Microwave Low-Coherence Interferometer

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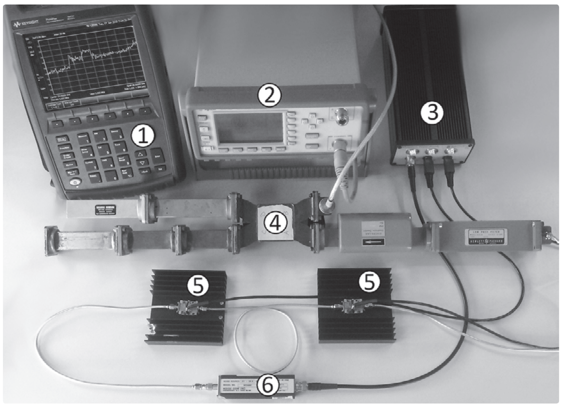
On today's market there exists a multitude of LCI's (Low-Coherence Interferometer), which are usually used in the medical field. Most of these devices work with a spectrum within or near the visible light, to measure distances with high precision. The idea behind this thesis is to test the possibility of using microwaves to realise such a device, as well as to develop improvements and investigate possible applications for such a system.

Introduction
A LCI can only measure matter that is partially transparent for the utilised wavelengths. The matter has to be transparent to some extent, or otherwise there couldn't be gained any depth information. Total transparency on the other hand would fail to return a signal and with that, make measurements impossible. Microwaves used in a LCI offer more and different wavelengths in the millimeter and centimeter range, compared to visible light that has a nanometer range. Additionally microwaves are reflected by metal, which allows the possible detection of metallic structures like cables for example, within matter.

Goal
For the first step of this thesis the feasibility and functionality of a microwave based LCI was verified. After the functionality was proven, the device was modified to improve the signal quality and the overall properties of the device, to make it useful for potential applications. The required measurements were performed with the prototype microwave LCI, shown in the image.



1: Network analyzer, 2: Power sensor, 3: Power supply, 4: Interferometer, 5: Amplifier, 6: Noise source

Implementation
To determine the functionality of the system, the microwave LCI was first regarded as a regular OCT (Optical Coherence Tomography) device, since both microwaves and visible light are electromagnetic waves. With this substitution, several defining parameters, like the systems resolution for example, could be determined theoretically. These theoretical calculations were later used as a reference value for the performed measurements on the prototype, to verify the functionality of the system and to test the applicability of the OCT theory on a microwave based LCI.
Multiple experiments have been done to determine the characteristics of the elements in the setup, like filters and isolators. Furthermore one of the tested improvements was to fill the hollow waveguides with different dielectrics to improve the resolution of the whole measurement system.
Besides the improvements to the system and its components, an optimised device should also be capable of measuring objects. This means that it needs a targeting system. The research and development of the antenna system for the microwave LCI formed the last part of this thesis. As such and as antennas are well researched, the improved antenna for a precise targeting system was done only theoretically.

Results
A microwave based LCI works just as the theory suggested, however, compared to a OCT device, the realised prototype has a much lower resolution, with its 3.5 centimeters that can be distinguished. This changes the possible uses for such a device in the way, that it can't be used to analyse small elements, but it is capable of measuring big objects and structures that cannot be measured with visible light.

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