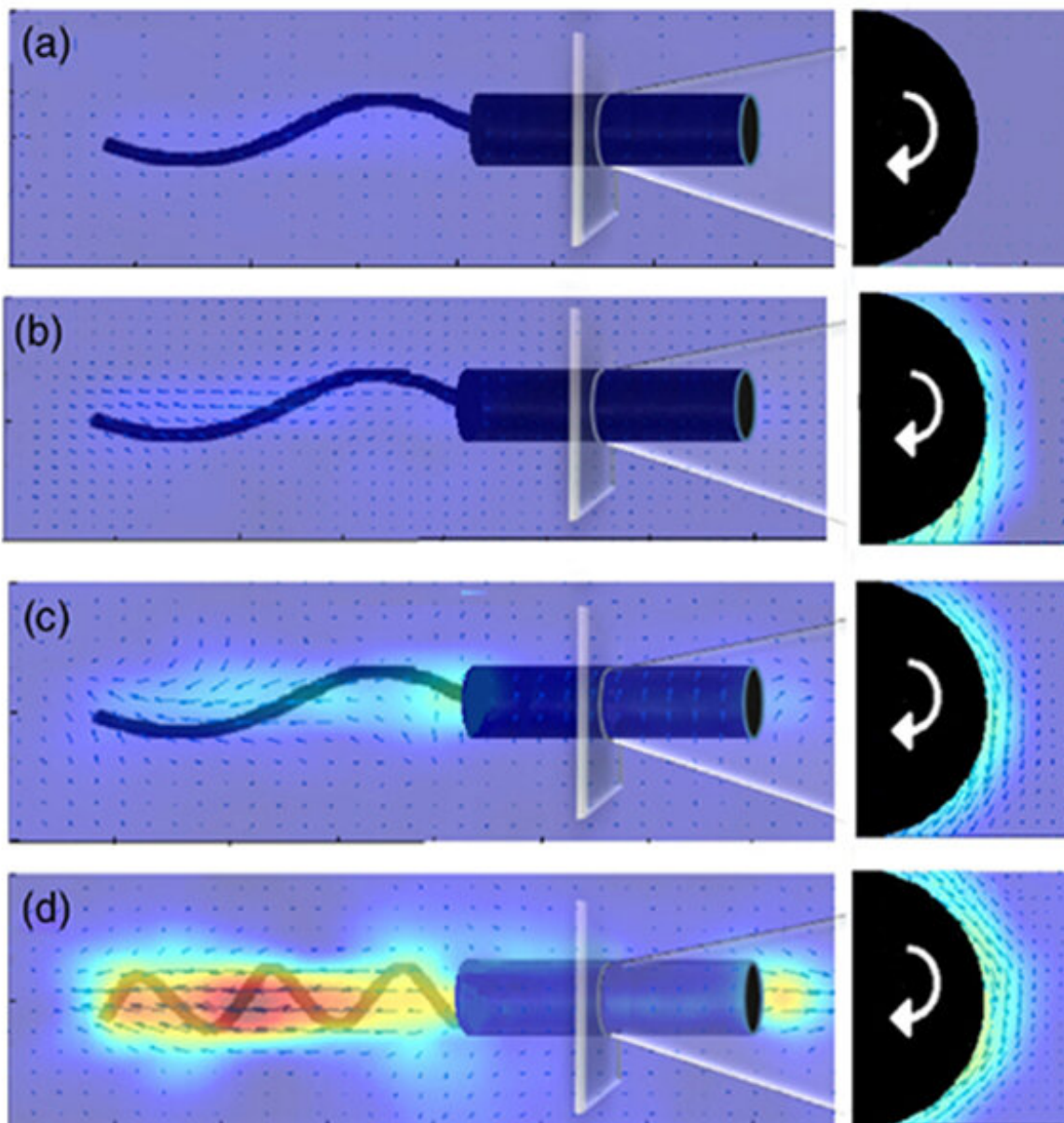


Researchers use 3D models to investigate bacteria movement

May 12 2023, by Trisha Radulovich



An illustration of the 3D printed model of spiral-shaped bacteria made by researchers at the FAMU-FSU College of Engineering. Using particle tracking and imaging techniques, the researchers measured the speed of the bacteria and visualized the distribution and density of the fluid around it. The diagram shows how the fluid around the model changes as the model spins and moves forward. Credit: Hadi Mohammadigoushki

The spiral-shaped bacteria *Helicobacter pylori* are common and troublesome.

More than 13 percent of Americans have an *H. pylori* infection, although rates vary with age, race and socioeconomic status. The microorganism uses its corkscrew-like tail to power forward through viscous fluids such as stomach mucus. When it arrives at the epithelium of the stomach wall, it can cause everything from ulcers to cancer.

In a new study published by *Physical Review Letters*, FAMU-FSU College of Engineering researchers created a 3D model of this bacteria to better understand its movement, hoping to crack the code governing the organism's motility and develop [alternative treatments](#) for infections, such as strengthening the gastric mucus barrier that stands against the bacteria.

