SEE THE UNREACHABLE

A 2-INCH-WIDE ROBOT CALLED MAX SLITHERED THROUGH PIPES during a test demonstration in a nuclear power plant. Its developers see the 37-inch-long snake robot simplifying plant inspection and taking on other jobs, too. The same algorithms developed for the inspection routine could slash the time needed to program a robot to paint a car, said Max's lead developer, Howie Choset, a robotics professor at Carnegie Mellon University.

Max consists of 16 segments connected to one another by universal joints. A video camera sits in the front and a power cable trails from the rear. The robot is slender enough to crawl through pipes, joints, and valves as narrow as 3 inches.

"There's all kinds of places that really are either incredibly difficult to inspect or don't get inspected at all," Choset said. "We believe that this snake robot technology can really get to almost all places in the nuclear power plant."

The snake replaces a borescope, a camera fixed on a rod that inspectors push into pipes. Borescopes do not extend very far or make multiple turns.

The snake's camera software uses the robot's sensors and accelerometers to correct images so they always align with gravity. Whatever inspectors see is always right side up. This gives inspectors a much clearer picture of the vessel than they get with a borescope, whose image rotates as technicians twist it through the pipes.

According to Choset, the stable camera view greatly impressed power plant inspectors during a test run at a never-commissioned nuclear plant in Zwentendorf, Austria.

While developing Max, Choset invented new algorithms to rapidly calculate the path needed to inspect all pipe surfaces. He said similar routines can automate the calculation of robot arm movements needed to paint cars.

"It takes about three to five months to program the robots to paint the car." Choset said. "The coverage algorithms have the potential to reduce that to two weeks."

Choset also developed new ways to estimate the robot's location and determine its actions inside the pipes by fusing information about the robot's speed, direction, and sensor data with partly constructed maps of the robot's location.

"We developed algorithms that weigh these pieces of information to produce an accurate location," Choset said.

Max still has some kinks. Its power cable sometimes catches after a few turns, though Choset plans to fix this by adding a tether to pull it free. He wants to harden Max to survive radioactive environments. He also plans to shrink Max's diameter to 1 inch so it can wiggle through smaller openings. **ME**

ARIANA MARINI

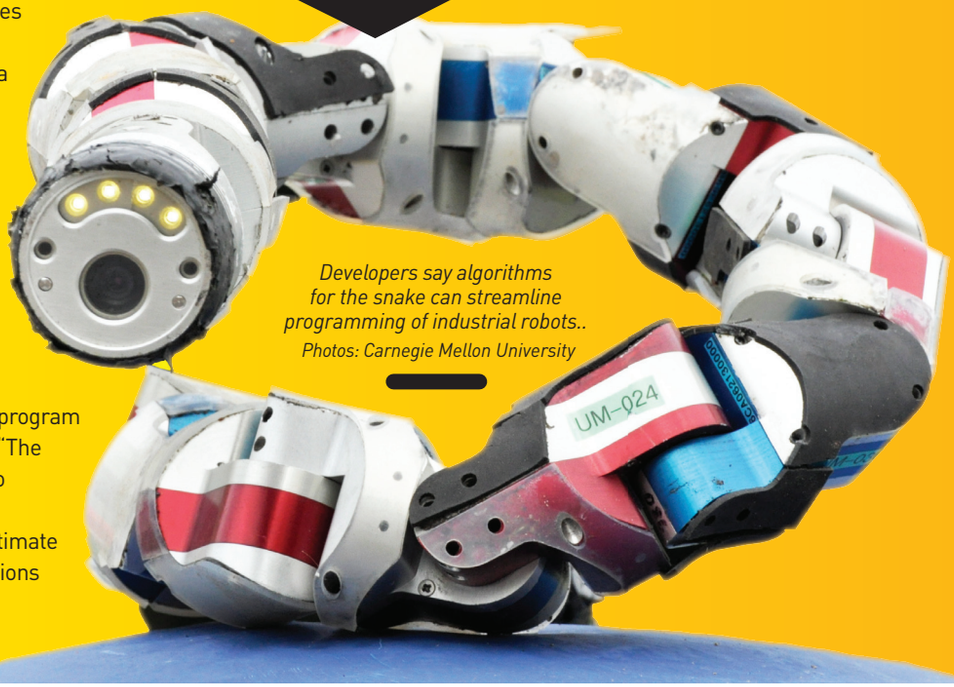
QUICK FACTS:

WHAT IT IS:
Robotic snake that gets into hard-to-reach places.

COMPONENTS:
16 segments connected by universal joints.

APPLICATION:
When it is equipped with a camera, inspectors can use the robot to check otherwise inaccessible areas for damage.

DEVELOPER:
Biorobotics Lab, Carnegie Mellon University.



Developers say algorithms for the snake can streamline programming of industrial robots..
Photos: Carnegie Mellon University