thicknesses of the materials by observing the echoes and knowing the properties of the materials.

Technologies Used

MATLAB® python™

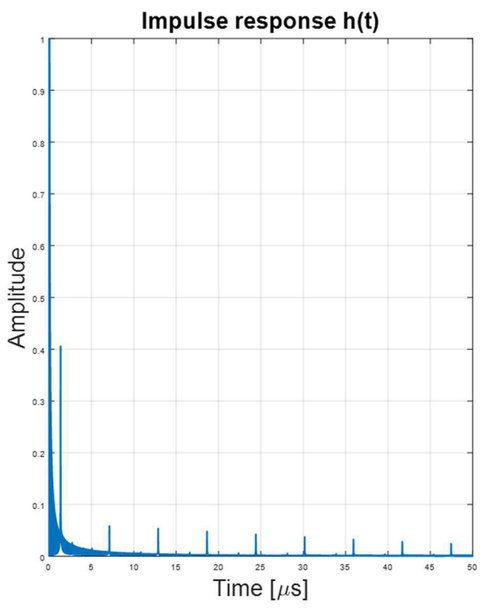
Adaptative Filtering

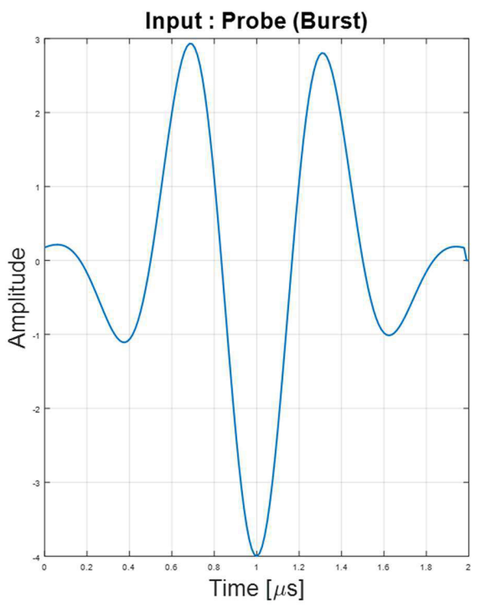
We use a method based on the use of wideband excitation signals and an optimisation method. Our optimization methods are the **Least Mean-Square** method (LMS), the **Normalized-Least-Squares** method (NLMS), the **Recursive Least Squares** method (RLS) and the **Wiener algorithm** with a FIR filter for the estimation of the A-scan.



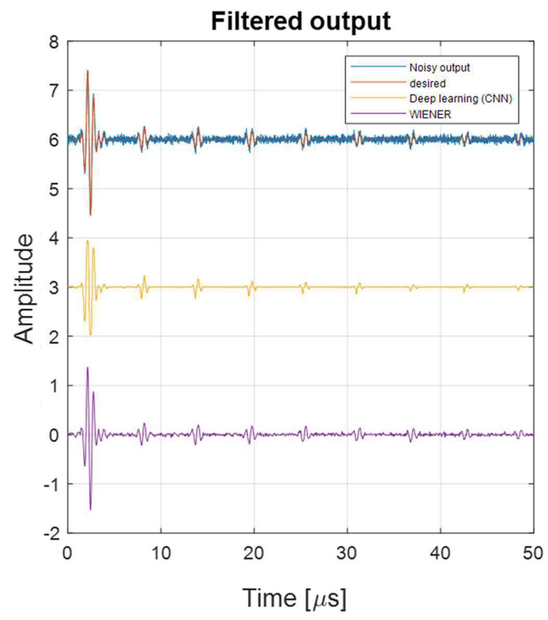
Basic structure of an ultrasonic NDT instrumentation: conventional approach (a), reconstruction by adaptive filtering (b)

