MPPs of Consecutive Running Fixes

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Several responses from my 23001 post suggest that some clarification would be useful. So we'll start at the beginning, at our point of departure where we know our position accurately. After a run of some length we are at a DR location having some uncertainty. This uncertainty could be quite different in different directions. For example a very accurate log with very uncertain currents could yield different uncertainties in different directions. Although we're not considering the art of DR here, we are very much considering that we have some knowledge of the expected DR accuracy. With no other information we'll assume a circular distribution of DR error (Figure 1 below) for our example. When known, other shaped distributions can be easily considered, but they are irrelevant for this discussion.

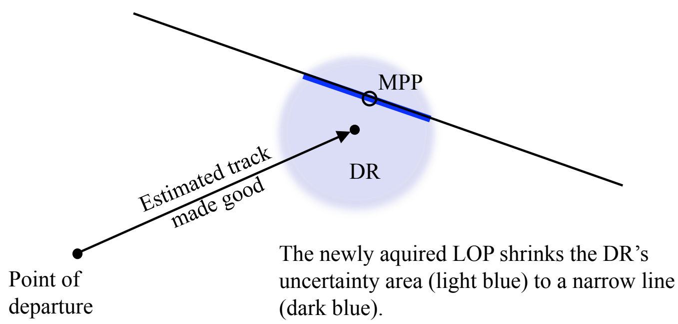

Fig. 1 A LOP Aquired at a DR Position

At a given DR location shown above, we acquire a LOP that has significantly greater accuracy than our DR information. This is the case of a celestial LOP after a long DR run in a typical ocean cruising sailboat. (It's not the case for a round of sights taken over a short period on a moving ship.) In this example, the LOP will shrink the DR uncertainty back to the smaller dark-blue area with a width of a couple of miles, centered on the LOP (as shown above). The dark-blue line is the closest possible location to the DR, while still being centered on the more accurate LOP. Only the length of this line is determined by the size and shape of the DR error distribution. The circular symmetry of this particular DR error distribution places the MPP in the center of the dark blue line, as shown in the figure.

This simple example demonstrates the common-sense principles of rational inference: (1) We use all available information – in our case, the knowledge the DR track made good and its uncertainty, and if we knew more about that uncertainty distribution, we'd use that too. We use the new LOP to update our position, including the likely error distribution of a mile or so on each side of the LOP, which we know from many previous sights taken from known location. (2) We've assumed nothing. And (3) We have no contradictions.

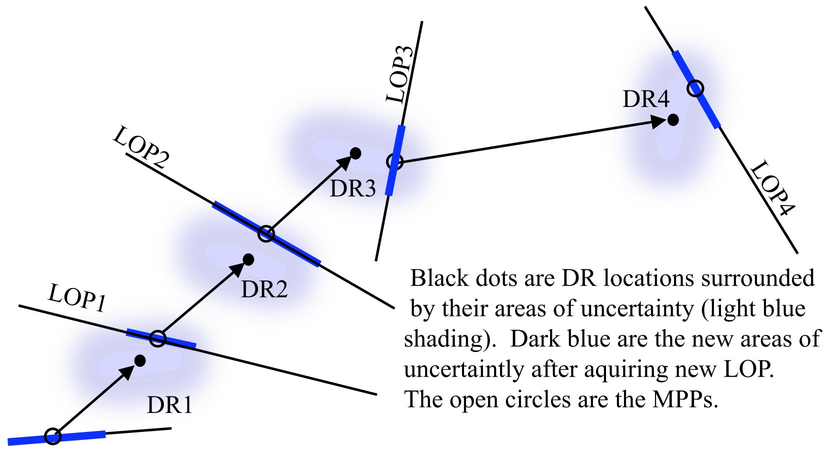

Fig. 2 MPPs of Consecutive Running Fixes

The estimated position running fix (EPRF), shown above, uses exactly the same ideas as in Figure 1. Starting in the lower left-hand corner with the first MPP after departure, we plot DR1 with it's error distribution. Note that the error distribution from the first LOP has now grown from its relatively thin line (in dark blue) to a larger oval-shaped area (light blue). With no other information its uncertainty grows equally in all directions, maintaining its oblong shape. Hence its orientation remains constant, with its long axis parallel to the LOP that originally determined it. Again. The new updated MPP lies in the middle of the uncertainty along the new LOP because we have no information to the contrary.

As shown in the plot, successive dead reckoning and LOPs are handled the same. As we navigate along, the larger light-shaded areas of DR uncertainty are continually shrunk back to the smaller dark-blue areas, constrained by the comparatively much narrower widths of the most recent LOP. This navigation is completely independent of LOP orientations, taking advantage of LOPs of all orientations – those at small angles to the previous LOP, and even parallel successive LOPs. After all, shouldn't any LOP, regardless of orientation, improve the position estimate? This EPRF uses all available information, make no assumptions, and has no contradictions.

