How do you turn 10 minutes of power into 200? Efficiency, efficiency, efficiency

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DARPA has created the M3 Actuation program, with the goal of achieving a 2,000 percent increase in the efficiency of power transmission and application in robots, to improve performance potential. Credit: DARPA

A robot that drives into an industrial disaster area and shuts off a valve leaking toxic steam might save lives. A robot that applies supervised autonomy to dexterously disarm a roadside bomb would keep humans out of harm's way. A robot that carries hundreds of pounds of equipment over rocky or wooded terrain would increase the range warfighters can travel and the speed at which they move. But a robot that runs out of power after ten to twenty minutes of operation is limited in its utility. In fact, use of robots in defense missions is currently constrained in part by power supply issues. DARPA has created the M3 Actuation program, with the goal of achieving a 2,000 percent increase in the efficiency of power transmission and application in robots, to improve performance

potential.

Humans and animals have evolved to consume energy very efficiently for movement. Bones, muscles and tendons work together for propulsion using as little energy as possible. If robotic actuation can be made to approach the efficiency of human and animal actuation, the range of practical robotic applications will greatly increase and robot design will be less limited by power plant considerations.

M3 Actuation is an effort within DARPA's Maximum Mobility and Manipulation (M3) robotics program, and adds a new dimension to DARPA's suite of robotics research and development work.

"By exploring multiple aspects of robot design, capabilities, control and production, we hope to converge on an adaptable core of robot technologies that can be applied across mission areas," said Gill Pratt, DARPA program manager. "Success in the M3 Actuation effort would benefit not just robotics programs, but all engineered, actuated systems, including advanced prosthetic limbs."

Proposals are sought in response to a Broad Agency Announcement (BAA). DARPA expects that solutions will require input from a broad array of scientific and engineering specialties to understand, develop and apply actuation mechanisms inspired in part by humans and animals. Technical areas of interest include, but are not limited to: low-loss power modulation, variable recruitment of parallel transducer elements, high-bandwidth variable impedance matching, adaptive inertial and gravitational load cancellation, and high-efficiency power transmission between joints.

Research and development will cover two tracks of work:

Track 1 asks performer teams to develop and demonstrate high-

efficiency actuation technology that will allow robots similar to the DARPA Robotics Challenge (DRC) Government Furnished Equipment (GFE) platform to have twenty times longer endurance than the DRC GFE when running on untethered battery power (currently only 10-20 minutes). Using Government Furnished Information about the GFE, M3 Actuation performers will have to build a robot that incorporates the new actuation technology. These robots will be demonstrated at, but not compete in, the second DRC live competition scheduled for December 2014.

Track 2 will be tailored to performers who want to explore ways of improving the efficiency of actuators, but at scales both larger and smaller than applicable to the DRC GFE platform, and at technical readiness levels insufficient for incorporation into a platform during this program. Essentially, Track 2 seeks to advance the science and engineering behind actuation without the requirement to apply it at this point.

While separate efforts, M3 Actuation will run in parallel with the DRC. In both programs DARPA seeks to develop the enabling technologies required for expanded practical use of robots in defense missions. Thus, performers on M3 Actuation will share their design approaches at the first DRC live competition scheduled for December 2013, and demonstrate their final systems at the second DRC live competition scheduled for December 2014.

Provided by DARPA