

# You can't squash this roach-inspired robot

By [Kara Manke](#) | JULY 31, 2019

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This robot has some eerie similarities to cockroaches



**A new insect-sized robot scurries at the speed of a cockroach and can withstand the weight of a human. (UC Berkeley video by Stephen McNally)**

If the sight of a skittering bug makes you squirm, you may want to look away — a new insect-sized robot created by researchers at the University of California, Berkeley, can scurry across the floor at nearly the speed of a darting cockroach.

And it's nearly as hardy as a cockroach, too. Try to squash this robot under your foot, and more than likely, it will just keep going.

"Most of the robots at this particular small scale are very fragile. If you step on them, you pretty much destroy the robot," said Liwei Lin, a professor of mechanical engineering at UC Berkeley and senior author of a new study that describes the robot. "We found that if we put weight on our robot, it still more or less functions."

Small-scale robots like these could be advantageous in search and rescue missions, squeezing and squishing into places where dogs or humans can't fit, or where it may be too dangerous for them to go, said Yichuan Wu, first author of the paper, who completed the work as a graduate student in mechanical engineering at UC Berkeley through the **Tsinghua-Berkeley Shenzhen Institute** partnership.

"For example, if an earthquake happens, it's very hard for the big machines, or the big dogs, to find life underneath debris, so that's why we need a small-sized robot that is agile and robust," said Wu, who is now an assistant professor at the University of Electronic Science and Technology of China.

The **study** appears today (Wednesday, July 31) in the journal *Science Robotics*.



**The robot is built of a layered material that bends and straightens when AC voltage is applied, causing it to spring forward in a “leapfrogging” motion. (UC Berkeley photo by Stephen McNally)**

The robot, which is about the size of a large postage stamp, is made of a thin sheet of a piezoelectric material called polyvinylidene fluoride, or PVDF. Piezoelectric materials are unique, in that applying electric voltage to them causes the materials to expand or contract.

The researchers coated the PVDF in a layer of an elastic polymer, which causes the entire sheet to bend, instead of to expand or contract. They then added a front leg so that, as the material bends and straightens under an electric field, the oscillations propel the device forward in a “leapfrogging” motion.

The resulting robot may be simple to look at, but it has some remarkable abilities. It can sail along the ground at a speed of 20 body lengths per second, a rate comparable to that of a cockroach and reported to be the fastest pace among insect-scale robots. It can zip through tubes, climb small slopes and carry small loads, such as a peanut.

Perhaps most impressively, the robot, which weighs less than one tenth of a gram, can withstand a weight of around 60 kg — about the weight of an average human — which is approximately 1 million times the weight of the robot.

“People may have experienced that, if you step on the cockroach, you may have to grind it up a little bit, otherwise the cockroach may still survive and run away,” Lin said. “Somebody stepping on our robot is applying an extraordinarily large weight, but [the robot] still works, it still functions. So, in that particular sense, it’s very similar to a cockroach.”

The robot is currently “tethered” to a thin wire that carries an electric voltage that drives the oscillations. The team is experimenting with adding a battery so the robot can roam independently. They are also working to add gas sensors and are improving the design of the robot so it can be steered around obstacles.

Co-authors of the paper include Justin K. Yim, Zhichun Shao, Mingjing Qi, Junwen Zhong, Zihao Luo, Ronald S. Fearing and Robert J. Full of UC Berkeley, Xiaojun Yan of Beihang University and Jiaming Liang, Min Zhang and Xiaohao Wang of Tsinghua University.

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