EM&I – laser scanning for FPSO tank inspection

Asset integrity management company EM&I is developing automated methods to inspect FPSO tanks with laser scanning

Asset integrity management company EM&I is developing automated methods to inspect tanks on FPSOs using laser scanning, so there is no need for people to enter tanks.

Tank inspection is considered by many to be one of most dangerous tasks which FPSO and tanker crew undertake, with a number of accidents reported on tankers. The spaces can be difficult to enter and exit. If crew have any accident or medical issue while in a tank, it can be difficult to summon help.

The solution developed by a Joint Industry Project (JIP) led by EM&I uses laser scanning at a distance, instead of close up inspection by people.

A laser beam is fired in multiple directions, and bounces back to a sensor next to the camera, enabling the computer to build up a 3D image of what the laser can "see", using multiple points (known as a "point cloud").

The same technology is used to make 3D models of old equipment, and also for navigation of autonomous cars.

The device does not have to be taken into the tank by a person – it can "see" the tank walls if the laser can be shot through a hole in the deck or an opposite wall.

Working with digital imagery taken remotely is something that the nuclear industry has done for a while, says Danny Constantinis, chairman of EM&I.

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A typical scan takes about 8 minutes, where it could take several days with people in the tank for a traditional tank inspection, he says.

With laser scanning, it would be possible to inspect all the tanks on an FPSO with 2-3 people "in a few days" – rather than having 10-12 people onboard for 3-4 weeks, doing dangerous work which involves going into tanks, as it is done today.

An alternative option to shooting the laser through a hole is to have the laser scanner mounted on a robot vehicle inside the tank. To guide the vehicle, railway type tracks would be fitted inside the tank, for example with rails a foot wide and 20 feet long. The laser could be installed onto a robot with wheels, which is lowered into the tank onto the tracks. This is probably a solution more for a new vessel than a retrofit, Mr Constantinis said.

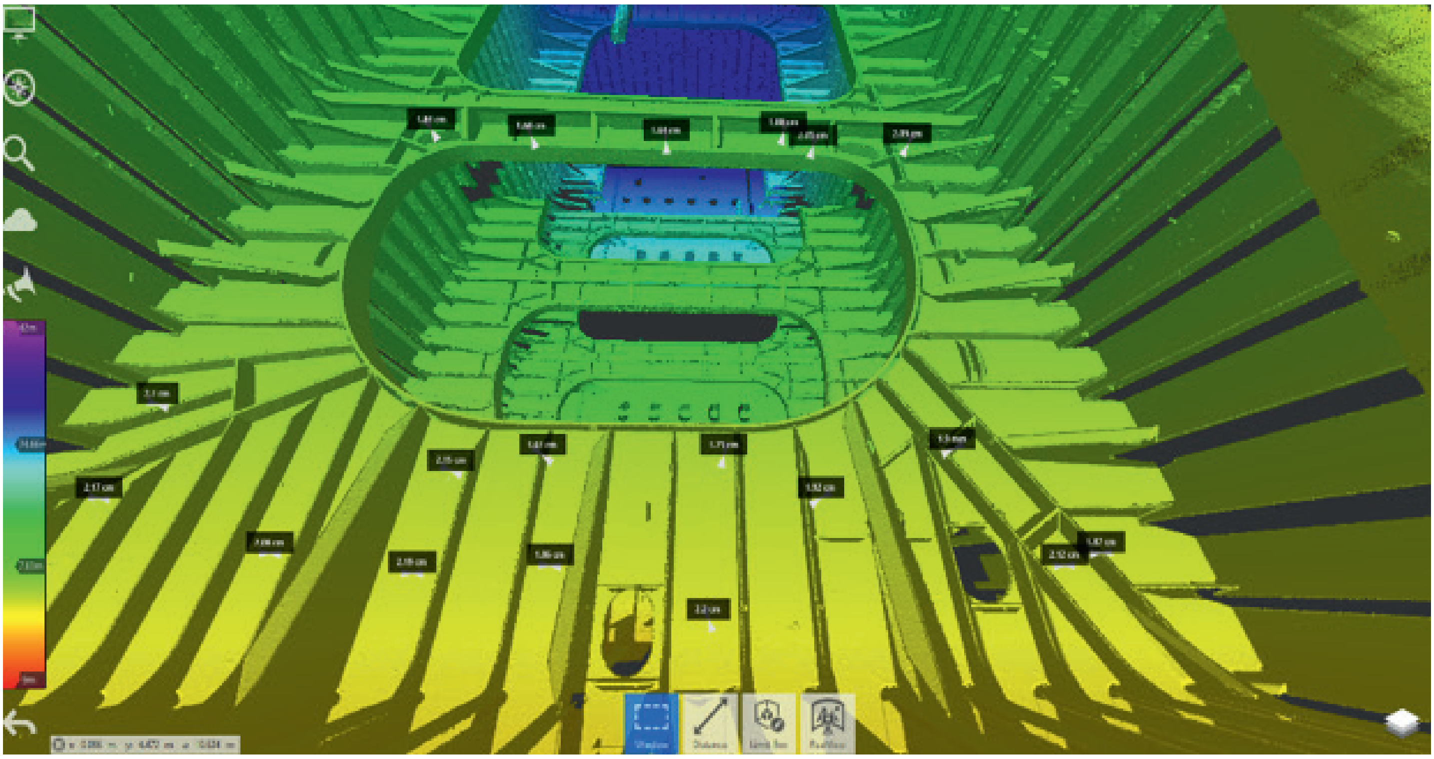
EMI considered drone mounted lasers inside a tank, but it proved to be not a very workable approach – it would still need someone in the tank to drive them. Also, the laser needs to be very static to take a good survey, so would be better sitting on something more solid than a drone.

