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| ARTIFICIAL INTELLIGENCE

A NEW FRONTIER OF AI-ENABLED GADGETS

Researchers are working on a wave of sophisticated devices for the home, from toilets that screen for viruses to robots that find missing keys

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T*he Future of Everything covers the innovation and technology transforming the way we live, work and play, with monthly issues on health, money, cities and more. This month is Artificial Intelligence, online starting July 2 and in the paper on July 9.*

Toilets that screen for disease



ILLUSTRATION: RUTH GWILY

Analyzing poop is an important way to prevent and diagnose gastrointestinal diseases, but the taboo around collecting it can make screening challenging, according to a 2014 study published in the British Journal of General Practice. Smart toilets could help change that.

Researchers at Stanford University have developed a prototype toilet that uses an artificial intelligence-trained camera to track the form of feces and monitor the color and flow of urine. A “lab-on-a-chip” device built into the toilet will analyze micro stool samples to detect viruses like Covid-19 and blood, says Seung-min Park, the lead researcher on the project. This digital diary could yield valuable health insights and facilitate early, noninvasive diagnosis of irritable bowel syndrome or colorectal cancer, Dr. Park says.

An app would allow users to track health parameters. The toilet could identify individual users by scanning their anus' unique characteristics, or anal print. Dr. Park says his team has signed an agreement with Izen, a Korean toilet maker, to manufacture the toilet. A unit would cost between \$300 and \$1,000.

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Scientists at Duke University are also developing a toilet that collects and analyzes waste, but after it has been flushed. The system, which uses AI-powered cameras and biochemical sensors, is more complex to install but preserves the user's privacy and could allow health authorities to monitor wastewater for pathogens such as Covid-19 at the building or even neighborhood scale, says Sonia Grego, the founding director of the Duke Smart Toilet Lab.

The toilet could be rolled out in the next couple of years, she says.

A new sense of smell

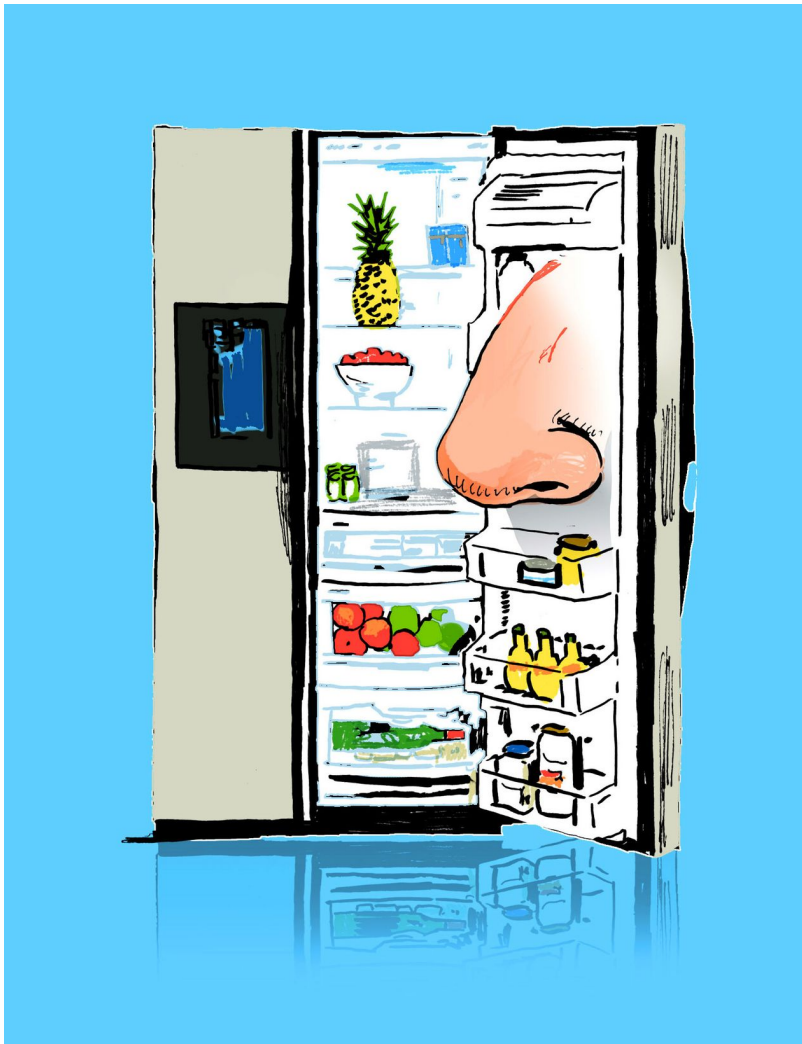


ILLUSTRATION: RUTH GWILY

Electronic noses that use AI could make our homes safer and our food tastier.

Just as algorithms can be trained to recognize unique words in a sentence, they can also be trained to identify and quantify odors in a complex sensory environment, says Ashok Prabhu Masilamani, the founder of Stratuscent, a Montreal-based tech company. Stratuscent last year launched a chip that can detect and catalog toxic fumes and volatile chemicals in indoor spaces. In the next few years, this “e-nose” could be embedded in a smart home’s ventilation system or an air purifier to improve air quality based on real-time monitoring, says Dr. Masilamani.

