Ultrasonic Characterization of Materials with Applications in Bone Tissue Modeling

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This work is situated in the field of material properties identification using a frequency domain approach, with specific biomedical applications for characterization of bones tissues. The used of ultrasonic waves is justified by their non-ionizing behaviour, moreover they are cheap, easy to generate and to detect. For all these reasons they could offer a good alternative in bone health assessment, where X- Rays are still widely used. A typical case is the “bone aging” exam, where several children are subjected to X-Ray measurements in order to monitor the bone growth through the years.

In this doctoral research we aim to offer a technique based on ultrasonic waves that could be used for the bone age test. Hence, we started performing transmission measurements over homogeneous and porous materials using water–resistant plane transducers. The interaction between ultrasonic waves and these materials is explained with the help of acoustics wave fronts visualizations by means of Laser Doppler Vibrometer (LDV) measurements. The modelling technique, the identification algorithm, and the signal processing used during the test allowed one to estimate at the same time density, speed of sound, thickness and attenuation coefficient of the material under test. Eventually we adapted this technique for the study in vitro of bovine and human bones. For the latter, we introduced a method based on focused transducers, able to deal with the small surface offered by the test sample.