Special

Door ing. A. Gerritsen

Jobs for Drones

Drones, whether aquatic or airborne, harbour lots of opportunities to save costs and reduce risk in maritime industry (by DNV GL).

Drones are used ever more often in maritime industry to perform complex tasks, save costs and avoid dangerous operations for humans. There are different types of drones, such as those for under water work, others for working on the water surface and "aerial" ones that fly in the air. A selection of the latest tests and uses of drones.

In "Project *Zeeslag*", (former) Imtech Marine & Offshore and researchers of the Knowledge Centre RDM of Rotterdam University work together on a complex and innovative project: building an aquatic drone. This unmanned autonomous "ship" is propelled by "green" solutions. The technology behind the drones is widely applicable and their tasks vary from cleaning up the "plastic soup", performing underwater inpections in ports and tracking pollution at sea to servicing vessels and offshore installations. During the project, four vessels have been designed and built. The vessels are 150-200 cm long and built from different materials: two from glass-fibre and epoxy, one from wood and one from aluminium. In addition, an open under water ROV has been built en is being tested. Electrical Engineering, Mechanical Engineering, Marine Engineering, Maritime Officer, Logistics Engineering, Technical Computer Science and Mechatronics students are all involved in the projects and were responsible for building the vessels.

Some of the Aquabots designed by students during Project Zeeslag (by RDM).

While students, research institutes and innovative companies work together on the development of effective maritime drones for different purposes, at the same time pilot projects, tests and practical application of unmanned vessels and vehicles for a variety of tasks, autonomous or remotely operated, are taking place.

Underwater Inspection and Maintenance

Eelume is an underwater robot shaped like a snake and able to perform tasks autonomously. This inspection, maintenance and repair robot is developed by a consortium of Kongsberg Maritime, Statoil

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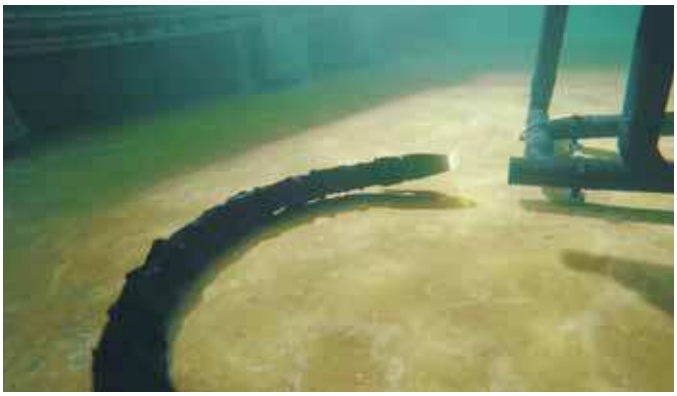


The snake-like underwater robot Eelume can perform planned and on-demand inspections and interventions (by Kongsberg).

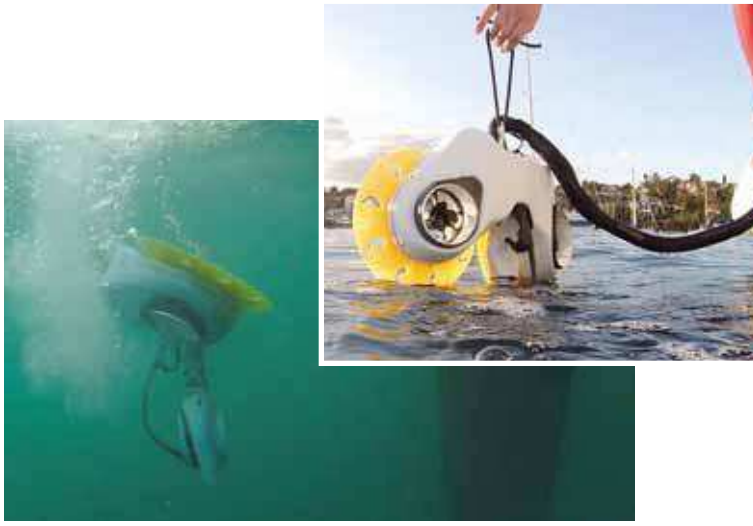
and the NTNU spin-off company Eelume. The goal is to accelerate new technology that will significantly reduce costs related to subsea inspection, maintenance and repair operations. The idea is to let the swimming robots do inspection and light intervention jobs on the seabed, thereby reducing the use of large and expensive vessels. With its snake-like form, the slender and flexible body of the Eelume robot provides access to confined areas that are difficult to access with existing technology.
Eelume robots will be permanently installed on the seabed and will perform planned and on-demand inspections and interventions. The solution can be installed on both existing and new fields where typical jobs include visual inspection, cleaning, and adjusting valves and chokes. These jobs account for a large part of the total subsea inspection and intervention cost.

