PNNL's Thomas tackles information glut.

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Research Highlights . . .

Hoppers leapfrog conventional robot wisdom

Hopping machines inspired by the clumsy jumping of grasshoppers being collected by a trout fisherman researcher may soon give robots unprecedented mobility for exploring other planets, gathering war-fighting intelligence, and assisting police during standoffs or surveillance operations. The unique robots, developed by researchers at the Department of Energy's Sandia National Laboratories, use combustion-driven pistons to make leaps as high as 20 feet. The work is funded by the Defense Advanced Research Projects Agency. The researchers believe the 'hopper' mobility provides the reliable, autonomous mobility in difficult environments that has eluded robot engineers and complicated planned planetary exploration missions.

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Microdrop particle search

Robert Millikan's oil drop experiment is well known for its study of the mass and the electric charge of falling fluid drops. Millikan's total mass throughput was about 100 drops and he used a stopwatch and a manually operated switch. Researchers at DOE's Stanford Linear Accelerator Center are using new technology to perform high-mass throughput searches for stable isolated subatomic particles with fractional electric charge and for stable massive particles with integral charge. The revised Millikan experiment used about 6 million drops. The primary purpose of this experiment was to establish that low-cost commercial quality computer video hardware could be used to take accurate charge and mass measurements.

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More cooks in the kitchen

Researchers at DOE's Pacific Northwest National Laboratory have cooked up a new way to help food processors solve some sticky, gooey or lumpy problems—add a little ultrasound to the mix. After developing methods to inspect commodities like orange juice and cooking oils for contraband, PNNL researchers thought the same technologies could be applied directly to the food processing industry. Earlier this year, ultrasonic sensor capabilities among PNNL's various research areas were consolidated into the Food Science and Process Measurement Laboratory. Now, PNNL researchers are putting non-invasive ultrasound technology to work to help food processors make sure they have smooth, not lumpy, pudding and tomato ketchup that is thick, not runny.

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Using light to fight old enemies

The war on infectious diseases will get easier if a team from DOE's Jefferson Lab and the College of William and Mary have any say in the matter. The project uses intense ultraviolet light to change material surfaces that would normally support microorganisms into antimicrobial environments. The ultraviolet light induces certain chemical processes that create antimicrobial entities on a processed nylon surface. These antimicrobial surfaces could be used on everyday products to annihilate organisms by destroying their path to a victim. Candidates for this procedure include medical garments, air conditioning filters and food packing. A patent has just been issued on this process.

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DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

Making a better battery

A flexible, plastic membrane developed at DOE's Idaho National Engineering and Environmental Laboratory advances the state-of-the-art of lithium rechargeable batteries.

The INEEL solid polymer electrolyte promises safer, more versatile and longer-lasting rechargeables. Lithium batteries made with the experimental electrolyte last about 50 percent longer than with competing electrolytes. The electrolyte is safer and more environmentally friendly to produce than others—the waste products are essentially glass, phosphate and nitrogen compounds, which can be converted to fertilizer.

According to team leader Mason K. Harrup, their initial target is for batteries to be used in space or heart pacemakers—situations where a low-power battery needs to last a long time or work in very cold conditions. The team is pursuing development collaborations with the space and satellite industry.

Electrolytes are the key to creating a battery's electrical current. They separate the positive and negative electrodes. Positive ions such as lithium can move through the electrolyte, but negatively charged electrons can't, so electrons travel out of the battery and through the device being. Conventional electrolytes are made of toxic salt solutions within a liquid or gel base, such as a car battery's water-based electrolyte.

The INEEL solid electrolyte is a mix of a liquid polymer known as polyphosphazene and a ceramic powder that turn into a clear, non-toxic flexible membrane when properly blended.

The chemists needed the polymer to hold shape without interfering with its ability to transport lithium ions. They discovered that the ceramic creates a stable scaffold and the liquid polymers weave through it like ribbons. Most importantly, this particular way of stabilizing the polymer interferes with lithium transport 20 times less than a more common stabilization method developed at other research institutions.

In addition, the researchers analyzed the electrolyte to determine how lithium ions traveled within the composite and if they would interact with the ceramic, a problem that could reduce ion movement. Using analytical chemistry methods, they determined that the lithium ions travel along the highly conductive polymer and virtually ignore the scaffold.

The electrolyte structure does have its drawbacks, Harrup explained. The ponderous routes that the polymers take through the ceramic scaffold slow the travel time for lithium ions. Also, the ions are limited to traveling single-file along the polymer paths, unlike in a liquid where ions simultaneously move across the electrolyte at once, like an army marching over a field. These limitations make the electrolytes optimal for low-power, slow-release.

For its potential impact on consumers' lives, the lithium battery solid polymer electrolyte being developed at INEEL topped a list of over 100 technologies nominated by the DOE laboratories nationwide for two special awards in the Energy 100 awards program.

Submitted by DOE's Idaho National Engineering and Environmental Laboratory

Thomas visualizes future of numeric data analysis

While computers have changed how people work, shop and view the world, Jim Thomas understands these new opportunities also bring mammoth amounts of information that can be overwhelming for many people, including teachers, businesspeople and scientists.

As senior chief scientist for information technology at DOE's Pacific Northwest National Laboratory, Thomas long ago recognized the need for new ways of handling information overload. He has dedicated much of the last 10 years to developing visualization programs that can analyze large amounts of text. Government agencies and corporations across the nation now use these programs.

His newest venture is to apply those same core principals of reducing information overload to the issue of burdensome amounts of data being generated by experiments and computer models. Thomas and fellow PNNL scientist Pak Chung Wong have created a program that analyzes enormous volumes of data and applies a signature – or mathematical representation—to numeric data. Then the program displays those signatures in specially designed visualizations.

"We as humans do have the ability to analyze these amounts of data given clever methods for display and interaction," Thomas says "Our proof-of-concept work shows data signature visualizations can be an effective tool for scientists to better comprehend huge amounts of data."

"You never know when you're doing something that will be a major breakthrough," he says. "I believe this is important, because it will allow us to have a better understanding of data."

Thomas believes these types of advances are more likely to occur at national laboratories.

"We have the various disciplines living here together," Thomas says. "It makes a significant difference in the contributions we can make."

Submitted by DOE's Pacific Northwest National Laboratory