Ultrasonics 2017, Demo Exercise 4.

Deadline 30.4.2017 23:59.

Schlieren demo

Problem 1

Explain the basic principles behind Schlieren photography:

- How does the direction of propagation of a light ray change when it travels through an optically inhomogenous (refractive index not constant) region?
- How is the Gladstone-Dale relation related to Schlieren photography?
- What do we measure and how this is achieved?
- What is the function of the knife-edge in a Schlieren setup?

Problem 2

Describe at least two different Schlieren setups

- How do they differ?
- What are the error sources?
- Pros and cons

Include also diagram pictures / drawings of these measurement setups

Problem 3

Find an article where Schlieren photography was used to obtain quantitative data of a pressure field (e.g. a shock wave). Write a short summary (max. one page) of the article. Focus on the following points:

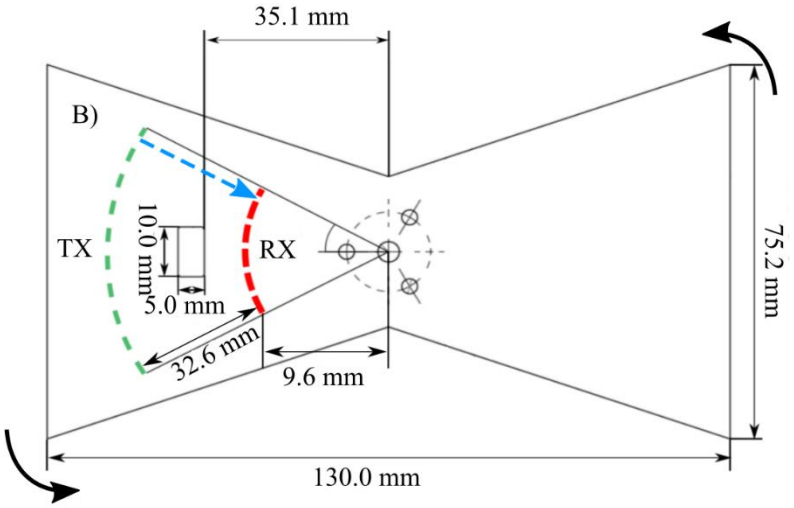
- What kind of a Schlieren setup was used?
- Was the Schlieren setup calibrated and how was it done?
- How was the quantitative data obtained from the Schlieren image?

An excellent source of information for problems 1 and 2 is the book “Schlieren and Shadowgraph Techniques” by G.S. Settles.

Lamb waves

Exercise 1: What is a Lamb wave? What kind of boundary conditions are required to derive the dispersion curves for Lamb wave propagation? Explain the difference between the different wave modes.

Exercise 2: You want to study the variety of reindeer populations in Lapland with your new drone. To quickly assess the structural integrity of your propellers you use a laser ultrasound system. A laser Doppler vibrometer (LDV) measures Lamb wave amplitude (RX) and a Nd:YAG excites them (TX). In the end of the day you detect a pit in one of the blades $10x5x2.4\ mm^3$ in size.



Assume that the propeller is $130x75.2x4\ mm^3$ in size, the group velocity of the fundamental antisymmetric mode in the undamaged region $\mathrm{v_g} = 3180\ \mathrm{ms^{-1}}$ and in the damaged sector $1686\ \mathrm{ms^{-1}}$. Following the figure calculate the time difference on the arrival of the Lamb waves (blue arrow) between the waves that travel in the intact region to those that propagate through the defect.