Hull Cleaning

Hullbot is a swimming robot that preemptively cleans the hulls of private yachts so that no significant biofouling develops. This continuous cleaning diminishes the need for traditional biocide antifouling products that release toxics into the marine ecosystem. Hullbot's interchangeable cleaning pads gently brush the wetted surfaces of the yacht's hull while at anchor. Cleaning occurs every four hours so that the gentle action only has to remove microorganisms and small particulates that are not yet well attached. It uses the combination of a sensor package, stereoscopic cameras and an internally stored model of the yacht's hull to determine its orientation in the water and its progress through the cleaning cycle. The robot is agile enough to swim around near the boat, driven by its three thrusters and articulated tail.
Power and control signals are sent to and from Hullbot via a tether. Between cleaning cycles, the tether is wound onto a spool which retracts Hullbot into its garage. Boat owners purchase the complete unit, lock it to the railing and can then configure the device to suit their vessel and preferences. The garage contains the electronics that support autonomous operation and is connected to the Internet to gather weather data and provide web-based remote control. A touchscreen interface on the inboard side of the garage allows the user to configure the device and provides updates about Hullbot's status and the cleanliness of the hull. The garage acts as a carry case and is easily detached from the vessels railing and stowed in a locker for safety during sailing.

Tank Inspection

Classification society DNV GL is testing the use of drones for the inspection of cargo tanks or holds in a large oil tanker, a chemical tanker and a bulk carrier, both in Europe and in China. A camera-equipped drone enters the tank to visually evaluate structural components through video streaming to a tablet or a screen on the bridge. One surveyor can operate the drone, while a second checks the video feed in real time. During the first tests, the video stream was recorded for review and documentation purposes. Equipped with a powerful headlight, the drone is able to produce a video of sufficient quality for initial inspection purposes. In the event any damage is detected, a traditional close-up survey may still be required.
After analysis of the first test results, further developments may lead to drones that operate autonomously. A 3D model of a vessel could be loaded into a drone's memory, which could then orientate itself inside the tank and follow a pre-defined route, stopping at points of interest inside the compartment to capture video and still images. The operator could use the camera and lights to document findings, while the drone's autopilot takes care of the flight. At some stage, it may be possible to have a drone with its own scanning capabilities. The drone could be dropped into an unknown space, make a scan, create its own 3D map and then proceed to carry out the survey independently.
Utilising the test experiences and results, DNV GL is developing a special guideline for performing drone-based surveys. This could open the way to remote or even autonomous inspections being carried out as part of the survey scheme in the near future.



The Hullbot is a portable drone that helps boat owners clean their vessels' hulls.

Delft-based start-up company RIMS (Robotics In Maintenance Services) uses drones for inspection and survey inside tanks and other enclosed spaces. Here, they are about to launch their "Flyability" drone inside a tank.

Shipyard & Production Survey

Japanese shipyard Tsuneishi Holdings Corporation is analysing the potential of using drones at its Hiroshima shipbuilding facility in an effort to increase both safety and productivity in daily operations. Yard supervisors use a flying drone, weighing about 3 kg to capture high-quality photos and video and transmit the data live back to a central information processing area. From there, the Tsuneishi team hopes to use the collected information to oversee operational progress, facility inspections and potentially manage dangerous situations from a distance. Tsuneishi tested the drone over a four day period in May 2015 and covered all these applications, in particular trying to detect potentially dangerous situations, including the inspection of equipment located at high places. Additionally, the drone was used to oversee operational progress, such as construction and placement of blocks.

Finally, drones can also be used to capture an overview of a shipyard, as Irving Shipbuilding in Halifax did, see the video at www.cbc.ca/news/canada/nova-scotia/drone-takes-shipbuilding-facility-tour-1.2930539.

Safety Inspections and Water Cleaning in Ports

In use in the Port of Rotterdam since last summer, are the inspection drones by Aquasmart XL, a tech startup in the Netherlands that provides small surface navigating vessels, equipped with a camera and remotely controlled by radio signal. Visitors at the 2016 World Port Days in September had the chance to "experience" the view from the drone, a 40 cm long boat with the camera mounted only inches above the water surface, through virtual reality glasses – basically a smartphone in a headset. The Aquasmart XL is now being tested at port operating companies, where it is used to monitor docking, detect spills and monitor quayside activities at night. Port authorities are preparing to use the sailing drone for these same reasons.

