

# Localization in Wireless Sensor Networks

## Summary

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### Introduction

Localization in wireless sensor networks (WSN) refers to determining the physical coordinates of sensor nodes of the WSN. Knowing the coordinates of all or some sensor nodes is a key-enabling information because it might make sensed data meaningful. Furthermore, determining the physical location of nodes might be the sole purpose of the WSN. An example for the first might be warehouse logistics where in addition to temperature and humidity, the location of boxes is critical, since it might or might not trigger safety mechanisms. Another example might be an (indoor) search-and-rescue operation of multiple drones, where each drone is considered a wireless sensor (having e.g. FLIR), whose location is important to find and rescue persons. Conventional localization such as GPS or taking advantage of cellular networks is not an option due to the necessary hardware and energy footprint.

WSN-approaches classically fall in one of the categories (a) centralized vs. distributed, (b) range-based vs. range-free or (c) anchor-based vs. anchor-free. These categories describe whether (a) a centralized base station is involved or whether many nodes share computation loads, whether (b) physical distance between nodes is measured or (c) whether some dedicated (anchor-)nodes do know their location as a preset information (e.g. by using GPS), which is then used by the others to determine theirs.

### Techniques

Among many well-known techniques, this presentation focuses on range-based techniques, because they are predominant and well described. Most prominently the received signal strength (RSS) can be measured by received signal strength indicators (RSSI) to determine the distance from one node to another. This information can then be used for instance in time-of-arrival (TOA) or angle-of-arrival (AOA) procedures to determine the location of nodes. Also the well-known trilateration and angulation-techniques can be applied to determine location of nodes.

### Algorithms

According to a paper from 2013 as many as 50 different localization algorithms for WSN were described. Using a similar categorization for algorithms as the one described earlier, six categories for localization-algorithms for distributed WSN are highlighted. Three examples for one of these categories (the anchor-based algorithms) are (a) the Bounding-Box-algorithm, (b) the Gradient-based algorithm and (c) the APIT-algorithm. All of those use information from anchor nodes as well as from neighboring nodes to determine a nodes location. Decision on which algorithm to choose depends on the required resources and the available resources, such as computational load, communication load and of course the power footprint.

### Conclusion

The topic of WSN is both well researched and applied in many practical industrial and personal domains. Though, there is room for further research and improvements for instance in high density WSN or when considering the practical relevant three-dimensional space rather than the theoretical two-dimensional space. Also, considering mobile sensor nodes imposes several challenges regarding the localization within the network.