'Targetless' sensors for DP

Environmental referencing ('targetless') sensors for DP applications can reduce the opportunities for interdependence failures

Dave Sanderson
Guidance Marine, Engineering Group Manager

A modern Dynamic Positioning (DP) equipped vessel is reliant on its position reference sensors to enable the advanced functionality that computer control brings. These reference sensors fall broadly into two categories: global references, and local references. Global references are systems such as GNSS, which rely on a set of globally visible satellites or other known global reference to provide a position. Local reference systems provide a range and bearing to a local cooperative target. These might be laser or microwave Radar-based local position reference sensors.

Target failure

Conceptually, there is little difference between local position reference systems, traditional celestial navigation, and GNSS based systems, other than the actual range to the reference point.

Practically, however, both the stars and GNSS satellites are fixed. They are very hard to disrupt or disturb – issues with GNSS jamming notwithstanding. Local reference points are more prone to accidental disruption. In the local reference system the reference point, or target, is often overlooked as a point of failure, even though the system is reliant on it to function.

A typical example can be seen in platform supply operations. Many platforms are equipped with laser targets which allow the supply vessels to line up with the appropriate spot on the platform and then maintain position using their DP systems. An ideal operation will allow the vessel to approach the platform using multiple different local reference sensors to ensure safety, thorough redundancy, and speed of operation.

If the platform does not have appropriate targets installed, then the vessel will typically approach under manual control and hand over to the platform crew a target for them to temporarily install – for example, a prism cluster that will then act as a radar target. The vessel will stand-off while the platform crew install the target, and then re-approach under DP control once the target is in place. This practice exposes weaknesses in the safety chain:

- The initial approach to hand over a suitable reference is not as safe and simple as it could be.
- The vessel crew has to rely on the platform crew to position the target appropriately.

Another weakness with dedicated targets, even when they are permanently in position, is that the system complexity is distributed across multiple separated devices:

- Radar responders are active pieces of electronics, with power supplies and associated potential failures.
- Prism clusters, although a totally passive piece of equipment, can fail due to damage sustained in the handover process.
- Retro reflective tape targets often suffer from aging related issues, such as UV damage, abrasion, and being made from poor quality retroreflective tape.

In all of these cases a functioning sensor can be made unusable by a mistake that causes a target failure.

The LIDAR alternative

Freedom from the need to hand over targets often comes near the top of typical vessel crew's wish list for local position reference sensors. This has been partially addressed by oil companies ensuring that their platforms and other assets have appropriate instrumentation. Another possibility currently being developed to remove this form of distributed failure mode lies in the use of LIDAR (Light Detection and Ranging). The system under development measures the time it takes light to travel from the sensor to the target and back to determine an accurate range (figure 1). The rotating sensor head allows an accurate determination of bearing to the target.

Retroreflective targets provide a cooperative position reference.

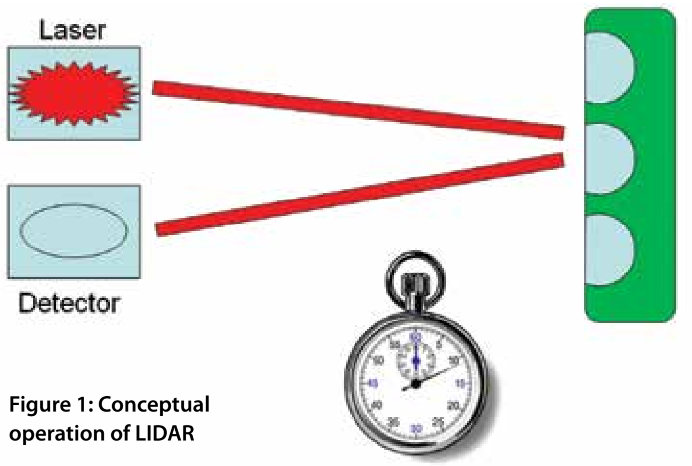

Figure 1: Conceptual operation of LIDAR

The nature of the return is specular, and as a result simple to detect. However, the emitted laser pulse can also provide a return if it strikes another surface. This return is usually diffuse. As a result it is less bright, and harder to detect.