"People around the world have treated ulcers with antibiotics because antibiotics kill bacteria, but it's a double-edged sword," said study co-author Hadi Mohammadigoushki, an associate professor in the Department of Chemical and Biomedical Engineering. "If we understand how these bacteria move, we can work toward providing other solutions for treatment."

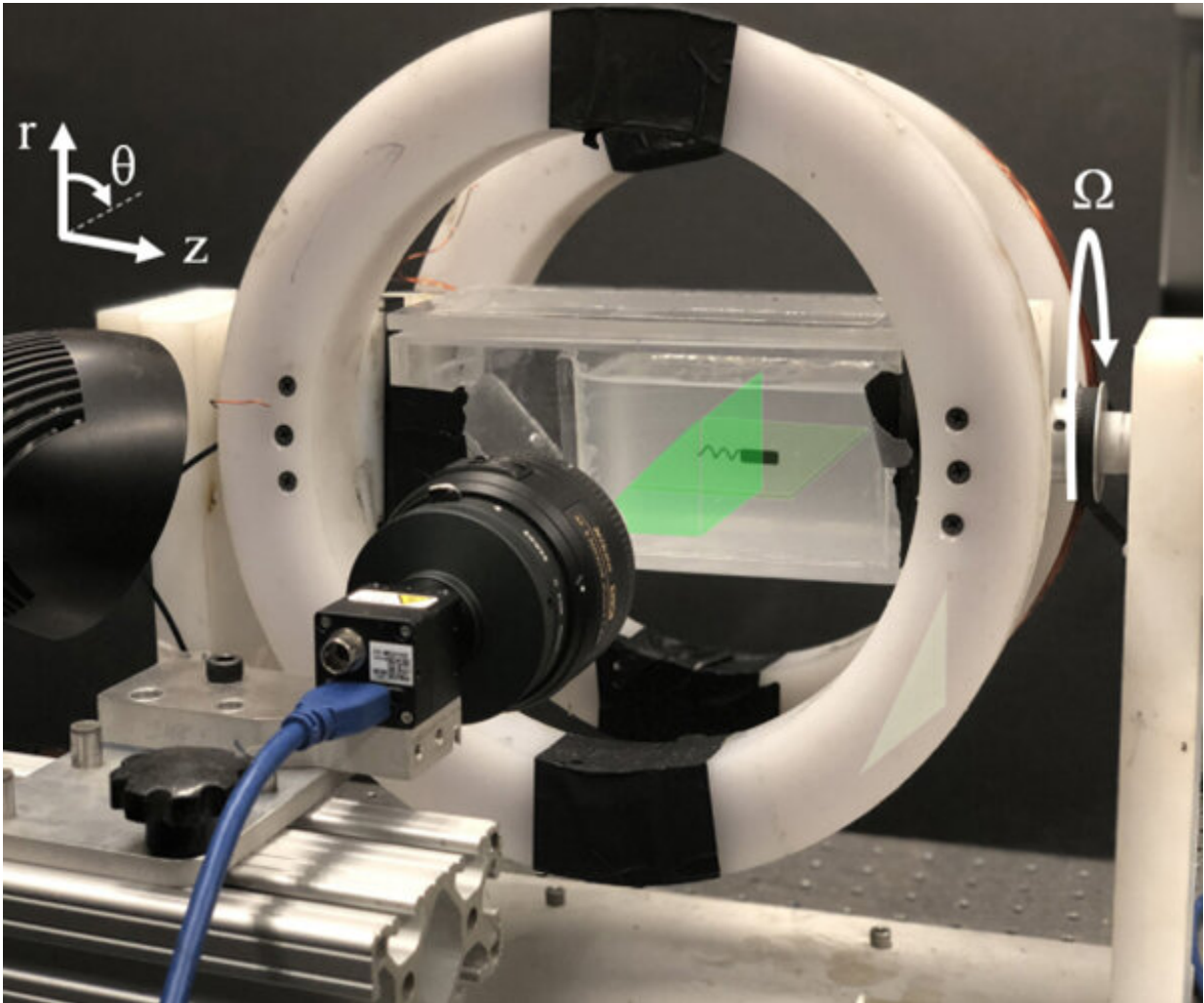
In the experiments, the team placed a model of the bacteria in a high-

viscosity polymer gel, an example of what's called a yield-stress fluid. Those fluids behave as solids under small stresses but flow like liquids beyond a critical stress point.

Then they used a [magnetic field](#) to rotate the 3D model, mimicking the behavior of the microorganism. Using [particle tracking](#) and [imaging techniques](#), the researchers measured the speed of the bacteria and visualized the distribution and density of the fluid flowing around it.

The researchers identified two critical thresholds that the bacteria must overcome: the torque needed to rotate the swimming model and the [force](#) needed to propel the model forward.

"We found that if the tail propulsion was too weak, the bacteria remain stuck in the gel," Mohammadigoushki said. "If the force was strong enough it could penetrate the gel. It's kind of like when you are drilling a screw into a solid wall. If your drill isn't strong enough and you are not pushing the screw with enough force, it won't penetrate the wall, but with the right amount of force, it can break through."