The Port of Rotterdam also features four Waste Sharks. During 2016, port authorities and RanMarine participate in a pilot to use these autonomous robots to get floating debris and pollution out of port waters. The Waste Shark has two floating bodies like a catamaran, is about 1 m wide and 1.5 m long. The device can be deployed 24/7 to collect up to 500 kg of plastic waste using its open mouth 35 cm below the water's surface. Once it is full, the drone sets off to empty its load and recharge itself at the same time. The aquadrone device navigates using GPS data fed into a computer. It is also able to avoid collisions with ships using signals sent by the ships themselves, namely the AIS signal, mandatory for all commercial vessels. The Waste Shark's compact size means it is able to access tight corners where litter accumulates. Plastic waste in the water is not just an environmental problem, it also hampers shipping. Plastics and other debris can get wrapped around a ship's propeller. The 24/7 aquatic clean up robot was an idea of RanMarine's Richard Hardiman and co-developed by Genuin Engineering. The device came into existence during last June's Shakedown event organised by PortXL.

The Aquasmart XL is used to monitor docking, detect spills in the water and monitor quayside activities at night (by Aquasmart XL).

The Waste Shark can clear up to 500 kg of plastic waste (by RanMarine).

Delivering Packages

Maersk Tankers is testing delivering small packages to vessels with flying drones that have been certified for explosive environments. The April test, in collaboration with drone maker Xamen Technologies, was the first using a drone to make a delivery on board. In the

The Spyboat model Duck is a small glassfibre polyester shallow boat propelled by aerial propellers (by Spyboat).

tanker business, it can be hard to predict far in advance which port will be called next and even when in port, it can be complicated and expensive to deliver items to vessels as they are not alongside the quay. Costs for a barge are on average USD 1000 or higher. According to Maersk, this means the use of a drone could potentially save USD 3000-9000 per vessel per year.

Drones must be safe for the environment they are operating in and, for tankers, certified as intrinsically safe, so they cannot create any spark even if they were to crash. The purpose of the test at Kalundborg was to use a drone that was ATEX (ATmosphères EXplosibles) approved for potentially explosive environments, and see how the concept worked. The drone used was ATEX zone 2 approved for use in potentially explosive environments. It is an octocopter with a wingspan of 104 cm, 40 cm high and a maximum speed of 16 m/s. Delivery of a small parcel over 1 km from shore to vessel took about 1.5 minutes. The max load of this test drone is 2 kg. Other drones, which are not (yet) ATEX approved, can already carry up to 10 kg.

Drones are being tested for inspections across the Maersk Group. Maersk Oil is using them for installations in the North Sea and APM Terminals for cranes in its ports. Camera-equipped flying drones carry out inspections or function as piracy look-out in high-risk transits. Inspections of ships or offshore installations could include high quality photos or videos of certain areas, such as the transom stern and flare on the bow, or the inside of cargo tanks. Once a suitably ATEX approved drone is available, Maersk Tankers could avoid the costs and time for washing, gas-freeing and re-inerting during a cargo tank inspection. Drones could increase the quality of inspecting challenging areas and provide high quality images, meaning cracks can be identified faster. Those potential early findings could avoid higher expenses if problems are only discovered later.

Flare Tip Inspection on Offshore Rigs

Lloyd's Register (LR) commonly deploys Unmanned Aircraft Systems (UASs) for inspection of offshore rigs. Drone inspection offers key benefits that a traditional inspection would not have, LR states. A particular benefit being to minimise and even avoid the need for a shutdown – planned or unplanned. With the application of UAS inspection, the technical inspection data received is reviewed and reported by competent personnel and an integrity assessment outlines areas of concern. So the UAS inspection included the specialist data interpretation as well as the data collection. This specialist data interpretation has been added to the service as the use of drones has evolved. As a class society, LR sees to it that correct paperwork is processed, such as an Integrated Safe System of Work (ISSOW), method statements and Risk Assessment Safety Procedures. Deriving necessary data from the drone inspections, the process towards form completion was quick and easy to set up. Unmanned inspections eliminate the need of putting men at risk to scale the flare tip to confirm the condition of the flare tip and boom chords. The drone provided clear imagery – both video and stills – and a permanent record. The UAS was able to cover large areas. Apart from the inspection of the flare tip, it performed additional tasks such as identifying potential dropped objects (PDOs) which may have been difficult to spot. Crucially, the UAS facilitates the application of a screening tool that allows closer inspection of suspect areas and ongoing monitoring over a period of time to evaluate the rate of degradation. This enables operators to plan maintenance and repair in a structured and budgeted way.

