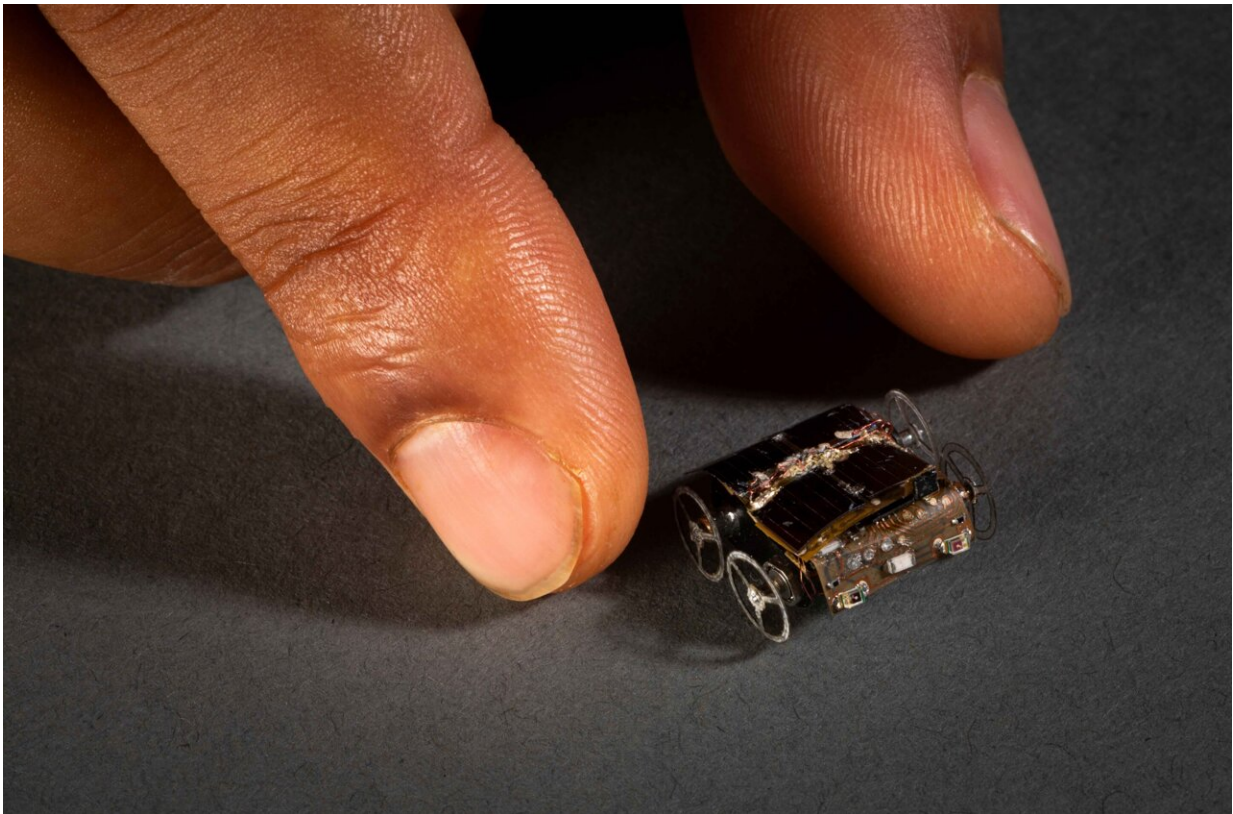


# MilliMobile is a tiny, self-driving robot powered only by light and radio waves

September 27 2023, by Stefan Milne

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Researchers at the University of Washington have created MilliMobile, a tiny, self-driving robot powered only by surrounding light or radio waves. It's about the size of a penny and can run indefinitely on harvested energy. Credit: Mark Stone/University of Washington

Small mobile robots carrying sensors could perform tasks like catching

gas leaks or tracking warehouse inventory. But moving robots demands a lot of energy, and batteries, the typical power source, limit lifetime and raise environmental concerns. Researchers have explored various alternatives: affixing sensors to insects, keeping charging mats nearby, or powering the robots with lasers. Each has drawbacks: Insects roam, chargers limit range, and lasers can burn people's eyes.

Researchers at the University of Washington have now created MilliMobile, a tiny, self-driving robot powered only by surrounding light or radio waves. Equipped with a solar panel-like energy harvester and four wheels, MilliMobile is about the size of a penny, weighs as much as a raisin and can move about the length of a bus (30 feet, or 10 meters) in an hour even on a cloudy day. The robot can drive on surfaces such as concrete or packed soil and carry three times its own weight in equipment like a camera or sensors. It uses a [light sensor](#) to move automatically toward light sources so it can run indefinitely on harvested power.

The team will present [its research](#) Oct. 2 at the [ACM MobiCom 2023 conference](#) in Madrid, Spain.

"We took inspiration from 'intermittent computing,' which breaks complex programs into [small steps](#), so a device with very limited power can work incrementally, as energy is available," said co-lead author Kyle Johnson, a UW doctoral student in the Paul G. Allen School of Computer Science & Engineering.

