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Skimming the surface

Ocean currents

Lebanon – Leila Issa, LAU assistant professor of applied mathematics, is developing mathematical and numerical methods to improve surface velocity estimation near the coast of Lebanon, using data assimilation techniques. This will better predict the transport of pollutants originating from the Lebanese coast.

In Lebanon, marine pollution is a particularly serious problem, given the amount of solid waste that has been and is being dumped into the sea. The country is also constantly at risk from oil spills and the oil and gas exploration activity currently taking place in the eastern Mediterranean.

The accidental release of contaminants into the ocean – either near its highly populated coastline or in the open sea – poses a major threat to water and food supplies. Not only does it have an immediate and local effect, but the resulting damage also extends over large distances and lengthier times, as ocean currents transport the contaminants. An accurate estimation of surface currents is key to understanding pollutant transport mechanisms, specifically the fate of floating objects released in the sea or near the coasts.

The term "surface ocean currents" is used to describe the continuous movement of water from one location to another on the surface of the ocean. Forces acting on water affect their speed and direction. In the open ocean the forces are the earth's rotation and the wind, while along the coast – in addition to the wind – they can be influenced by waves, upwelling, sea bottom interaction and other complex factors. Questions as to where oil spills may move and how long it would take for them to biodegrade could be answered, once these currents are understood.

The large-scale motion (meso-scale) of the Mediterranean's currents is characterised by length scales on the order of tens of kilometres. This motion is much better understood than its small scale local counterpart, which can occur near the coasts for example, on a monthly, weekly or even daily basis.

Altimetry, a method that consists of using satellite measurements of sea surface height and converting it to velocity, has beenwidely used to predict the mesoscale features of the ocean. It is inaccurate, however, in resolving short temporal and spatial scales. To improve overall velocity estimation, in-situ observations provided by surface drifters can be used. Drifters follow the currents and, when numerous, they allow for an extensive spatial coverage of the region of interest.

Combining several types of data such as altimetry, drifter positions and wind speed, the research came up with an efficient computer algorithm based on a mathematical model of these currents, to efficiently and accurately estimate them at various scales near the Lebanese coast.

The method is accurate and efficient, making it well suited for near real-time applications. This is very important in events where a fast response is needed, such as search and rescue or predicting the fate of oil spills. Such findings also provide new information to help predict the movements of pollutants dumped from Lebanese coastal cities.

Birzeit instructor revolutionises new robotic crane control model

Palestine – Sima Rishmawi, an instructor at the Department of Mechanical and Mechatronics Engineering at Birzeit University, has pioneered a control method for tandem-operating robotic crawler cranes, in a well-received study that was presented at the 2017 Future Technologies Conference (FTC).

The study, entitled "Control of Robotic Crawler Cranes in Tandem Lifting Operations," details a model that facilitates the control and synchronisation of the two tandem cranes' movements by replacing the human operator of the second crane with a robot that mimics the actions and movements of the first crane.

The basis for the model of control is derived from the dynamics of the tandem lifting operations, which are usually implemented to lift an object heavier than the lifting capacity of one crawler crane, or one shaped in such a way that two cranes are needed to do the lifting.

Having the two cranes move in perfect unison also limits the chances of sudden actions or unsynchronised movements, thereby reducing the chances of accidents on construction sites.

Rishmawi's model not only executes any lifting operation perfectly every time, but it also frees the workforce to focus on other, more delicate matters that need immediate attention. A lifting operation that required three personnel to carry out – two crane drivers and one lift director – now only requires one crane driver.

Rishmawi's paper also reviews the factors that contribute to a tip-over accident – by analysing the movement of the bases of the cranes – and presents a guideline to prevent such accidents from occurring.

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