Estimated Position Fix Compared to Traditional Running Fix

In Figure 3 below, we show the advanced LOPs (in green) of the traditional running fixes (TRF) compared to the EPRF. In all cases the TRF is farther from the DR than is the MPP of the estimated position, but approaches the same distance as the two LOPs approach 90°, as seen in the DR3/LOP3 fix.

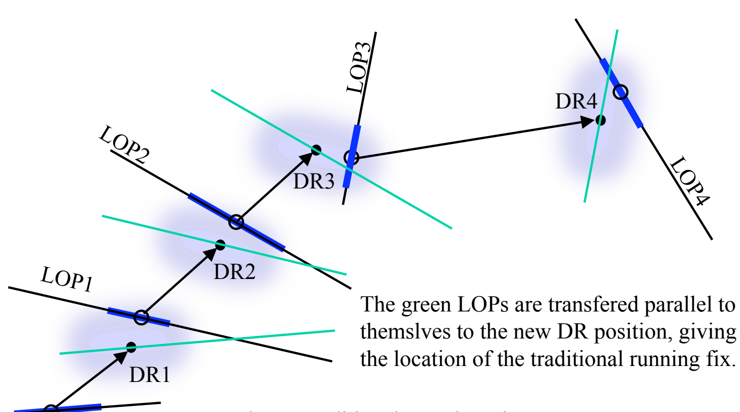

Fig. 3 Traditional Running Fixes

We can see in Figure 4, below, that locating RFIX at the intersection of LOP2 and the advanced LOP1 presumes the DR error is zero perpendicular to LOP1, while the DR error is unlimited parallel to LOP1. So while the TRF logic ignores thoughts of error distributions, it inherently assumes the DR error must be as marked by the thin dark-blue line along the advanced LOP1. The figure compares this assumption to the error distribution used in the EPRF. Note well, that this thin blue-line of the TRF, which represents the DR error uncertainty, is determined completely by the orientations of the LOPs and is completely independent of our DR skills and knowledge. Should we call this an outrageous assumption or call it a contradiction?

Now, which seems more rational in estimating our DR track made good? Do we need to take into account (the best we can) effects in all directions: current, drift, accuracy of distanced logged, and heading maintained. Or should we be convinced that the orientation of the LOP (taken some time ago, maybe even days ago) should dictate that only one component of the DR is valid? And furthermore, that its direction has nothing whatsoever to do with the variables of estimating DR track error? Unwarranted assumption or contradiction??

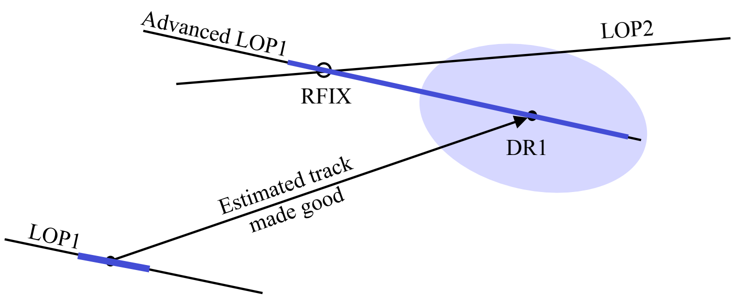

Fig. 4 The traditional RFIX assumes the track error is zero perpendiclar to LOP1 and is unlimited parallel to LOP1.

As we pointed out above, these two approaches to the running fix can give very different results for LOPs crossing at small angles, but they become identical (Figure 5 below) when the two LOPs are at right angles. But it's only in the estimation approach, that a fix outside the expected DR (as below) warns us to reevaluate the expected uncertainties in the LOP and DR position.

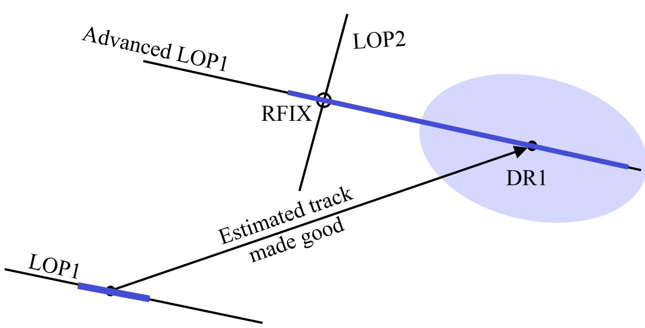

Fig. 5 When the LOPs are perpendiculaular, the inference rational and the traditinal thinking give the same result.

Most traditionalist will say this is all irrelevant. They'll say just don't use LOPs that aren't near right angles to one another. But does a good navigator throw away perfectly good position information, just because he prefers something that's not available?? Does he allow unwarranted assumptions, contradictions?? Traditions die hard, new thinking gives birthing pains.