Together with the significant upside to UAS inspections, there are also challenges to overcome. The drone can capture very detailed data, but it cannot carry out repairs which a team could. Similarly, it relies on experts to operate the kit, guide it to the right locations, including suspect areas, and identify further inspection requirements.

Inspection of Wind Turbines

ABS Group and DroneView Technologies have joined in a project to deliver aerial wind turbine and equipment inspections utilising sophisticated drone technology as a cost-effective solution. Potential

The Lisbon University's swarm of robots can act together in a large group (by miguelduarte.pt).

damage to wind farm equipment will be surveyed using a drone controlled by a certified, licensed operator. The drone is capable of producing high-resolution photos and videos, to be analysed by an ABS Group wind turbine specialist. Based on the analysis, recommendations for operation and/or repair will be reported to the wind farm operator. The data computed by the drone and transmitted in real time to the operator can be stored in a maintenance archive of valuable data for future reference.

Navigation in Ice

In December 2015, a drone helped navigate the Australian ice breaker Aurora Australis through the sea ice on its annual resupply voyage to Casey station in Antarctica. It was the first time the Australian Antarctic Division used drone technology to assist ship operations. The proof-of-concept flights were undertaken by an Australian UAV (Unmanned Aerial Vehicle). The project had a number of technical challenges. Electronics do not like snow, the batteries do not like the cold and the drone's compass did not like the ship's thousands of tons of steel. The quadcopter made five flights during the nine-day voyage to Casey, needing eight minutes in the air for each flight to collect the necessary data.

Environmental Monitoring & Seismic Acquisition

French company Spyboat has developed three types of aquatic drones, mostly applicable for monitoring the ecological state of the water they navigate in. The Spyboat models Duck and Swan are small glassfibre polyester shallow boats that are propelled through the water by aerial propellers, like a Florida swamp boat. Therefore, these boats can operate in very shallow water and also in highly contaminated water, like in the direct surroundings of a crude oil spill. Aerial propellers will not get stuck in the thick sludge. Sensors on board allow for visual inspections, measurement of water temperature and the water's pH (acidic) state, turbidity and oxygen level. The boat can take water samples from the surface and from up to 200 m of depth.

Swarms of Aquatic Drones

Research by the University of Lisbon speaks of collectives of relatively simple and inexpensive aquatic robots (swarms). This alternative approach, in which robots are easily replaceable, has a high potential of applicability on essential tasks such as prospecting sites for aquaculture, environmental monitoring, sea life localisation, bridge inspection, sea border patrolling, and so on.
Maritime tasks, such as surveillance and patrolling, aquaculture inspection and wildlife monitoring, typically require large operational crews and expensive equipment. These task can be performed by drones. Recently, the first tests and actual assignments in inspection and hydrographic research have been carried out using drones for these tasks. These vehicles, however, tend to be expensive and have limited coverage, which prevents large-scale deployment. The researchers of the University of Lisbon propose a scalable robotics system based on swarms of small and inexpensive aquatic drones. They take advantage of bio-inspired artificial evolution techniques in order to synthesize scalable and robust collective behaviour, when acting together in a large group. This behaviour may be combined hierarchically with pre-programmed control in an engineered centric approach, allowing the overall behaviour for a particular mission to be quickly configured and tested in simulation before the aquatic drones are actually sent out in the water. The Lisbon University researchers demonstrated the scalability of the hybrid approach by successfully deploying up to 1000 simulated drones to patrol a 20 km long strip for 24 hours.

'Try This at Home'

These projects and tests reflect a growing trend of applying drone technology to commercial applications. As a result, regulation societies are developing rules and guidelines for flying with drones, such as Lloyd's Register and DNV GL. Yet, operators should be aware of national rules that may require pilot's licences for the operators of airborne drones.
Availability of simple, cheap and easy to operate drones for recreational use may allow for low-scale experiments for using drones in professional application in the maritime industry. If you want to try this at home, there are (next to the big projects) more and more small and accessible solutions for the civilian market, like taking underwater pictures with a smartphone (myziphius.com) and building your own ROV (www.openrov.com).

Drone
drone (*drōn*): male bee; unmanned vehicle (thefreedictionary.com)
Drones are mostly remote controlled vehicles, some can operate autonomously to perform tasks at places where a signal from the operator can not reach: too far for cable control and in surroundings that block radio frequencies, like water.