E-noses could also be integrated in smart fridges to detect early signs of expiring food and guide users to items that will expire next, says Dr. Masilamani. Scientists at the Nanyang Technological University of Singapore have developed a colored bar code that reacts to gasses from decaying food and a bar code reader that uses AI models to predict food freshness, according to a study published in the Advanced Materials journal in October.

Finder of lost keys



ILLUSTRATION: RUTH GWILY

Scientists are working to end the curse of lost TV remotes and misplaced keys. Researchers at the Massachusetts Institute of Technology's Signal Kinetics research group have developed a robot that uses AI and wireless technologies to find hidden objects.

To spot a wallet wedged between cushions on a sofa, for instance, a roving robot outfitted with a robotic arm will send radio waves bouncing off an RFID tag—a sophisticated bar code now used by retailers and manufacturers—printed on the item. It will then analyze electromagnetic signals to calculate the distance to the target item, use a built-in camera to navigate to the sofa and lift the cushions until the wallet comes into sight and can be picked up. An algorithm will help the robot adapt its rummaging and grasping to changing objects and environments.

The latest version of the robot has a 96% success rate at finding and picking up objects in a lab setting, including clothes and household items, says Fadel Adib, the research group's founding director.

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In the future, this home helper could also retrieve a specific wrench or screwdriver from a toolbox and assist a human in assembling a piece of furniture, says Dr. Adib. It might tidy up a

home and place objects where one might expect to find them. “It’s a Roomba on steroids,” Dr. Adib says.

The researchers are aiming to make the robot available to consumers in five to 10 years at a cost of between \$500 and \$1,000, he says.

An in-home recycling center



ILLUSTRATION: RUTH GWILY

Tossing a container in the wrong recycling bin is enough to spoil a whole batch of material, according to the Environmental Protection Agency. New home appliances could help solve this problem.

Lasso, a California-based startup, has raised \$1.6 million to develop a smart bin that sorts, cleans and recycles a household’s used materials. Users load metal, plastic and glass items into a “sensing chamber” where an AI-powered camera and infrared sensors sort them by material. The appliance then steam cleans containers and sends them to a grinder where they are processed into plastic flakes, crushed glass and metal shreds.

Users will be able to dispose of the recycled material by arranging between three and eight pickups a year by Lasso’s collection teams, says Aldous Hicks, the company’s chief executive.

Future versions of the robot could process plastic films, paper and cardboard, and, eventually, organic materials including food scraps.

Units are set to go on sale in 2024 and be sold at around \$3,500, Mr. Hicks says.

AI in a shoe

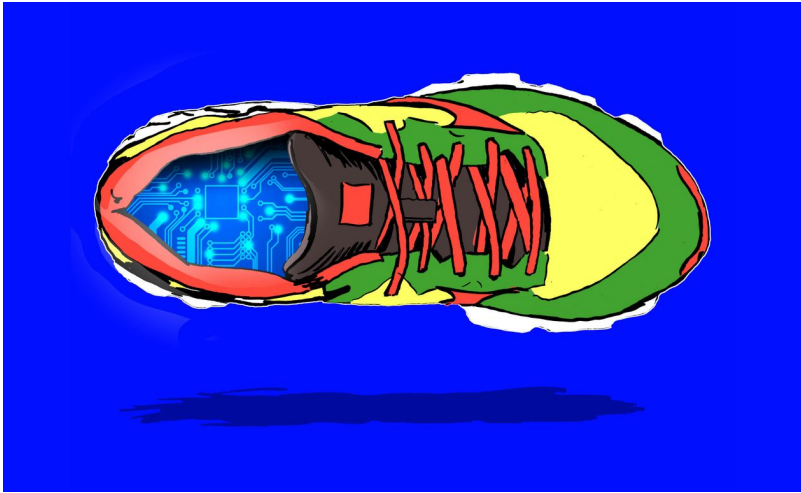


ILLUSTRATION: RUTH GWILY

Intelligent shoes could help identify early signs of motor disorders and make runners better athletes.

Smart insoles that analyze wearers' gaits and keep track of their steps already exist but aren't very accurate, says Damiano Zanotto, the director of the Wearable Robotic Systems Lab at the Stevens Institute of Technology. This could change with SportSole, a new system developed by Dr. Zanotto and his team.

It uses AI models to analyze data provided by sensors and more accurately measure the speed and length of a user's stride in real time, says Dr. Zanotto. Runners could use SportSole to get real-time feedback on their techniques and compare their performances to those of top athletes. Dr. Zanotto wants to make the product available to consumers by mid-2023.

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SportSole could also help diagnose neurological disorders that affect motor functions, quantify the efficacy of medical treatments, or reduce the risk of accidental falls among the elderly by flagging haphazard step patterns, he says. “You want to be able to capture subtle changes in those gait parameters,” Dr. Zanotto says. The technology is currently being used by researchers at Stanford and Columbia universities to monitor children with motor disorders and will soon be used at the University of Texas Medical Branch at Galveston to help with physical therapy for Covid-19 long-haulers, he says.

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