# Advanced Techniques for Acoustic Positioning

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**Abstract**

Classical, both military and commercial underwater acoustic positioning is dominated by very advanced digital signal processing techniques. This tutorial will review the basic principles of the most common methods, including: "Long Baseline", "Ultra Short Baseline", "Short Baseline", and "Doppler".

## Introduction - Back to the Basics

If you want precision, you - no longer - an underwater object (or beacon) has to have distance data.

Underwater acoustic positioning systems are based on measuring the distance between a transmitter and a receiver (or pairs of receivers) and then using simple geometry to determine the position of the receiver (or transmitter). Typically, the geometry is a set of coordinates (or bearings and/or ranges) in "polar" or "cartesian" coordinates (or bearing and/or ranges).

Underwater acoustic positioning systems are based on measurements of travel time of transmitted hydrophone and/or pulse (or tone) acoustic signals. Typically, the transmitted signal is a short pulse of a single frequency sinusoidal signal. Typically, the received signal is a time-shifted, and attenuated version of the transmitted signal. Typically, the time-shift is proportional to the distance between the transmitter and receiver.

A "Ranger" or other hydrophone receiver (see sketch) can measure slant range distance data to the ship (i.e. by measuring a time-shift and/or phase-shift of the received signal). Typically, the "Ranger" or other hydrophone receiver (see sketch) can also measure the bearing to the transmitter (see sketch). The ship can also measure its own pitch and roll angles (see sketch). The ship can also measure its own heading (see sketch). The ship can also measure its own depth (see sketch). The ship can also measure its own precise Frequency transmission (or not). The technical jargon/cute name for this system/sensor "roll your own" is Fetch-a-rock-bearer-pitch-roll-depth-freq-ranger.

The set of data (slant range, bearing, pitch, roll, heading, depth, and frequency) can be used to determine the position of the "Ranger" or other hydrophone receiver (see sketch) with respect to a ship (see sketch). Typically, the "Ranger" or other hydrophone receiver (see sketch) is towed behind a ship (see sketch).

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The technical jargon/cute name for this system/sensor "roll your own" is Fetch-a-rock-bearer-pitch-roll-depth-freq-ranger-search-lost-object-in-ocean-find-lost-object-in-timely-manner-recover-lost-object-intact.

Not all of the "Ranger" or other hydrophone receiver (see sketch) data is good. Some of the data is bad. Typically, the "Ranger" or other hydrophone receiver (see sketch) generates a great deal of bad data. Typically, the "Ranger" or other hydrophone receiver (see sketch) generates a great deal of bad data in the form of "spikes".

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