Robotics 101 with NASA's Chris McQuin + Jaret Matthews

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A University of Waterloo Robotics Team member tests their robot on the practice field two days prior to the NASA WPI Sample Return Robot Centennial Challenge. Credit: NASA/Bill Ingalls

(Phys.org) -- When you hear the word "robot," you might think of Hollywood creations such as the Terminator, C-3PO or Megatron. Thankfully, the reality of current robotics isn't quite that sinister, emotional or out for world domination.

In fact, robots are primarily designed to help us, whether they are performing dangerous or difficult tasks, repetitive labor or just making life easier (think: self-vacuuming robot). Although they can't "think" for themselves in a literal sense, they can be very intuitive and self-sufficient, relying on their components to figure out what do to next, and the more advanced robotics technologies become, the "smarter" they will continue to get.

What *IS* a Robot?

"It is very difficult to fully capture and define a robot," said Christopher McQuin, a NASA mechanical robotics engineer. "The word means different things to different people."

The term "robot" originated in 1921, derived from the Czech word "robota," meaning forced labor or work. While experts differ on the exact definition and classification, a robot is generally agreed upon as something that can sense its surroundings, plan and decide what action to take and then take that action. They can function in a variety of ways, from human-controlled to autonomous or a combination of both.

"For some people, a robot could be a mechanism that looks like it is performing complex operations," said McQuin. "However, for me, a robot is a smart, reprogrammable mechanism, able to interact with its environment. The key part is, not only is a robot a physical mechanism that can do something, it also contains a computer that can control and adapt how it operates, whether it is controlled remotely by a human or it autonomously responds to its environment."

Robots operate with a set of basic components: sensors, effectors, power sources and a communication method. Sensors gather information that orient the robot and allow it to decide what to do next. These can be any number of devices varying in sophistication, including cameras, GPS,

lasers, sonar, radar, bump panels and touch sensors.

Once data is collected, effectors allow it to move, interact and perform tasks. Effectors such as arms and grippers can allow the robot to manipulate its environment, while others such as wheels, tracks and legs allow movement.

Power sources, like motors or hydraulics, keep the robot in action, and communication systems, such as a wireless connection to a user-operated computer, relay information.

"A mentor of mine -- and one of the founders of the field -- likes to say that a robot is ‘a computer-controlled mechanism that can destroy itself,’" said NASA Jet Propulsion Laboratory technical staff member Jaret Matthews, who works in the Robotic Vehicles Group. "Fundamentally, modern dishwashers, microwaves, etc., all have motors, sensors, computers, software -- things that most people associate with robots. However, most people would not call a microwave a robot. A machine that has the strength, mobility, degrees of freedom and sophistication such that if software were to go haywire, it would result in self-destruction -- that is what separates a robot from a microwave."

Robots Matter

One of the most important roles robots play is to protect humans from injury or danger by doing jobs and performing functions in their place. Whether they are doing heavy lifting and repetitive actions in factories or investigating mines or bomb threats, they have revolutionized the way the world operates, McQuin said. Robots aid surgeons in complex operations, skim spilled oil from the surface of water, mow lawns, execute farming tasks and help the physically impaired become mobile. They can perform difficult, delicate duties or the most mundane actions. As robotic technology continues to advance, their capabilities expand

and become more sophisticated.

"Three words -- self-driving cars," said Matthews. "Someday, we will be driven around safely, quickly and most importantly, efficiently by self-driving cars. They were just made legal in Nevada, and Google has already driven hundreds of thousands of miles with no hands on the wheel.

"Traffic jams and stop lights will soon be a thing of the past. Cars will each communicate with each other to regulate their speed and glide safely through intersections without stopping. This will eliminate the dirty and inefficient use of fuel sitting idle at red lights or in traffic. We will save time, money and help reduce the amount of carbon dioxide being released into the air by idling tailpipes," he said.

Beyond everyday tasks, McQuin said robots are also pushing our own boundaries of what and where we can explore. "Robots have explored the depths of the oceans and the surfaces of other planets and moons, furthering our understanding of our own planet and universe," he said.

Staying Ahead of the Game

The main reason programs such as Centennial Challenges exist is to engage the public to develop advanced technology solutions that will benefit both NASA and the nation. Like the Wright Brothers, after whose centennial flight anniversary the competition is named, some of the most important and useful innovations have come from inquisitive people with ideas on how to make things better.

The inventions and knowledge that arise from events such as the Sample Return Robot challenge can lay the groundwork for future technology. Many NASA technologies and projects have spun off into products and ideas that benefit society every day. NASA satellites warn us of

impending severe weather and other disasters. Cochlear implants, the computer mouse and water filters have all either come about because of, or were spawned from, NASA ideas and developments that originated in another form.

"A challenge like this is interesting and could lead to many benefits to society," said McQuin. "For instance, the same technology that allows the robots to autonomously navigate a landscape could be used by industry or government to remotely inspect the outside of remote infrastructure such as pipelines, power lines, etc. The ability to identify and collect a relevant sample could be applied to some mining or scientific operations here on Earth as well as on another planet."

The Future of Robotics

"Robots are here to stay," said McQuin. "They are able to augment and enhance human capabilities and make us faster and more efficient at completing tasks while also giving us the ability to go to and do things we were never able to do before. For these reasons, in a highly competitive world, we must continue to make robotics a priority to keep our industries growing and competitive, continue to affordably explore our planet and the solar system, maintain our military capabilities and improve our daily standard of living."

Matthews agreed, "Pushing robotic technology will ensure that robots will have an increasingly important impact in all of our lives as they help to solve a myriad of the world's most pressing problems."

Provided by NASA