Early laser trials were held in 2019 on an FPSO in Equatorial Guinea under the HITS JIP programme managed by EM&I.

EMI is seeking more projects with oil majors and class societies to further improve the technology. It should be ready for full commercial launch in late 2020 or early 2021.

How it works

Laser scanning technology has advanced greatly in the past few years, and it is now possible to "see" in enormous resolution. A laser scan shows up distortion in the steel, rusty patches and paint breaking down. Laser scanning can reveal pits in steel due



A laser scan image of a tank

to corrosion, and areas where the steel is thinning or corroding. The data can also be converted into stress models, to identify where the weak areas are.

A big challenge when evaluating tanks is measuring the thickness of the steel (and if it has been thinned through corrosion). People used to tap the steel with a hammer, or by using a calliper (if they can access both sides of the steel), or ultrasonic technology – but all of this involves someone entering the tank.

EMI is developing a technique using "synchronous lasers", when you do laser imaging from different positions in the tank, and then put the images together. This can be used to evaluate thickness if you can 'see' both sides of the steel with a laser and also relate the two laser positions.

If you can only see one side of a tank wall with the laser, one approach to measuring steel thickness is to use datum points, such as a point on the tank wall which can also be seen from outside the tank (such as an access point). You can use this datum point to connect together multiple images.

A similar technique is used in building construction to ensure (for example) different sections of piping connect together. Two pipe sections can be designed to connect at a 'virtual' datum point.

"We can measure the thickness as accurately as if a man was in there," Mr Constantinis says.

Software can handle basic quality control over the data collection, so as to confirm that all of the tank area has been surveyed.

The laser data can be collected by a few specialist technicians and sent to the engineers. Surveyors are generally much happier analysing information from their desks, rather than having to pass medicals and survival training courses to be able to go on a helicopter and go offshore, Mr Constantinis says.

The remote surveyor could also review data while the survey is happening, and request that certain areas of the tank are given special attention.

EMI worked together with statistics experts to assess how much data is actually needed to get a high level of reliability in the predictions.

Replacing divers for underwater inspection

The tank inspection project is part of a Joint Industry Project (JIP) which EM&I formed with a number of class societies and oil majors in 2013, looking at better ways to do inspections on FPSOs.

The discussions clarified three concerns – the risk of using divers for inspection underwater, the difficulties inspecting tanks, and a desire for automated tank cleaning methods.

When looking at better ways to do underwater repairs, one solution was to find a way to fix a "cofferdam" (a box fixed to the side of a hull giving it protection while repairs are done) without divers.

It is normally done with divers fixing bolts to the side of the hull. But EMI found a way to do it by drilling holes into the hull from inside(using class approved ODIN® access ports)without allowing any water ingress, pushing wires through the holes, and then pulling the cofferdam into place from inside.

These methods have the advantage both of having fewer people exposed to high risk, but also requiring less travel offshore altogether.

It is possible to do hull inspections, fix valves, repair a sea chest (seawater intake system), without divers, using other methods, he said.

It works with any floating oil and gas equipment, including FPSOs and Mobile Offshore Drilling Units (MODUs).

Automated tank cleaning

The next research project may be to look at automated cleaning methods for tanks. The challenge is to find a way to remove the liquid sediment which falls to the bottom of the tank.

The initial efforts are based around looking for technological ways to determine which parts of the tank justify most cleaning effort.

"We've tried different [automated] technologies to go through the sludge – it can be done but it is very slow at present but work is progressing to speed things up" Mr Constantinis said.

Electrical inspection

Another interesting project looks for ways to inspect electrical equipment without opening it.

Normally, electrical equipment needs to be switched off to inspect it, which can lead to disruption of people using the electricity.

EMI developed an approach using techniques developed for medical imaging, to look at electrical boxes without opening them.

It is possible to see loose connections, wiring not properly crimped, or faulty seals.

Most people would approach the challenge by looking for "better ways of opening the box, but we thought 'outside the box'" he says.

Inspecting mooring chains

Another project is to find automated ways to do inspection of mooring chains of deepwater equipment.

Doing it with ROVs can be tricky because the ROV can move in the water.

But EMI's technical group found a robot technology developed for the logging industry to climb trees, and developed an underwater version which could be used to inspect chains. It is now going into sea trials. The company has named it LORIS, after the forest primate which climbs trees.

LORIS will be tested in late 2020.

EM&I's approach

EM&I's business approach is to orient around what question needs answering, rather than what technology can do. "There's so much technology out there," Mr Constantinis says. "Very often, the assembly of the technology is not the problem. It is understanding the question."

"We know there's solutions out there, our world is so advanced," he says. "The difficulty is trying to nail down the real problem, and ensuring that if you solve it there's a commercial interest."

"We don't stand up and say, 'we're the best in the world.' We're good assemblers of information – we simply act as a catalyst."

Mr Constantinis originally trained as an aircraft engineer then as a commercial diver on the Maui gas field in New Zealand. This led to a career in the UK nuclear industry developing robotic systems.

This experience helped him found EM&I as a provider as innovative services and safety products to the offshore industry.

EM&I has offices in UK (Cheshire, Aberdeen, Jersey), Brazil (Rio de Janeiro and Macaé), Tianjin, Perth, Singapore, Nova Scotia, Angola, Malta, Kuala Lumpur, and Houston.

The "alliance" refers to the relationships it has with other industry sectors, including via the joint industry projects, and relationships with people working in aerospace, nuclear, medical and other industries.

EM&I is now forming a second Floating Gas JIP which addresses integrity challenges in the growing floating gas sector.