Localisation of Wireless Signals

Coursework Part-B

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EE401: Advanced Comm. Theory

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1 Task-1 TOA&TDOA Localisation

1.1 TOA Localisation

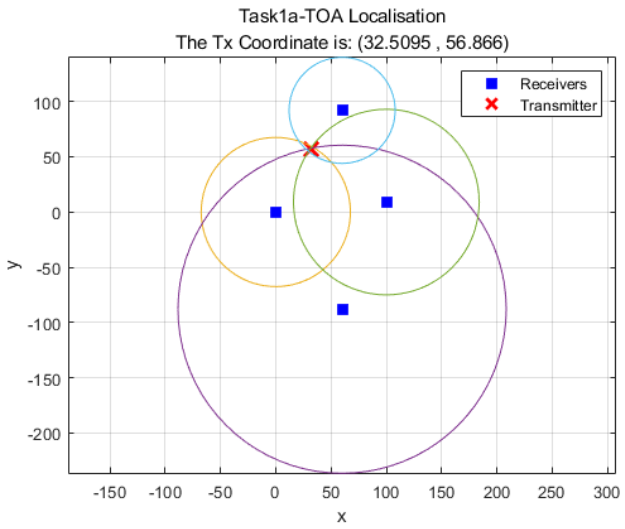

Figure 1: TOA Localisation

The Time of Arrival (TOA) algorithm is a localisation algorithm based on the estimation of distance ρ between Tx and Rx. Loading my personal data, the estimated coordinate of Tx is (32.5095, 56.866), shown in Figure 1. The circle in Figure 1 represents the estimated distance ρ.

1.2 TDOA Localisation

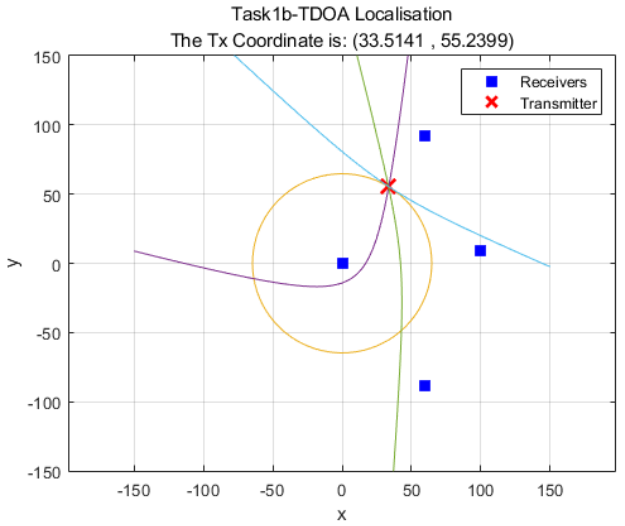

Figure 2: TDOA Localisation

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The TDOA (Time Difference of Arrival) localization algorithm is a method used to determine the position of a source (Tx) by measuring the difference in TOA of a signal at Rx. Loading my personal data, the estimated coordinate of Tx is (33.5141, 55.2389), shown in Figure 2. The circle and hyperbolas in Figure 1 represents the estimated distance ρ_1 between Tx and Rx1, and different distance ρ_{1i} from Tx to the Rx1.The position of Tx is estimatd at the intersection point where the circle and hyperbolas converge.

2 Task-2 RSS Localisation

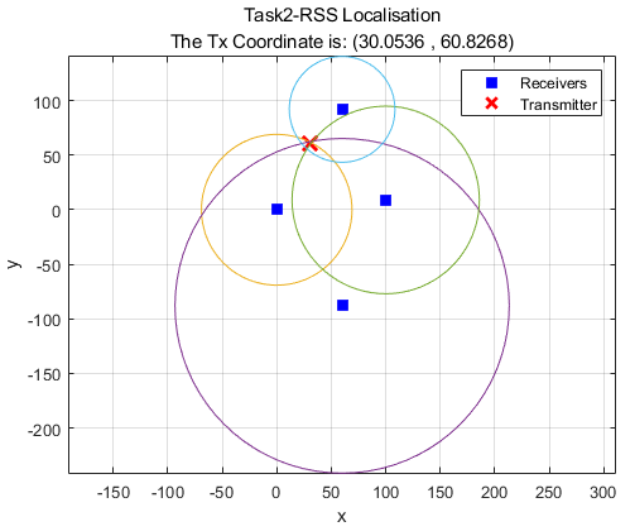

Figure 3: RSS Localisation

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RSS (Received Signal Strength) or RSSI (Received Signal Strength Indicator) Localisation is a algorithm that estimates the location of Tx based on Friis equation to calculate the strength of received signal from Rxs. Loading my personal data, the estimated coordinate of Tx is (30.0536, 60.8268), shown in Figure 3. The distance ρ between Rx and Tx is estimated by the received strength power of signals and be represented as the circle in Figure 3.