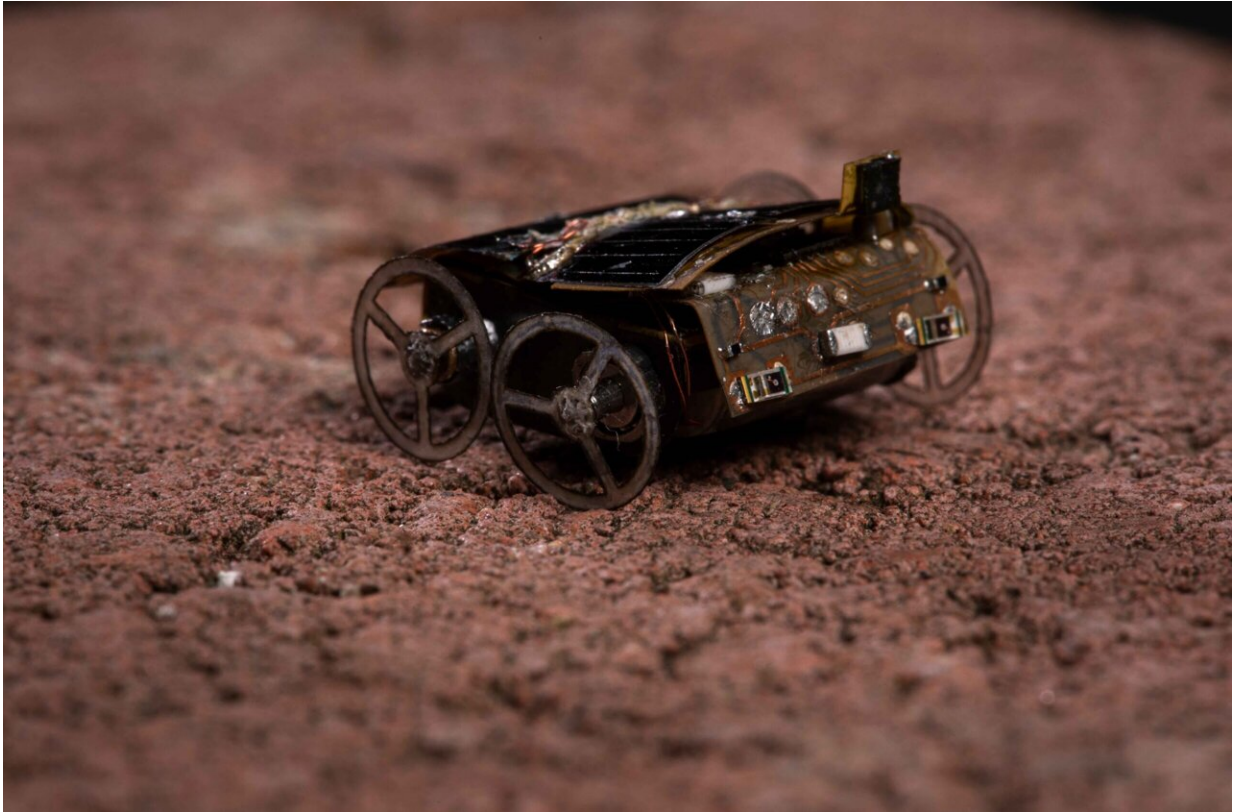
"With MilliMobile, we applied this concept to motion. We reduced the robot's size and weight so it takes only a small amount of energy to move. And, similar to an animal taking steps, our [robot](#) moves in discrete increments, using small pulses of energy to turn its wheels."

The team tested MilliMobile both indoors and outdoors, in environments

such as parks, an indoor hydroponic farm and an office. Even in very low light situations—for instance, powered only by the lights under a kitchen counter—the robots are still able to inch along, though much slower. Running continuously, even at that pace, opens new abilities for a swarm of robots deployed in areas where other sensors have trouble generating nuanced data.

These robots are also able to steer themselves, navigating with onboard sensors and tiny computing chips. To demonstrate this, the team programmed the robots to use their onboard light sensors to move towards a light source.

"'Internet of Things' sensors are usually fixed in specific locations," said co-lead author Zachary Enghardt, a UW doctoral student in the Allen School. "Our work crosses domains to create robotic sensors that can sample data at multiple points throughout a space to create a more detailed view of its environment, whether that's a smart farm where the robots are tracking humidity and [soil moisture](#), or a factory where they're seeking out electromagnetic noise to find equipment malfunctions."



The tiny robot is able to move across a variety of surfaces, including concrete and packed soil. Credit: Mark Stone/University of Washington

Researchers have outfitted MilliMobile with light, temperature and humidity sensors as well as with Bluetooth, letting it transmit data over 650 feet (200 meters). In the future, they plan to add other [sensors](#) and improve data-sharing among swarms of these robots.

Vicente Arroyos, a UW doctoral student in the Allen School, was a co-lead author. Dennis Yin, who completed this work as UW undergraduate in electrical and computer engineering, and Shwetak Patel, a UW professor in the Allen School and in electrical and computer engineering, are co-authors, and Vikram Iyer, a UW assistant professor in the Allen School, is the senior author.

**More information:** Kyle Johnson et al, MilliMobile: An Autonomous Battery-free Wireless Microrobot, [DOI: 10.1145/3570361.3613304](https://doi.org/10.1145/3570361.3613304)  
[homes.cs.washington.edu/~vsiye ... obile-compressed.pdf](https://homes.cs.washington.edu/~vsiye...obile-compressed.pdf)

Provided by University of Washington

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