New moves for self defense—how plants can inspire future soft robotic design

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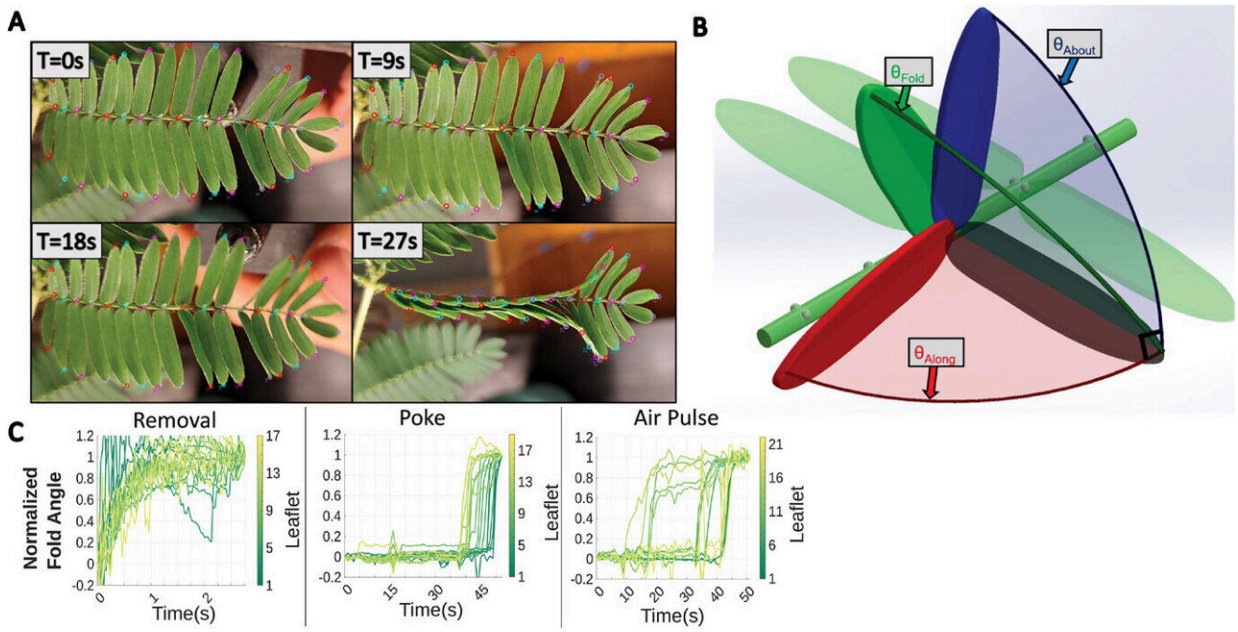

A) Four snapshots of M. pudica during stimulation via poking with blunt AWG23 (American Wire Guage) metal tip, showing a propagation of actuation between T = 18 s and T = 27 s. B) Kinematic coordinate system used. θ_{about} . Credit: *Advanced Science* (2024). DOI: 10.1002/advs.202404578

For plants, cleaning the air, providing food and medicines, and preserving our ecosystem is just another day's work. In the Department of Mechanical Engineering at Carnegie Mellon University, however, plants are being studied in new ways to inspire future biohybrid soft

robotic designs.

"Plants are a system much like planes, trains, and automobiles," explained Phil LeDuc, Professor of Mechanical Engineering. "We want to understand plants' mechanical systems, especially their sensing and signaling behavior, to potentially integrate them into biohybrid systems."

Mimosa pudica, the subject of the study recently published in *Advanced Science*, rapidly closes its leaves when exposed to touch, wind, temperature and various other stimuli. Researchers theorize that this response is potentially an evolutionary advantage to protect against predators.

Alex Naglich, a Ph.D. candidate in the Department of Mechanical Engineering, observed Mimosa pudica's responses to three different mechanical stimuli to gain a better understanding of its macroscopic behavior. To emulate a predator, Naglich cut a cluster of leaves from the plant and watched as nearby clusters folded together immediately in seemingly self defense.

When Naglich prodded just one leaf on the plant to create a mild disturbance, like that an insect might cause, only the affected leaf folded. After repeated poking, however, the leaves folded one after another the whole way down the plant. For the final test, Naglich used an air pulse to imitate wind and found that only the leaves directly affected by the pulse of air folded.

"When mimosa folds, it's less efficient for photosynthesis, so it makes sense why it wouldn't want to stay folded," Naglich said. "If a light breeze is only hitting a couple of leaves, why hide the entire plant?"

While the "intelligent" plant's small size, impressive power density, and high efficiency make it a promising candidate to act as a biohybrid

actuator, Naglich also believes its response system could be the foundation for improved agricultural health monitoring.

"If we can continue to explore this plant's intelligence, its ability to distinguish against threats and respond accordingly, we could integrate it with electronics to create a biohyrbid sensor and place it among crops so that farmers can be notified in real time when there's a disturbance in the field."

Moving forward, the lab plans to explore how Mimosa pudica's physical structure plays a role in its behavior.

"When it comes to biohybrid robotic research, there are a lot of naturally occurring mechanisms that could advance the field and we just haven't looked into them yet," said LeDuc. "Plants are one of those complex and sophisticated systems that we need to be studying more."

More information: Alex Naglich et al, Plant Movement Response to Environmental Mechanical Stimulation Toward Understanding Predator Defense, *Advanced Science* (2024). DOI: 10.1002/advs.202404578

Provided by Carnegie Mellon University Mechanical Engineering