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News

Resilient robot adapts to environment

Marie Theresa Bray

Cosmos Online

SYDNEY: A star-shaped robot that can adapt to changes to its body and the environment has been built by U.S. scientists.

Humans and other animals adapt to such changes by altering their behaviour. Robots, on the other hand, are usually less versatile, and fail to recover from unanticipated situations.

But in a paper published today in the U.S. journal *Science*, researchers describe a new robot that can sense changes - to its body or surroundings - and adapt its movements accordingly, an ability that would be invaluable in unknown or dangerous terrain.

A team led by Josh Bongard of the University of Vermont in Burlington built the four-legged robot that uses tilt and angle sensors in its joints to observe its own movements. It then creates a concept of itself on an internal computer.

"In the first phase of the robot's life, it is somewhat like a human infant: it knows very little about its own body, but quickly discovers that it's made up of four legs, and that it can move those four legs in a certain pattern to walk," said Bongard.

After damage to the robot's body, it creates a new self-concept: to simulate injury the researchers shortened one of the robot's legs.

"In the second phase, the robot senses that those self-models are no longer appropriate, and searches for a new description of itself. By doing this it discovers what and where the damage is on its body," said Bongard.

Using this new, updated view of itself, the robot can internally rehearse new manoeuvres to accommodate its injury, and continue with its mission when it finds a way to solve the problem.

The robot builds an understanding of itself using "actuation-sensation relationships", said the researchers. In this process, it momentarily switches on some of its motors, then senses the resulting orientation of its body.

The robot then calculates how much the action has caused its body to tilt left or right, forward or backward, and uses this relationship to deduce how it is put together.

According to the researchers, their robot evokes human-like qualities such as curiosity: the robot is constantly trying to act in new ways, and to learn more about its body and its environment.

"It also suggests something about self-awareness, because this robot literally builds ... a sense of self," said Bongard.

In a related perspective published in the same issue of *Science*, Christoph Adami from the Keck Graduate Institute of Applied Life Sciences in Claremont, California, also suggests that problem-solving robots might not be so different to humans.

Adami explains how a robot might operate in unknown territory by first exploring the landscape, then dreaming up new ways to overcome any obstacles encountered.

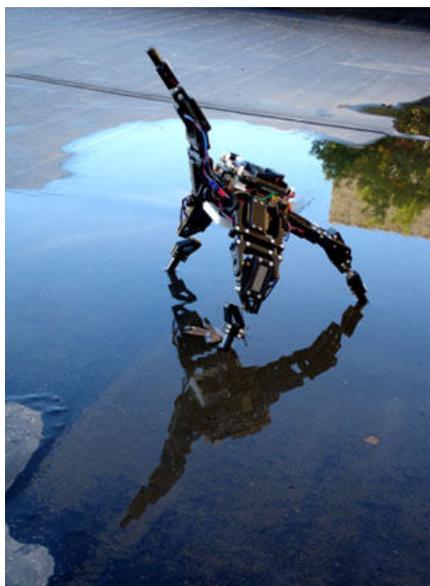
"A robot would spend the day exploring part of the landscape, and perhaps be stymied by an obstacle. At night, the robot would replay its actions and infer a model of the environment," said Adami. "Informally, then, the robot would dream up strategies for success ... and approach the morning with fresh ideas."

Bongard and colleagues believe that if a robot continues to produce new, adaptive behaviours in unexpected situations, it might provide information about how humans and animals adapt to their constantly changing environments.

"Our robot maintains not just a single representation of its body, but constantly maintains and updates multiple competing possibilities. Perhaps animals and humans do the same thing," said Bongard.

"We are always asking ourselves: 'What would happen if I did this, or did that? What would be the

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The four-legged robot that adapts to changes to its body or environment.

Image: Science

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repercussions?" Robots could be used to help us investigate how and why we do this."

Aside from shedding light on human behaviours and contributing to philosophical debate, the research might also have practical applications - robots that can adapt to unforeseen circumstances when exploring uncharted worlds.

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