Supriyo Chatterjea

Within one year, hundreds of small buoys may be guarding the vulnerable environment of the Great Barrier Reef near Australia. Inside the buoys will be intelligent sensor nodes, together forming a huge wireless sensor network. Supriyo Chatterjea wants to know the best ways of gathering all the data while consuming an absolute mimum of energy.

Sensors guarding precious coral

"There are several environmental issues around the Great Barrier Reef. Scientists want to know how to protect the reef from bleaching, for example. Another issue is the excess fertilizer that washes out into the ocean from the Australian mainland. What effect does this have on the reef? Monitoring temperature and light intensity provides scientists of the Australian Institute of Marine Sciences with invaluable information. Fishermen can benefit from it as well. Until now, many of the fish they have been catching are inedible and have to be thrown back, and others are needlessly damaged. If you know the preferences of certain fish for certain temperature regimes, you can choose your fishing area and you don't have to roam all over the reef."

"Currently, there's only one data logger, covering a reef seven kilometres in length. There are satellite images of the reef area, but the temperature profile they provide has a very low resolution. To improve spatial resolution and accuracy, we now want to introduce a network of about one hundred sensor nodes. Each of the nodes will consist of a buoy from which a string of sensors runs down. We will then be able to monitor vertical temperature and light profiles in the whole area. We already have five buoys close to the coast now, as an experimental setup, and we are doing larger scale experiments on land. The conditions we have to take into account can be quite harsh at sea. A buoy may even be damaged by sharks! On land we have already had to deal with inquisitive kangaroos."

"A sensor node is more than just a measuring device with a radio transmitter that sends out its data continuously. If they were that simple, we would need a central server to gather and analyze all the data. In practice, this would involve too much communication, too much sampling and, therefore, too much waste of precious energy. The nodes will have to operate for several years without the batteries being replaced, so the amount of available power is severely limited. What we want to do instead is to put the intelligence in the network itself. There is no need to transmit data from all available nodes all the time if certain trends in temperature can be assumed. With this knowledge, you can suffice by communicating fewer samples more efficiently, and save energy in the process. Nodes have enough processing power to enable them to decide what to do autonomously. We can use time series forecasting, a technique used in stock markets, to send more compact trend information rather than raw sensor data. Figuring out energy-efficient strategies is one thing, but you always have to bear in mind that, in the end, the user wants reliable data. Achieving the right balance is a real challenge for me."

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"Apart from sharks, we will face changing weather conditions. The sea can be rough, and some nodes will be unable to communicate all the time. The network is therefore designed to be self healing: it finds alternative combinations that work. The same technique enables the network to be easily upgraded and extended. We learn a great deal from real-life deployments. Even with the nodes we used on land we discovered that they couldn't communicate with a layer of water on top of the box. That's something to take into account when you're facing harsh conditions in the ocean."