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'Instinctive' robot recovers from injury fast

Restorative algorithm has potential to make a variety of machines resilient.

Davide Castelvecchi

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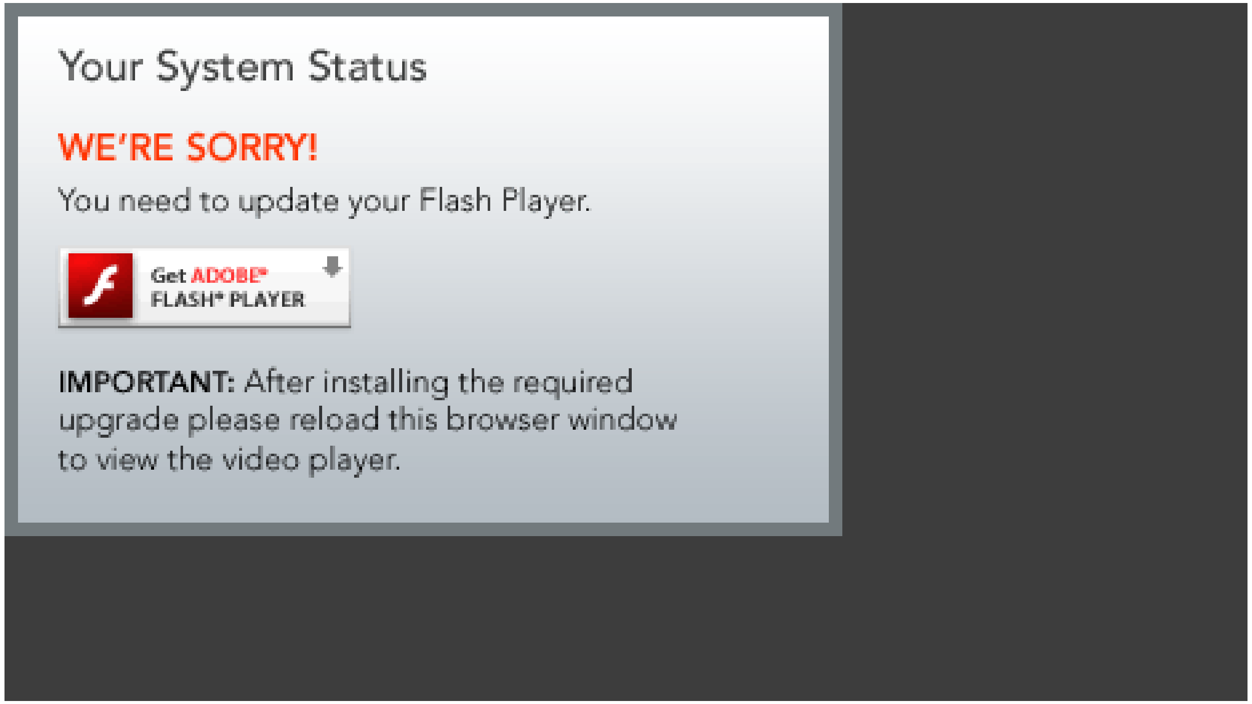

Computer scientists have endowed a six-legged robot with the ability to rapidly modify its motion to cope with damage, such as the loss of a foot. They say the algorithm that enables this recovery, which they liken to an instinct, could add resilience to other machines, from robots that work in disaster areas such as the stricken Fukushima nuclear power plant to self-driving cars.

Although robots can be pre-programmed with contingency plans, there will always be problems that engineers had not foreseen or that they cannot diagnose from a distance. “We want to have robots that can be useful for

bacterial epidemic.

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a long period of time, without humans to perform maintenance," says Jean-Baptiste Mouret, an artificial-intelligence researcher at France's national computer science agency INRIA in Villers-lès-Nancy, who led the work, which is published in *Nature* today[1].

In pioneering work in 2006, evolutionary roboticist Josh Bongard at the University of Vermont in Burlington and his team built a six-legged robot that diagnosed its own injuries[2] and calculated new motion patterns that enabled it to resume operations. But although the hexapod robot broke new grounds in machine self-awareness, it was slow to adapt to new situations. "Time is of the essence," says Bongard. "If a car starts to skid off the road, it needs to find a way to recover very quickly."

In the latest work, Mouret and his team devised a simpler strategy — a "shortcut", as he describes it — for their six-legged walker. After a fault, such as the loss of one of its feet or a stuck knee, the robot uses its on-board camera to detect that something is slowing it down or preventing it from walking straight. Rather than attempting to diagnose the problem, the robot simply tries out new patterns of motion until it finds one that enables it to restore an acceptable level of

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To help their hexapod recover faster than previous machines, Mouret's team equipped it with a library of about 13,000 walking patterns that were calculated in advance using a computer model of the robot. They compare this library to the innate knowledge that makes up an animal's instinct

Choosing these patterns from the much larger pool, or 'space', of all possible movements took a computer work station two weeks: the researchers initially encoded the walking patterns as 36 variable parameters — such as how wide a leg swings forward, and by what angle, at each step — and then cut down the number of parameters to six by focusing on plausible movements.

Armed with this knowlege, the hexapod usually needed just a minute or less to start walking again after a failure. In some cases, the robot found that hopping was now the most efficient way to move (see video above).

The algorithm also enabled the hexapod to adapt in situations where there was no mechanical failure but the environmental conditions, for example the type of terrain, had changed — as the researchers discovered when they tested an early version after their lab's floors had been freshly waxed.

The work is “very exciting”, Bongard says, although he warns that it remains to be seen whether the team’s methods can be scaled up to more complex machines: a robot's space of behaviours grows exponentially as its complexity increases.

One advantage of the approach is that it relies mostly on software and so works independently of a robot's specific physical design. The researchers successfully tested the algorithm on an entirely different kind of machine — a robotic arm. “Virtually any robot would benefit from this," says Mouret.

Nature | doi:10.1038/nature.2015.17641

Read the related News & Views article 'Artificial intelligence: Robots with instincts'.

- References

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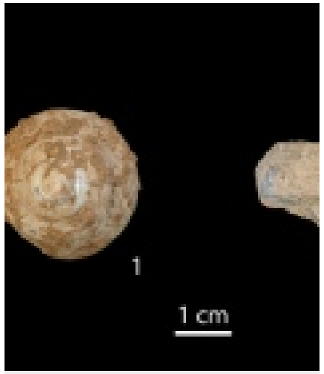

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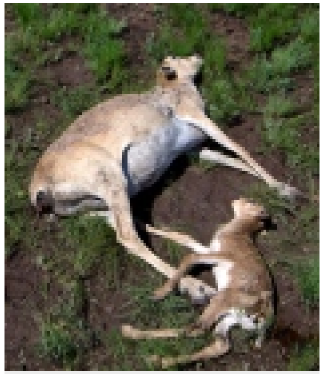

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