Turning to nature for inspiration: Bio-inspired sensors hold promise

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with applications ranging from medical devices to robotics to new consumer goods – Chang Liu looks to biology.

Liu, professor of mechanical engineering and electrical engineering and computer science at Northwestern University's McCormick School of Engineering and Applied Science, is using insights from nature as inspiration for both touch and flow sensors — areas that currently lack good sensors for recording and communicating the senses.

Liu will discuss his research in a symposium at the annual meeting of the American Association for the Advancement of Science (AAAS) in Washington, D.C., to be held Saturday, Feb. 19.

For the past 10 years, Liu has led a research group that develops artificial hair cell sensors. Hair cells provide a variety of sensing abilities for different animals: they help humans hear, they help insects detect vibration, and they form the lateral line system that allows fish to sense the flow of water around them.

"The hair cell is interesting because biology uses this same fundamental structure to serve a variety of purposes," Liu says. "This differs from how engineers typically design sensors, which are often used for a specific task."

By creating artificial hair cells using micro- and nanofabrication technology, Liu's group is increasing sensor performance while

deepening the understanding of how different creatures use these sensors. For example, every fish in the world uses hair cells in the lateral line as sensors, but so far no manmade vehicle does. If a submarine had sensors similar to that of a fish, it could record much more information on water movement.

Liu's current focus is the medical application of these biologically inspired sensors. He hopes that artificial hair cells could be used to measure acoustics in an artificial cochlea or could be embedded as flow sensors in a wide variety of medical devices.

Liu is also developing new touch sensors to improve minimally invasive surgery techniques. Currently many minimally invasive procedures are conducted through a catheter that is inserted into the body and controlled by a doctor on the outside.

"During a heart treatment, the doctor controlling the catheter has no sense of touch and cannot tell if the catheter has touched the heart wall and successfully completed the therapeutic treatment," Liu explains. "We want to use microfabrication technology to put sensors on the end of the catheter to provide feedback."

In order to achieve his goals, Liu has assembled a multidisciplinary team that includes biologists, engineers, materials scientists and physicians. A mix of fundamental and applied research is necessary to make biologically inspired sensors a reality, he says.

"Using a bio-inspired approach is really important," Chang says. "Nature has a lot of wonderful examples that can challenge us. No matter how good some of our technology is, we still can't do some of the basic things that nature can. Nature holds the secret for the next technology breakthrough and disruptive innovation. We are on a mission to find it."

Provided by Northwestern University