



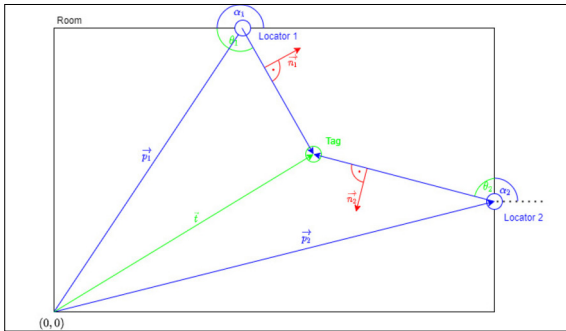
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Subject Area	Wireless Communications

Positioning with Bluetooth Direction Finding

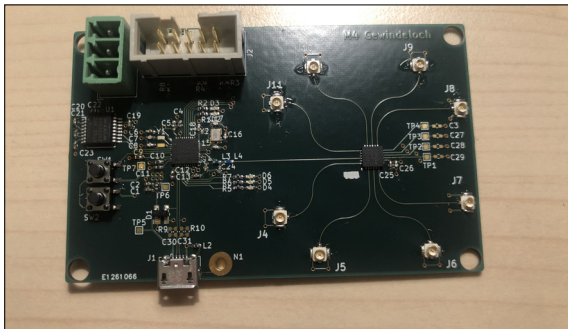


Concept of Bluetooth Angle of Arrival localization
Own presentation

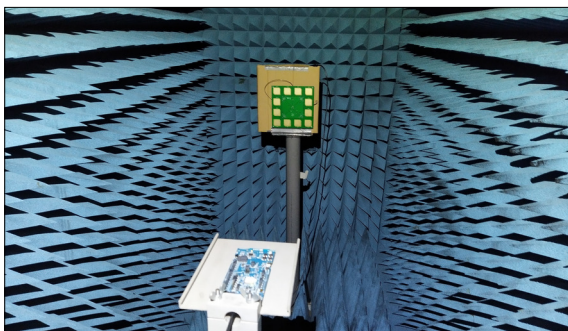
Introduction: The object of this thesis was to evaluate the new Bluetooth 5.1 Direction Finding feature, and discover its capabilities and boundaries. Direction Finding utilizes the idea of Angle of Arrival or Angle of Departure. The goal of this thesis is to achieve two-dimensional positioning. By measuring the angles using two antenna arrays the position can be estimated.

Approach: As starting point a Bluetooth 5.1 capable development board was used. IQ data, collected from the antenna arrays, is utilized to find the Angle of Arrival. The calculated angles are then sent to a PC, where the data is filtered and the position is estimated. The position and angles can then be displayed in a GUI. The Bluetooth specification does not consider a method to calculate either the angle or position, so an algorithm was developed. This algorithm was tested in simulation and on the test hardware. To replace the development board, a custom hardware was designed, which is capable of supporting a generic antenna array with up to 8 antennas.

Result: Measurements in the anechoic chamber showed that the Angle of Arrival estimation works properly within an error range of two degrees. The dynamic error is very low, so the filtering generates sufficient results within angles of 30 to 150 degrees in ideal conditions. This shows that the concept of Bluetooth Angle of Arrival works. In a real environment effect such as multipath or interference of other sources can impede a successful localization. To resolve multipath issues, more advanced algorithmic should be implemented. However within certain constellation proper localization can be achieved with a precision of 10 centimeters.



Custom Hardware
Own presentation



Measurement in the anechoic chamber
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