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This knowledge of the local environment can be used in a technique called SLAM - Simultaneous Location And Mapping. As the name implies, this involves building a local map of the vicinity, and then using this map to locate the position of the sensor within it. 'Driverless' cars use LIDAR systems to enable them to build up a picture of their surroundings.

Using SLAM techniques, based on the weaker reflections that are returned from the local environment, this sensor allows vessel crews to reference the position of their vessels without having dedicated cooperative targets.

SceneScan - Guidance Marine's latest generation of sensing technology – on sea trial

Recent sea trials in the North Sea and the Gulf of Mexico (above) have provided data that shows this sensor has performance that is comparable with existing local DP reference sensors. Figure 2 below, shows an example of post-analysis data, overlaying positions from microwave, radar and LIDAR sensors. These results show very good correlation. Minor differences are attributable to sensor mounting positions and reference point locations. The data clearly shows the sub-decimetre movements caused by typical wave motion during station keeping.

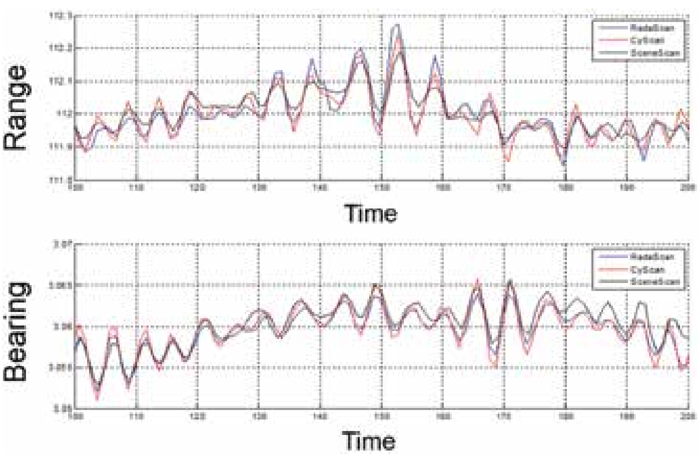

Fig 2: Ground truth comparison of reference sensors

During sea trials a real world example of the usefulness of this system was captured:

The supply vessel was requested to suspend operations and stand off to allow a crew boat to come into the platform. After the crew boat departed, the supply vessel performed a drift test as part of the setup to recommence operations. This showed that the current had changed direction, and the vessel needed to offload at the opposite crane location.

With a current local position reference system, this movement would require the re-selection of targets. Depending on the platform set-up, it might also require rig personnel to physically move a target from one location to the other. Both of these actions add an extra risk to the operation, and potential delays.

LIDAR sensors can track from one location to the next, using the self-referencing map that is built as part of normal SLAM type methodology – see figure 3.

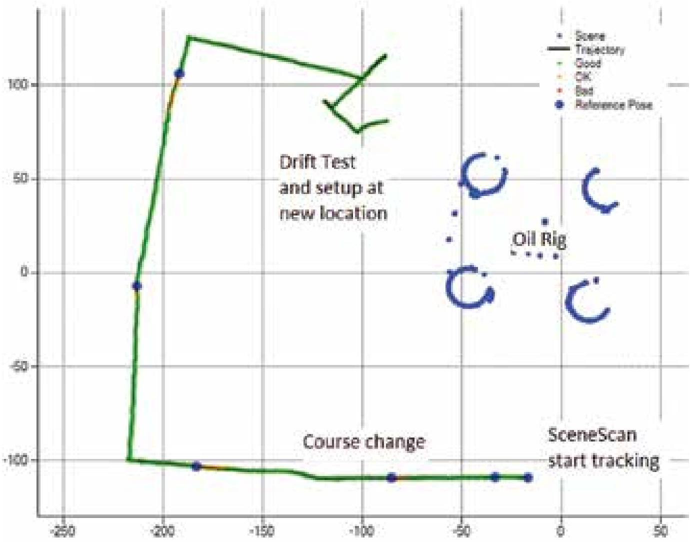

Fig 3: Offload location change tracked by SceneScan

This technology offers a major advance in local position referencing. The sensor, and therefore the vessel, is no longer reliant on the provision of cooperative targets. This greatly reduces the interdependence between the two ends of the system. To conclude the progression to a shippable product, human factors and user interface work are required. This will ensure that the potential gains in productivity and safety are realised by the end users.

The biggest question is not will this technology improve dynamic positioning operations, but how, and when?