

Using microorganisms to quickly monitor water quality

June 16 2021



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Researchers from the Singapore University of Technology and Design (SUTD) have demonstrated a technology that rapidly detects pollutants in water by measuring their impacts on swimming microorganisms.

Their proof-of-concept, published in *Scientific Reports*, does not require any chemicals, reagents or laboratory equipment. Instead, it leverages the regular camera of a smartphone as well as microorganisms called *Paramecia* that are ubiquitous in [water bodies](#)—making it especially suitable for assessing water drinkability in underdeveloped regions.

Typically, levels of environmental pollutants are measured by assessing their impact on a given population. Though such impacts may be visible after several days for microorganisms, it takes several years for the true scale to be revealed in larger animals.

To accelerate these measurements, researchers led by Assistant Professor Javier Fernandez at the Fermat Lab used a simple computer vision method to track and measure the impact of pollutants on the behavior of microorganisms. Specifically, they used the changes in the swimming speed of *Paramecium aurelia*—a single-celled organism can move at surprising speeds of more than ten times their body length per second.

"We chose *Paramecia* because they are ubiquitous in water bodies and large enough to be seen with a normal camera," explained Fernandez. "They are also fast swimmers, so small differences in their swimming speed will translate to large changes, making them easy to measure."

By tracking the swimming speeds and movements of waterborne *Paramecia* through a simple microscope set up on camera phones, they found that they could accurately infer the presence of pollutants in water samples within minutes.

To track the *Paramecia*, the team recorded videos, then ran an object identification and tracking algorithm that would detect the creatures automatically and calculate their swimming speeds and movement.

"Swimming speeds are slightly different between [different individuals](#).

But with all this data, we are able to reduce the impact of that variability and obtain general features of their swimming," said Fernandez.

Through their efforts, the researchers showed that the swimming speeds of *Paramecia* are affected by pollutants like the heavy metals zinc chloride and copper sulfate, as well as the common antibiotic erythromycin. These changes occurred within the range of the pollutants' permissible limits; for instance, at heavy metal concentrations half of those considered unsafe for drinking water, the average swimming speed of *Paramecia* was nearly halved.

Likewise, there were immediate and significant reductions to the swimming speed of *Paramecia* at concentrations considered hazardous—potentially allowing researchers to quickly evaluate a specific [pollutant](#)'s impact in a specific environment.

"Taking a sample of water and measuring the speed of *Paramecia* can therefore be used as a straightforward method to assess the drinkability of water without the need for specialized equipment or chemicals," said Fernandez. "Usually, you would need a different test for each pollutant, but *Paramecia* swimming is a global measurement."

The team designed the system under the umbrella of what is known as "frugal engineering," where advanced methods like object tracking and analysis perform tasks with minimal frills, enabling widespread applicability with little resources.

According to the authors, the demonstrated correlation between the swimming [speed](#) of microorganisms and pollutant presence, and its assessment in just a few minutes, can be used as a straightforward, resourceless way to assess water quality globally or as a substitute for standardized methods to measure toxicity in laboratory environments.

"In the future, someone might try a different type of microorganism. Various pollutants would affect organisms differently, so pulling data together from multiple [microorganisms](#) would enable us to better understand the source of the pollutants," concluded Fernandez. "What we've demonstrated proves that we can get information on [water](#) quality in a cheap and simple way, without any technical instruments and in no time at all."

More information: Ashaa Preyadharishini Shunmugam et al, Measurements of the swimming speeds of motile microorganisms using object tracking and their correlation with water pollution and rheology levels, *Scientific Reports* (2021). [DOI: 10.1038/s41598-021-91134-1](https://doi.org/10.1038/s41598-021-91134-1)

Provided by Singapore University of Technology and Design

Citation: Using microorganisms to quickly monitor water quality (2021, June 16) retrieved 19 April 2024 from <https://phys.org/news/2021-06-microorganisms-quickly-quality.html>

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