US Navy Technologies Advance Science of Positioning

As the US Naval Observatory, which provides nearly half the global contribution to Coordinated Universal Time (UTC), shifts from a cesium to a rubidium standard atomic clock, we look to gain an order of magnitude in time precision from tens of nanoseconds to tens of picoseconds.<P>

Since we are talking about thespeed of light, spatial precision has a linear relationship with time precision and we can expect unprecedented spatial positioning precision as our time standard improves. This new spatial precision will be available to users through GPS III.

In the interim, hydrographers seek to continually optimise the dynamics and kinematics that improve the positioning for navigation resources currently in orbit. So while GPS III is still in the offing for navigation precision, and multi-beam, LIDAR and interferometric side-scan data have exponentially increased the coverage and resolution of the sea bottom, the question remains – how are we rendering the spatial precision of multi-resolution geospatial data?

The traditional product of a hydrographic survey has been the smooth sheet, which is the result of a thinning process where navigationally significant soundings are selected to support chart production at a particular scale. Much of the fidelity and resolution of the bottom, now surveyed with high-resolution sensors, is lost in the current charting processes. Selected soundings from multi-beam surveys are those having the greatest systematic errors in the shoal direction. The result is a shoal-biased model, which does not always result in the most accurate representation of the bottom.

Answering that challenge provided a unique opportunity for the Naval Oceanographic Office to operationalise a global bottom model that can seamlessly integrate both deep water, bathymetric and shallow water, hydrographic data holdings. This new model is based on some very good work done by the University of New Hampshire and it is called the ‘navigation surface’.

Until recently, the Digital Bathymetric Data Base – Variable Resolution (DBDB-V) has served as the Navy’s premier model for deep-ocean bathymetry. It is a database of grids with an Application Programmer’s Interface (API) and a Graphical User Interface (GUI) for extracting models of varying resolution. It has a foundation layer of a two-minute global grid derived from satellite altimetry. It contains grids of higher resolution data developed as a result of the production processes generally to support subsurface navigation in deep water.??With the increased availability of high-resolution shallow-water collection systems, DBDB-V version 5.x was enhanced to allow population of very high-resolution data down to one-meter grid-spacing. This allows bottom models to be developed at near full sensor resolution. The DBDB-V was also enhanced to include quality indicators to be stored at each grid cell.

Taking the next step, the University of New Hampshire’s Center for Coastal and Ocean Mapping developed a concept known as the navigation surface. The navigation surface results from hydrographic surveys and provides a bottom model at the best resolution the sonar will support. Soundings for charting purposes are taken from generalised grids of the surface, and an uncertainty layer provides a quantitative value of quality for every cell in the bottom model.

Efforts are now underway at the Naval Oceanographic Office to use the ‘navigation surface’ concept to merge the deep-water DBDB-V model with the high-resolution hydrographic source survey data. There are many challenges, but the central one is to provide the technical and systematic means for pooling the hydrographic data into homogeneous bottom models. This new morphed ‘navigation surface’, with its quantifiable uncertainty, will greatly enhance the utility of the DBDB-V.

Now the applications for the new bottom model become much more accessible and elegant, from providing boundary conditions for numerical models to derived navigation products and potentially a direct source for electronic chart display that could access and yield Digital Bathymetric Data Base for Navigation at a Variable Resolution (DBDB-NV) in real time.

Moving into the future, the US Navy’s long-standing commitment to embrace ground-breaking technologies and willingness to forge innovative partnerships will continue to improve the safety and ease of navigation.