Multi-Channel RF Signal Testbed

Graduate Candidates

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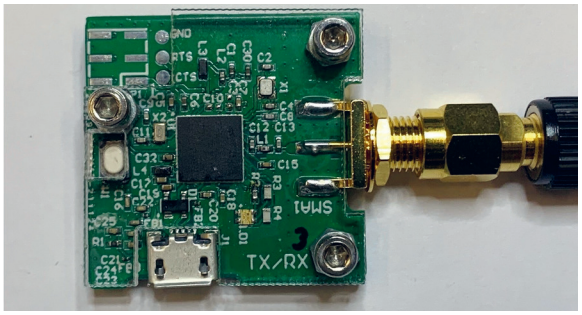
Introduction: This thesis investigates estimating the material properties of an object inserted into a radio channel based on the change of received signal strength. The electrical material characteristics of the object lead to attenuation of the signal, as it travels from the transmitter through the object to the receiver. By observing the progression of the received signal strength indicator (RSSI) on the receiver end, it may be possible to infer the material properties of the object in between the antennas.

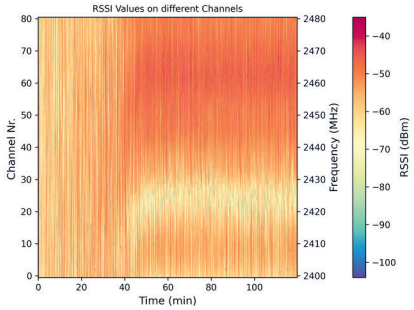
Approach / Technology: A measurement setup with suitable low-cost transmitter and receiver is developed. It is operating in the 2,4 GHz ISM band and able to utilize all dedicated Bluetooth channels to send and receive signals. A Python script is handling the entire setup, including setting the transmitting power, switching channels, logging and visualizing the RSSI progression, and executing suitable post-processing algorithms in order to observe the change of the object's material parameters. To obtain sufficient data for post-processing and estimation model development, the signals are transmitted several times per minute via each channel as the material parameters of the object in the radio channel change.

Result: The RSSI progression can be successfully measured and logged on a computer. The resulting noisy data is filtered, and fitted via suitable curve fitting methods to model the change of the object's material properties, and finally graphically displayed as RSSI time plot or heat map. By analyzing the data obtained and processed in this way, some unique features that allow for the detection of certain material changes based on the RSSI measurements are identified.
To apply this measurement procedure to live data, a set of reference measurement data is collected, which is then used to estimate a model that links the measured RSSI data to the associated material properties. At the current stage, the desired material parameter can be estimated with an accuracy of 5%.

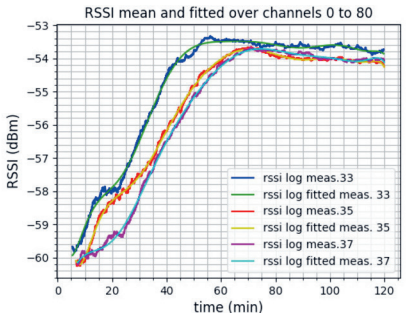
The designed hardware
Own presentment



Heat map of RSSI measurement no. 33
Own presentment



RSSI values of three different measurements
Own presentment



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Subject Area
Wireless Communications