



The total dead-reckoning error accumulated during the time between position fixes (fix interval) is a result of errors in along-track and cross-track velocity measurement and the error in azimuth measurement. Geometrically, this total error comprises two orthogonal error vectors. One vector is colinear with the direction of the shortest distance between each pair of position fixes. This component is basically the result of the error in the fore-aft or along-track velocity measurement. The orthogonal component combines the error in the port-starboard or cross-track velocity measurement and the error in measurement of the ship's azimuth. The heading error expresses any misalignment between the gyrocompass and the fore-aft direction as determined by the sonar beams. Thus, the error components are a direct and separate measure of average along-track and cross-track velocity errors. By prorating the vector magnitudes to the direct distance between fixes, we obtain relative or percent error factors.

Analytically, the total dead-reckoning error can be separated into total velocity error and heading error. In this, it is assumed that the relative errors in all velocity measurements are caused by the same sources, and higher-order cross-terms between velocity and heading error are ignored. The assumption is correct as far as the doppler sonar instrumentation is concerned and is plausible with respect to any environmental error sources.

Let

K = relative error in velocity measurements

θ_e = absolute heading error

Then

$V_{\text{true}} = (1 - K)V_{\text{meas}}$, true velocity

$\theta_{\text{true}} = \theta_{\text{meas}} - \theta_e$, true heading