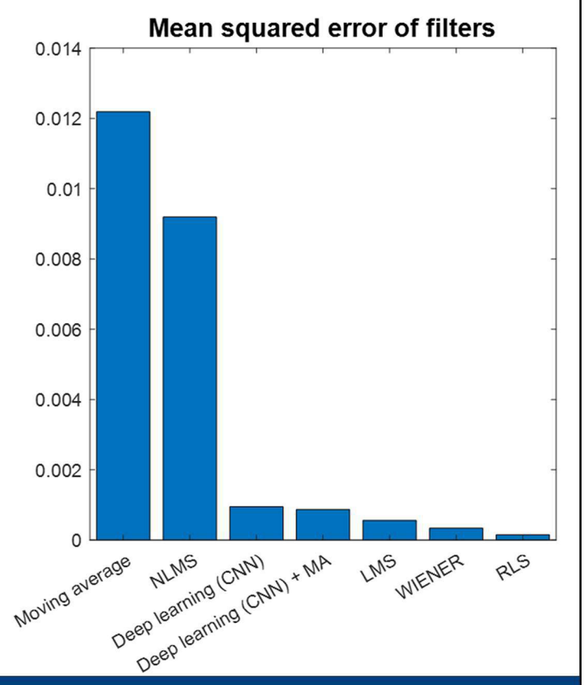
System and Input Signal Modelling



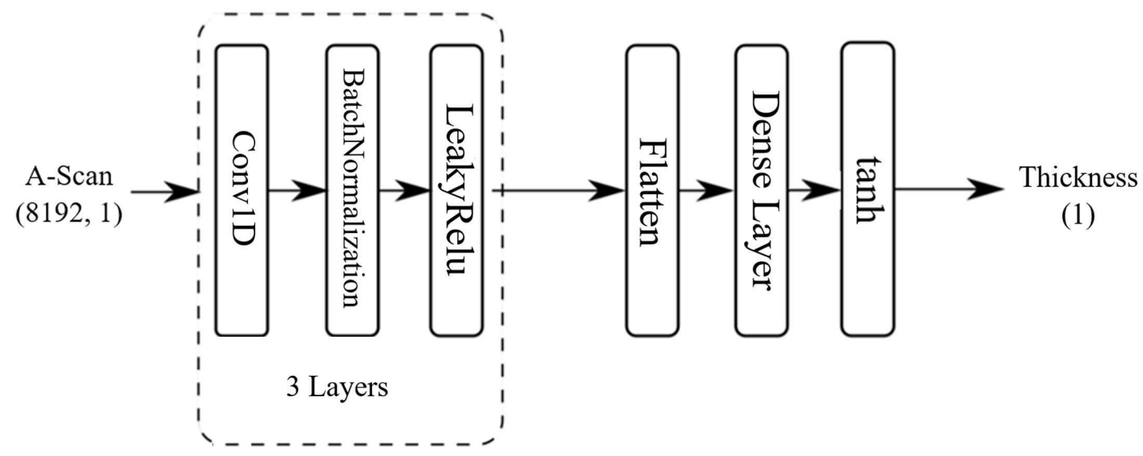


Denoising Methods Comparison

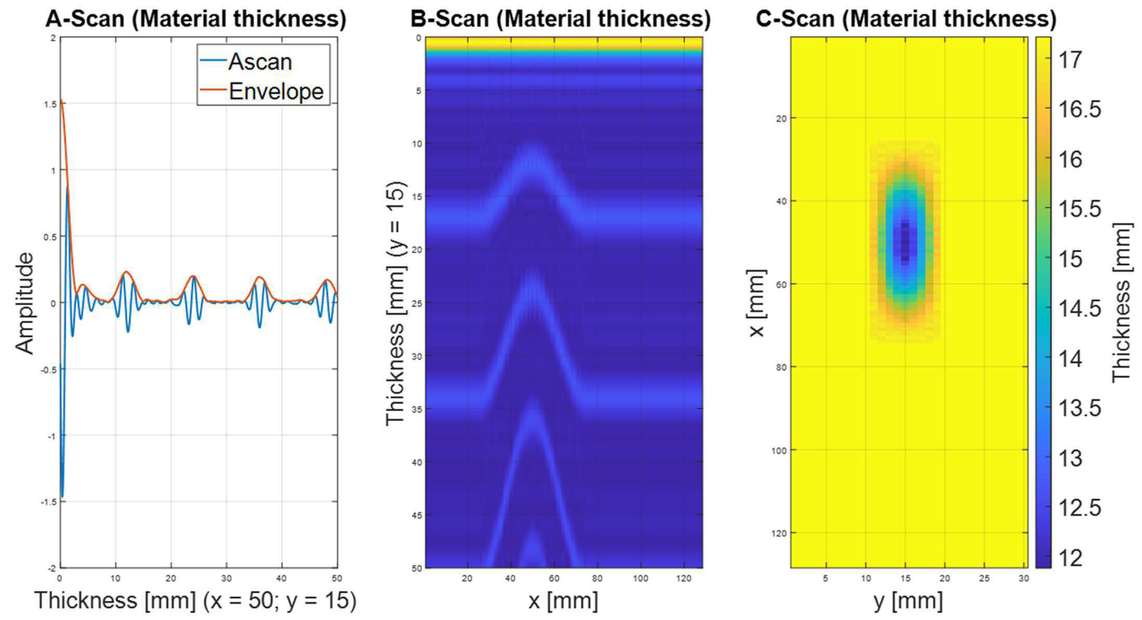




Thickness Estimation Methods



Material's thickness estimation using Deep Learning approach



Material's thickness estimation using peaks detection of Hilbert Transformation

Simulation App - User Interface

Configurable simulation with a comprehensive tool
Used to generate fully parameterised simulations

- Model parameters *(material types, layer thicknesses, multiples reflexions)*.
- Acquisition parameters *(sampling, attack signal)*.
- Optimizations parameters *(algorithm types)*.

Used to create its own database

Conclusion

Simulation of a non-destructive testing environment and allows to compare different methods to denoise our signals: LMS, RLS, NLMS, Wiener and Deep Learning.

It can also be used to estimate material thickness with peak detection method on the signal envelope and Deep Learning approach.

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