# Numerical Study of Source Localization using TDOA

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The time difference of arrival (TDOA) method is a well-known method for localizing a radiating source, such as an electromagnetic source. The method relies on the fact that in a free-space environment the time-of-flight between the source and an observer is simply given by the distance divided by the speed of light. For localization in two dimensions, as where the source is located on the surface of the earth at an unknown position $(x,y)$, a minimum of three receivers is needed in the absence of noise. Localization in the presence of noise is based on the minimization of the square error between the measured TDOA between each pair of receivers (multiplied by the speed of light) and the difference in distances between the source and the corresponding pair of receivers.

In this study we examine the localization accuracy using a simple dipole source radiating a carrier wave that is modulated by a lower frequency baseband signal. The TDOA for a pair of receivers is estimated by using a cross correlation between the received signals at the two different receivers.

The localization accuracy is studied in the presence of realistic constraints such as background noise (white additive Gaussian noise), as well as sampling rate and bit quantization error in the analog to digital conversion (ADC) that is used in the cross correlation. The localization accuracy is also studied as a function of the number of receivers and the location of the receivers.

As expected, the localization accuracy improves as the signal-to-noise ratio (SNR) increases. The localization accuracy is also studied as a function of the various system parameters such as the number of receivers, the position of the receivers, the sampling rate, and the bit quantization error. This allows for practical conclusions to be drawn about the system parameters. For example, it is useful to know what the sampling rate needs to be in order to achieve an accurate localization for a given SNR.