In the future, robots will perform surgery, shop for you, and even recycle themselves

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Daniela Rus is a robot evangelist.

She challenged a packed audience in the Interdisciplinary Science and

Engineering Complex on Tuesday to imagine a world where robots free us to be more creative by taking care of all our physical tasks—from playing with our pets to performing surgery without an incision.

As director of the Massachusetts Institute of Technology's Computer Science and Artificial Intelligence Laboratory, Rus delivered the inaugural lecture in Northeastern's Distinguished Speaker Series in Robots.

"Imagine a world where you're being driven home by your autonomous car," said Rus. "Your car is connected to your refrigerator, which tells it what ingredients you need for dinner. The car is also connected to the grocery store, which is run by robots that fill your bags so they are ready when you drive up. Then you bring the food home to the robot cook and you happily let your children help in the kitchen even though they make a mess, because the mess will be taken care of by the cleaning robot."

"I know this sounds like a futuristic cartoon, but it's not that far off."

While conceding that many of the innovations she discussed are still in the formative stages, she enthralled the audience with eye-popping demonstrations of the early iterations of a variety of futuristic robot applications.

Self-assembling robots

One way to accelerate robot development is to create robots that can build themselves— and reconfigure themselves into whatever shape is best for performing the task at hand.

While this might sound farfetched, Rus pointed out that this is the way nature already works, reconfiguring the building blocks of life into frogs, birds, and alligators. What if we could create a miniature robot cell that

could assemble itself into wide range of tools?

Not only is this possible, it's already being done.

Rus showed a video of robot cells created at MIT that can assemble themselves into different shapes. Granted, these one-centimeter cubes are not nearly small enough yet, but they do provide a proof of concept. With no human controlling them, these dice-sized blocks roll across the table and climb atop one another, assembling themselves into various pre-determined patterns.

Rus predicted that we will soon be able to create smaller, more sophisticated cells that can assemble themselves into a snakelike robot that can slither through small places, then reassemble itself into a slinky that can climb stairs.

Robot surgery

"What if I told you that we will be able to use robots to perform surgery with no incision, no risk of infection, and no pain?" asked Rus.

She demonstrated the concept with a video of simple stomach surgery performed by a tiny robot inside an artificial stomach.

The task: every year, 3,500 people swallow button batteries, the little silver discs that power watches, pacemakers, and hearing aids. These batteries often get lodged in the stomach and, if they aren't passed through the system quickly, they become embedded in the stomach lining and have to be surgically removed.

To perform the surgery, a robot the size of your pinky fingernail is incased in a pill made of ice. The pill is swallowed and melts in the stomach, releasing the robot. The robot then propels itself across the

stomach, locates the battery, and pulls it out of the stomach lining. The patient then swallows a second pill that contains a robot that delivers medicine to help heal the wound.

Origami robots

One of the most promising ways to reduce the cost of robot manufacturing is to develop origami robots that are printed in flat sheets and then intricately folded into robots that can perform specific tasks.

Because they are 3-D printed, these robots are inexpensive to manufacture. The biggest cost is the time spent manually folding the complex designs into a working robot. So what if these origami robots could fold themselves?

Again, it's already being done, according to Rus.

Instead of manufacturing an origami template as a single sheet, it's produced as a two-ply sheet with one layer made of a static substance like metal and the other made of a substance that shrinks when heated, like the child's toy Shrinky Dinks. To determine where the folds will be, you leave thin gaps in the metal substance wherever you want the two-ply sheet to fold. The angle of the fold is determined by the width of the gap in the metal.

Once the design is completed and the two-ply sheet printed, all you have to do is place the sheet on a heated surface and, voila, it folds itself.

Many developments underway

Rus showed robotic models of flying cars, robots that can recycle themselves, and lightweight robotic muscles made of tiny airbags that

inflate and deflate to mimic muscular contraction. These early-stage muscles can lift three times their own weight, and Rus said when they are attached to a skeletal system with joints, the possibilities will be endless.

Rus also described how developers are making robots more versatile by developing exoskeletons designed to perform specific tasks. "The robots can put on and take off these exoskeletons much like a human puts on a coat," said Russ. One exoskeleton might allow the robot to climb through a rugged landscape, while others might be for fine motor dexterity or to carry objects efficiently.

She also described efforts to create robots that can learn from a human who knows nothing about computer coding. "Today, you can drive a car without knowing anything about how the engine works," she said. "And soon, you will be able to program a robot just as easily."

She described how robots are being programed to learn by "watching" a human perform a complex task. The human wears a system of sensors on his arms, hands, torso, and legs, and these sensors are connected to the robot. As the person performs the task, of his movements are transmitted to the robot, which is pre-programed memorize how to perform the jobs. No additional coding is required.

"The possibilities are endless," said Rus. "And a world with a lot of robots is a world with a lot of fun."

Provided by Northeastern University