Pathogen research inspires robotics design for medicine and military

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A pathogen that attacks the small intestines of humans and animals is serving as the inspiration for developing robots that can fight disease and aid in military operations.

Mingjun Zhang, associate professor in mechanical, aerospace and biomedical engineering, at the University of Tennessee, Knoxville, and his team have made significant findings about the swimming and attachment of the microorganism Giardia. Giardia causes one of the most common gastrointestinal diseases in the world, giardiasis. For 250 years, scientists have tried to understand how the microorganism is able to attach to a multitude of surfaces and swim in harsh environments—enabling it to infect many kinds of species while most parasites have specific hosts. Zhang and his team have made significant progress to solve the puzzle.

"We found each of the four pairs of flagella conducts different functions," Zhang said of some of the team's findings. "This is amazing considering the length of the flagella is only about eight to 12 micrometers each, with a diameter of a few hundred nanometers."

The team's discovery can aid in fighting the pathogen's attack and others like it. The discovery may help to develop a way to block its attachment in the human intestine as an alternative for treating the disease. The discovery may also lead to bio-inspired swimming micro-robots for nanomedicine, such as site-specific controlled drug delivery and less invasive surgical procedures. For instance, micro-robots can navigate

through the body to break up kidney stones, deliver drugs to specific sites after injection and reduce the invasiveness of surgery.

On a larger scale, knowing Giardia's inner workings may buoy an energy-efficient propulsion system for underwater vehicles or designs for quick turn and agile control of underwater vehicles. The findings of Giardia's unique attachment and landing procedures may also inspire a more accurate and quick surface attachment mechanism.

"Giardia seems to be one of the most sophisticated swimming microorganisms and is very efficient and intelligent in terms of controlling its swimming behavior and energy utilization," Zhang said. "It is a source rife with bio-inspiration and innovation."

Provided by University of Tennessee at Knoxville