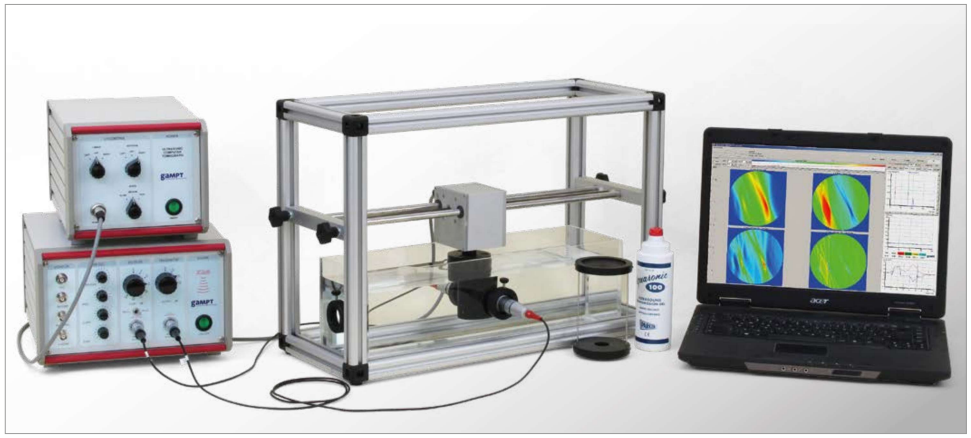
UE9020200
ULTRASONIC COMPUTER TOMOGRAPHY



EXPERIMENT PROCEDURE

- Record an ultrasonic CT image.
- Analyze different measuring parameters.
- Investigate the influence of filtering and image processing.

OBJECTIVE

Investigate the formation of an ultrasonic CT image and its relevant parameters

SUMMARY

The several steps of the formation of a computed tomography are illustrated. The difference between damping and sound velocity as measuring parameters is analyzed. The influence of filtering and image processing is investigated.

REQUIRED APPARATUS

Quantity	Description	Item Number
1	Ultrasonic Echoscope GS200	1018616
1	CT Controller	1017783
1	CT Scanner	1017782
1	CT Measuring Trough	1017785
1	CT Sample	1017784
2	Ultrasonic Probe 2MHz GS200	1018618
1	Ultrasonic Coupling Gel	1008575

BASIC PRINCIPLE

X-ray CT, MRT and PET are computer-aided imaging methods used in medical diagnostics, industry and research. Processes such as radiation absorption, nuclear magnetic resonance or particle emission are used to produce cross-sectional images by means of appropriately measurable physical quantities. Ultrasonic computer tomography is another CT method. It differs from X-ray CT in that instead of the attenuation of X-rays, the attenuation and times of flight of ultrasonic signals in the test object are measured. With the ultrasonic CT, line scans are recorded at different angles and put together to form a cross-sectional image. In this process, the sample arranged between transmission and receiving probe is moved and turned under computer control. The overlaying of the projections of individual scans can be followed step by step on the PC.

To form the image the attenuation of sound and the sound velocity are utilized. The attenuation coefficient of sound μ results from the measured amplitude A and the amplitude without sample A_0 after the law of attenuation:

(1) $$\mu \propto ln\frac{A_0}{A}$$

For the generation of the sound velocity tomogram the time of flight is used as the measuring quantity and the following is valid:

(2) $$c \propto \frac{t_0}{t}$$

where t_0 is the measured time of flight without the sample (the path length s is constant).
The sample (damping or velocity sample) is attached to the sample holder and by means of the scanner control is positioned exactly between the two sensors. Then the sample holder is moved half of the scanning way, the accuracy of scanning and the number of angle intervals are adjusted and the CT scan is started. During the measurements the individual line scans are observed and the generation of the tomograms by superposition of the projections of line scans is studied. The resulting images are optimized by means of various filters and by brightness and contrast adjustments, then the damping tomogram is compared with the velocity tomogram.

EVALUATION

The transmission signal (the diagram left above in Fig. 1) has been measured with regard to maximal amplitude and time of flight of the maximal amplitude and from this a line profile (scan at one angle, 500 µm point distance) has been built (diagram left below). The superposition by means of the CT-algorithm (25 angle intervals) yields for sound attenuation to the image left above (non filtered, contrast changed) and for the sound velocity to the image right above (also non filtered, contrast changed). Filtering the attenuation image improves the contrast so the edges become visible (reflection losses). The inner part hardly distinguishes from the surrounding water, in the sound velocity image (right) the sample and the inclusion are clearly visible as homogeneous regions of a different sound velocity.

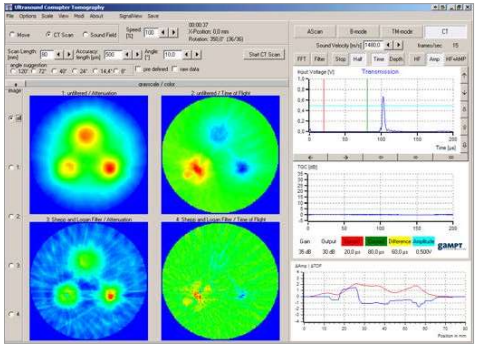


Fig. 1: Screenshot with attenuation and time-of-flight tomograms of the CT sample