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Robotic Legs Closer for US Soldiers

Lower body exoskeleton could also help firefighters and rescue workers

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Four years after being commissioned by the US military to create a strength-enhancing exoskeleton, researchers are set to showcase a self-powered set of robotic legs.

Created by researchers at the University of California, Berkeley, the exoskeleton could become a useful tool for applications that require "superhuman" capabilities.

"We set out to create an exoskeleton that combines a human control system with robotic muscle," says Berkeley researcher Homayoon Kazerooni. "We've designed this system to be ergonomic, highly maneuverable and technically robust so the wearer can walk, squat, bend and swing from side to side without noticeable reductions in agility. The human pilot can also step over and under obstructions while carrying equipment and supplies."

Performance enhancers

Robotic exoskeletons are human performance augmentation systems worn by humans to enhance mechanical strength and power.

Such devices can be used to maneuver heavy loads with great speed and dexterity and could therefore be beneficial in a number of applications where this is desirable.

Robotic exoskeletons are of great interest to the military, for example, because of their ability to increase the speed, strength and endurance of soldiers in combat environments.

The US Defense Advanced Research Projects Agency is currently running a program called Exoskeletons for Human Performance Augmentation. "Inclusion of exoskeleton technology into land-based operations could potentially increase the capabilities of the ground-based warfighter and radically alter the current military doctrine," reads a program description. "This technology will extend the mission payload and/or mission range of the soldier and increase the lethality and survivability of ground troops for short-range missions and special operations."

DARPA is spending US$50 million over the next five years on exoskeletons, including one called Millennium Jet that is an aerial vehicle.

Exoskeletons are challenging to build, however, for several reasons, including the fact that they have to be made of materials that are strong, lightweight and flexible.

Their frames can't be too awkward and they must be designed with joints that can bend as human joints do.

Finally, robotic exoskeletons must be powered by a generator that can run for long periods without needing refueling.

BLEEX

Funded by DARPA and begun in 2000, the Berkeley Lower Extremity Exoskeleton, or BLEEX, consists of mechanical metal leg braces that are connected to a user's legs.

The device includes a power unit and a backpack-like frame to carry a large load.

In one test of BLEEX, a human pilot moved about a room wearing a 100-pound exoskeleton and a 70-pound backpack while feeling as if he were carrying only five pounds.

One significant challenge for the researchers was to design an engine that would provide the energy needed to power the

exoskeleton for long periods.

To overcome this obstacle, they're using an engine that delivers hydraulic power for locomotion and electrical power for the onboard computer.

User-friendly

To use BLEEX, a wearer first steps into a pair of modified army boots that are then attached to the exoskeleton.

The wearer then puts on the exoskeleton's vest that is attached to the backpack frame and engine.

Over 40 sensors and hydraulic actuators form a local area network for the exoskeleton, which provide the computer with the information it needs to make necessary load bearing adjustments based on what the human is doing.

"We are taking great pains to make this as practical and robust as possible for the wearer," says Kazerooni. "Several engineers around the world are working on motorized exoskeletons that can enhance human strength, but we've advanced our design to the point where a 'pilot' could strap on the external metal frame and walk in figure eights around a room. No one else has done that."

Needs tweaking

Kazerooni and colleagues are now working on miniaturizing the exoskeleton's components and are trying to develop a quieter, more powerful engine and a faster, more intelligent controller.

In addition, the researchers are studying what it takes to enable pilots to run and jump with the exoskeleton legs.

Besides military applications, the BLEEX could be used by firefighters to haul their gear up dozens of flights of stairs to put out a high-rise blaze, or rescue workers to bring in food and first-aid supplies to areas where vehicles cannot enter.

The technology could also be used to help the disabled.

"Many scientists and engineers have been attempting to build a robotic strength enhancing device since the 1950s, and they've failed," says Kazerooni. "It is only through recent engineering

breakthroughs that this dream is now becoming a reality."

The researchers showcase their project from March 9 through 11 in Anaheim, California at DARPATech 2004.