

# Robotics first: Engineering team makes artificial muscles that can lift loads 80 times their weight

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A research team from the National University of Singapore's (NUS) Faculty of Engineering has created efficient artificial, or "robotic" muscles, which could carry a weight 80 times its own and able to extend to five times its original length when carrying the load – a first in robotics. The team's invention will pave the way for the constructing of life-like robots with superhuman strength and ability.

In addition, these novel [artificial muscles](#) could potentially convert and store energy, which could help the robots power themselves after a short period of charging.

Led by Dr Adrian Koh from NUS' Engineering Science Programme and Department of Civil and Environmental Engineering, the four-member team has been working on the project since July 2012.

## Robots – current limitations

Robots, no matter how intelligent, are restricted by their muscles which are able to lift loads only half its own weight – about equivalent to an average human's strength (though some humans could lift loads up to three times their weight). Artificial muscles have been known to extend to only three times its original length when similarly stressed. The muscle's degree of extendability is a significant factor contributing to the muscle's efficiency as it means that it could perform a wider range of

operations while carrying heavy loads.

## **Super, artificial muscles**

Explaining how he and his multidisciplinary team managed to design and create their novel superhuman muscles, Dr Koh said, "Our materials mimic those of the [human muscle](#), responding quickly to [electrical impulses](#), instead of slowly for mechanisms driven by hydraulics. Robots move in a jerky manner because of this mechanism. Now, imagine artificial muscles which are pliable, extendable and react in a fraction of a second like those of a human. Robots equipped with such muscles will be able to function in a more human-like manner – and outperform humans in strength."

In order to achieve this, Dr Koh and his team have used polymers which could be stretched over 10 times their original length. Translated scientifically, this means that these muscles have a strain displacement of 1,000 per cent.

A good understanding of the fundamentals was largely the cause of their success, Dr Koh added.

"We put theory to good use. Last year, we calculated theoretically that [polymer](#) muscles driven by electrical impulse could potentially have a strain displacement of 1,000 per cent, lifting a load of up to 500 times its own weight. So I asked my students to strive towards this Holy Grail, no matter how impossible it sounded," he said.

Though they could only achieve a modicum of their target, it is a first in robotics. For his contributions, Dr Koh was awarded the Promising International Researcher Award at the 3rd International Conference on Electromechanically-Active Polymer Transducers and Artificial Muscles in June 2013, held in Zürich, Switzerland. The Award recognises young

researchers from outside Europe, who have made significant contributions in the field of electromechanically-active polymers, and display promise to successful career in the field.

## **Green robots**

"Our novel muscles are not just strong and responsive. Their movements produce a by-product—energy. As the muscles contract and expand, they are capable of converting mechanical energy into electrical energy. Due to the nature of this material, it is capable of packing a large amount of energy in a small package. We calculated that if one were to build an electrical generator from these soft materials, a 10kg system is capable of producing the same amount of energy of a 1-ton electrical turbine" Dr Koh said.

This means that the energy generated may lead to the [robot](#) being self-powered after a short period of charging – which is expected to be less than a minute.

## **The next step**

Dr Koh said they are still beefing up their muscles. They will also be filing a patent for their success formula of materials and right degree of electric impulses. And in about three to five years, they expect to be able to come out with a robotic arm, about half the size and weight of a human arm which can wrestle with that of a human being's—and win.

Powerful artificial muscles need not only be used in robots, said Dr Koh.

"Think of how efficient cranes can get when armed with such muscles," said Dr Koh.

The research team plans to work further with researchers from Materials

Science, Mechanical Engineering, Electrical & Computer Engineering, as well as Bioengineering to create robots and robotic limbs which are more human-like in both functions and appearance.

Provided by National University of Singapore

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