Master Thesis

Microwave Sensing of the Moisture Content of Tree Trunks

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Topic description:

With the increasing number of very dry weather periods in many areas on earth, the early detection and prevention of forest fires becomes more and more important. Ideally, it would be even desirable to have a means to identify those forest areas where the danger of a forest fire is large. One way to judge the vulnerability of trees to fire is to measure the moisture content in the trunks of the trees. If this moisture content gets very small the vulnerability of the tree for fire becomes large. Consequently, an early warning system for forest areas with a high chance of a forest fire could consist of moisture sensors for some of the trees in a forest. Such moisture sensors have been investigated already, by using the so-called impedance tomography approach. Here many electrodes are drilled into the trunk of the tree and the impedance between different electrodes is measured, mostly for low frequencies. An issue with this approach is long-term reliability. The measured impedance depends strongly on the contact of the electrodes with the tree trunks and this contact changes due to resin production of the tree. The goal of this master thesis is to investigate contact less microwave sensors which are able to determine the moisture content of the tree. In a first step, possible sensor concepts shall be identified and evaluated with respect to their suitability. In parallel to this, an electromagnetic simulation model of a tree trunk needs to be set up which resembles the biological properties of the trunk as good as possible (e.g., in form of a layered cylindrical model representing bark, core, etc.). Based on the tree trunk model, the different sensor concepts shall be investigated with respect to the sensitivity to the trunk moister, but in the course of the thesis measurements shall also be performed in order to validate the simulation results. Measurements for the understand of sensors concepts can be performed by used a network analyzer with different sensing elements, but it might also be possible to work with commercially available radar evaluation boards.

Topic areas: Microwave sensing, electromagnetic modelling, microwave measurements, biology of trees

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