3 Task-3 DOA Localisation

DOA (Direction of Arrival) determines the location of a Tx by measuring the DOA at each Rx by MuSIC algorithm. Loading my personal data, the estimated coordinate of Tx is (32.9641, 54.745), shown in Figure 4.

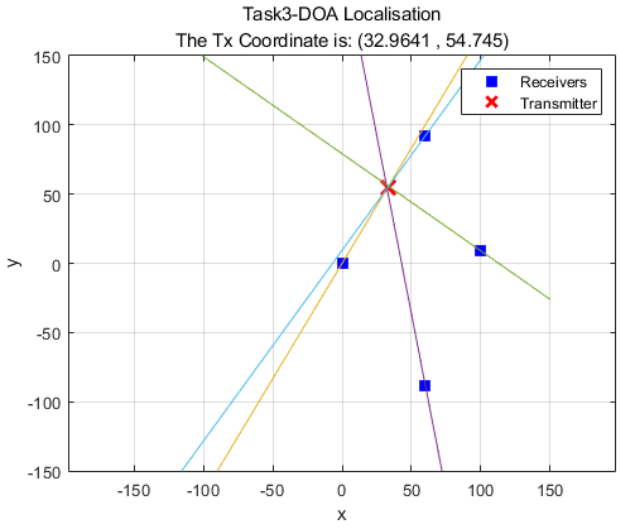

Figure 4: DOA Localisation

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4 Task-4 LAA Localisation

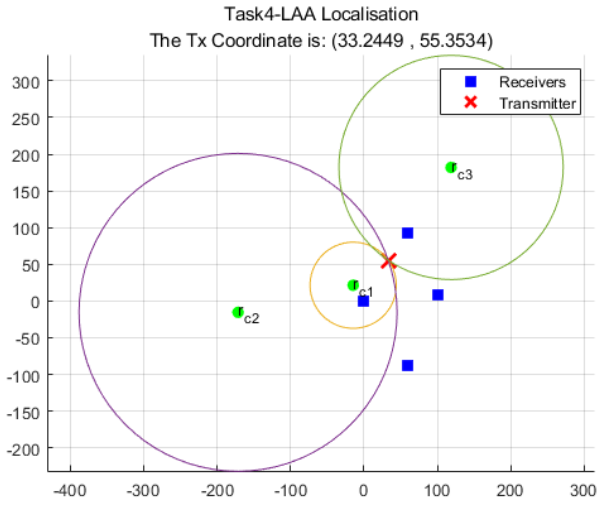

Figure 5: LAA Localisation

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The LAA (Large Aperture Array) Localization algorithm estimates the location of the Tx by analyzing signals received at various reference points within the large aperture array. In the LAA metric fusion stage, the location of reference point $\underline{r}_i \in \mathbb{R}^{3\times1}$ and radii R_{ci} of these loci can by defined as following[4]:

$$\underline{r}_i = \frac{1}{1-K_i^2}\underline{r}_i - \frac{K_i^2}{1-K_i^2}\underline{r}_1 \quad i = 2, 3, \ldots, N \tag{1}$$

$$R_{ci} = \left| \frac{K_i}{1 - K_i^2} \right| \cdot \|\underline{r}_1 - \underline{r}_i\| \quad i = 2, 3, \ldots, N \tag{2}$$

The location of the transmitter (Tx) can be determined at the intersection of loci, each defined by a radius of R_{ci}. Loading my personal data, the estimated coordinate of Tx is (33.2449, 55.3534), shown in Figure 5. The circle in Figure 1 represents the estimated loci.

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References

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[4] A. Manikas, Y. I. Kamil and M. Willerton, "Source Localization Using Sparse Large Aperture Arrays," in IEEE Transactions on Signal Processing, vol. 60, no. 12, pp. 6617-6629, Dec. 2012, doi: 10.1109/TSP.2012.2210886.

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[6] Tse D, Viswanath P. "Fundamentals of wireless communication[M]". Cambridge university press, 2005.