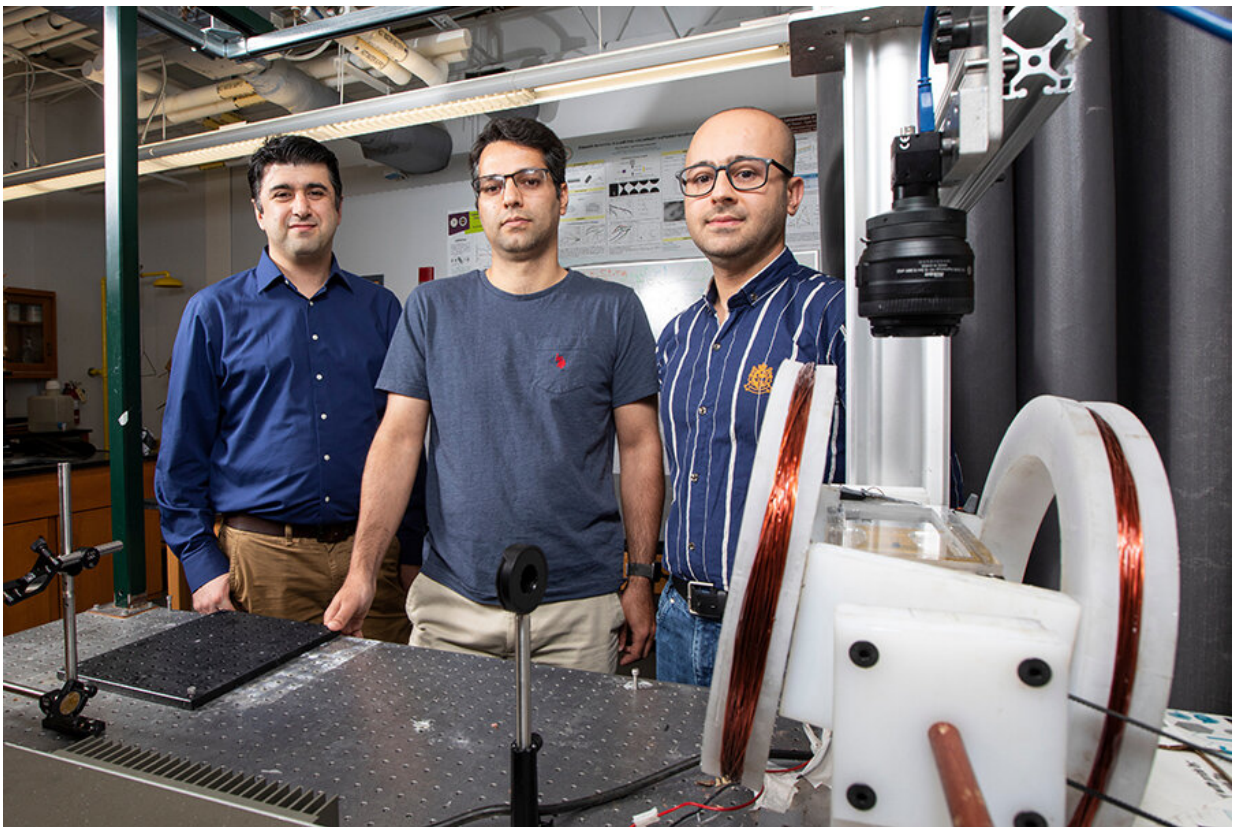
The custom-made rotating Holmholtz coil used in this study to activate the helical swimmer. This apparatus is rotating with a constant angular velocity (Ω). The green shaded zones show different planes for the analysis around the swimmer. Credit: Hadi Mohammadigoushki

The swimming motions and force that allow *H. pylori* to move also apply to larger objects, such as earthworms that burrow in the soil, various parasites and more.

"If we understand how the [bacteria](#) successfully move to attack our body,

we can use that information for whatever we can imagine," said Kourosh Shoele, an assistant professor in the Department of Mechanical Engineering.

Shoele is part of the multidisciplinary research team and is an expert in computational science. He explained how learning from nature can get a better response from mechanical and biological systems.



Kourosh Shoele, an assistant professor of Mechanical Engineering, Hadi Mohammadigoushki, Associate Professor of Chemical and Biomedical Engineering and Farshad Nazarinasrabad, a doctoral candidate in chemical engineering at the FAMU-FSU College of Engineering. Credit: Mark Wallheiser/FAMU-FSU College of Engineering

"In the future, we can design a micro-robot that can deliver a drug to a particular location in the body, in terms of fighting leukemia and other diseases," Shoele said. "Or perhaps we can design [tiny robots](#) that use swimming motion and force, like *H. pylori*, that can dig deep in the sand to explore for water or oil. The possibilities are endless."

Farshad Nazari, an FSU doctoral student in chemical and [biomedical engineering](#), is working with the two researchers and is the leading author of this paper.

More information: Farshad Nazari et al, Helical Locomotion in Yield Stress Fluids, *Physical Review Letters* (2023). [DOI: 10.1103/PhysRevLett.130.114002](#)

Provided by Florida State University

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