LATERAL THINKING
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An artificial version of a fishy sense organ passes its first two tests.

INVENTORS have long tried to copy nature. Most, though, have looked to the skies and the land, rather than the sea, for inspiration. And even when they have attempted to imitate marine life, they have tended to consider it through mammalian eyes. Submarines, for example, use the familiar human senses of sight and sound to build images of their surroundings.

But that is not the way that fish do it. Although fish can see and hear, they also rely a lot on a series of flow sensors strung along the sides of their bodies. These sensors are known as the lateral-line system. To navigate like a fish, it would help to sense like one. And, in research just published in the PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Chang Liu, of the University of Illinois at Urbana-Champaign, and his colleagues describe the first attempts to do so.

A natural lateral-line system consists of about 100 sense cells that run from the gills to the tail on each side of the fish. The cells detect subtle water movements, and from the different times that the individual cells are stimulated by these movements the fish's brain is able to reconstruct an image of what caused them in the first place. Blind a shoaling fish such as a herring and it can still follow its mates. Cut its lateral lines and it rapidly gets lost.

Dr Liu's artificial lateral line was somewhat shorter than a natural one. It consisted of 16 tiny flow sensors, rather than 100. The sensors themselves contained heated filaments and worked by recording how quickly the heat was lost. The faster that water moved past a filament, the quicker the filament lost heat. The output from the sensors was fed into a computer that had been programmed to try to work out what was going on in a simplified version of the way that a fish brain would.

First, the researchers tested whether their system could locate the small pulsing movement caused by a vibrating ball. Not only was the pattern of recordings along the artificial lateral line similar to the pattern recorded from the nerve cells of a real fish, but the computer could also decipher it to follow the source of the pulse as it moved along different paths.

The next test was whether the array could detect vortices left in the wake of escaping prey. The "prey", in this case, was a cylinder with water flowing around it. This time, the artificial lateral-line system could work out the general direction of the source and identify the pattern of the vortices. Much like weather vanes in whirlwinds, some sensors in a vortex receive water flowing one way while those on the other side find it flows in the opposite direction. Those in the middle are left unruffled, in the eye of the storm.

Having proved his point, Dr Liu is now trying to design sensors that work more like the sense cells in a real lateral line. Instead of heated filaments, these sensors have artificial hairs. The hairs flutter in moving water as flags do in moving air, and the way in which they flutter contains information about the direction and speed of the water moving past them. This principle should allow the team to build more sensitive arrays. Heating filaments in water causes bubbles to form, so turning the power up too much stops them working. Hair sensors do not suffer from the same upper limit.

Artificial lateral lines would have many applications. The most obvious would be in submarines, both manned and unmanned. In the case of military submarines they would have the advantage over sonar of being passive. Sending out a ping is a dead giveaway--literally so, in time of war. And merely listening for sound cannot detect stationary threats. A lateral-line system could. The vortices thrown off by water moving past even a stationary object would be visible to it.

Dr Liu also speculates about using lateral lines to detect air-movements. That could lead to some far less obvious applications, such as a lateral line-enabled iPod that automatically pumps up the volume in response to the onrushing air of an underground train or similar big, noisy object. That would, indeed, be an inventive brush with nature.