Dr. Al Emondi

Biological Technologies Office (BTO)
Program Manager

Dr. Al Emondi joined DARPA in June 2017. His focus is on neurotechnology and exploring novel approaches in non-invasive or minimally invasive neural interfaces for cognitive human-machine interaction.

Dr. Emondi came to DARPA from Space and Naval Warfare Systems Center (SPAWAR) Atlantic, located in Charleston, S.C., where he was the Chief Technology Officer (CTO) for SPAWAR Atlantic and served as Deputy CTO to the SPAWAR HQ CTO for the Atlantic region. He also led the Science & Technology competency, which included personnel focused on basic and applied sciences, technology transition, and technology transfer. Before his tour at SSC Atlantic, he was an early pioneer for software-defined radio research initiatives at the Air Force Research Lab in Rome, N.Y.

Dr. Emondi holds a Doctor of Philosophy degree in Neuroscience and a Master of Science in Electrical Engineering, both from Syracuse University, and a Bachelor of Science degree in Electrical Engineering from Wilkes University.

PROGRAMS

Next-Generation Nonsurgical Neurotechnology

The Next-Generation Nonsurgical Neurotechnology (N^3) program aims to develop high-performance, bi-directional brain-machine interfaces for able-bodied service members. Such interfaces would be enabling technology for diverse national security applications such as control of unmanned aerial vehicles and active cyber defense systems or teaming with computer systems to successfully multitask during complex military missions.

Hand Proprioception and Touch Interfaces (HAPTIX)

With a focus on wounded warriors and facilitating their return to military service, the Hand Proprioception and Touch Interfaces (HAPTIX) program is pursuing key technologies to enable precision control of and sensory feedback from sensor-equipped upper-limb prosthetic devices. If successful, the resulting system would provide users near-natural control of prosthetic hands and arms via bi-directional peripheral nerve implants. The program has a strong focus on technology handoff and aims to create and transition clinically relevant technology in support of wounded warriors suffering from single or multiple limb loss.

Neural Engineering System Design (NESD)

The Neural Engineering System Design (NESD) program seeks to develop high-resolution neurotechnology capable of mitigating the effects of injury and disease on the visual and auditory systems of military personnel. In addition to creating novel hardware and algorithms, the program conducts research to understand how various forms of neural sensing and actuation might improve restorative therapeutic outcomes.

ARLINGTON, Va. Defense Advanced Research Agency (DARPA) officials created the Next-Generation Nonsurgical Neurotechnology (N3) program to achieve high

levels of brain-system communications. Officials hope that at the end of the four-year effort, the program will conclude with a demonstration of a bidirectional system being used in a defense-relevant task that could include human-machine interactions with unmanned aerial vehicles (UAVs), active cyberdefense systems, or other properly instrumented Department of Defense (DoD) systems.

Officials say, if successful, N3 technology could ultimately find applications in these and other areas that would benefit from improved human-machine interaction, such as partnering humans with computer systems to keep pace with the anticipated speed and complexity of future military missions.

"DARPA created N3 to pursue a path to a safe, portable neural interface system capable of reading from and writing to multiple points in the brain at once," says Dr. Al Emondi, program manager in DARPA's Biological Technologies Office (BTO). "High-resolution, nonsurgical neurotechnology has been elusive, but thanks to recent advances in biomedical engineering, neuroscience, synthetic biology, and nanotechnology, we now believe the goal is attainable."

"We're asking multidisciplinary teams of researchers to construct approaches that enable precise interaction with very small areas of the brain, without sacrificing signal resolution or introducing unacceptable latency into the N3 system," he adds. The only technologies that will be considered in N3 must have a viable path toward eventual use in healthy human subjects.

If early program deliverables overcome the physics challenges, along with the barriers of crosstalk and low signal-to-noise ratio, subsequent program goals would include developing algorithms for decoding and encoding neural signals, integrating sensing and stimulation subcomponents into a single device, evaluating the safety and efficacy of the system in animal models, and ultimately testing the technology with human volunteers.

“Smart systems will significantly impact how our troops operate in the future, and now is the time to be thinking about what human-machine teaming will actually look like and how it might be accomplished,” Emondi says. “If we put the best scientists on this problem, we will disrupt current neural interface approaches and open the door to practical, high-performance interfaces.”

DARPA representatives invited federal regulators to participate from the beginning of the N3 program. They will be serving as aids for researchers to help them better understand regulatory perspectives as they begin to develop technologies. Later in the program, these regulators will again serve as a resource to guide strategies for submitting applications, as needed, for Investigational Device Exemptions and Investigational New Drugs.

DARPA is being similarly proactive in considering the ethical, legal, and social dimensions of more ubiquitous neurotechnology and how it might affect not only military operations, but also society at large. Independent legal and ethical experts advised the agency as the N3 program was being formed, and will continue to help DARPA think through new scenarios that arise as N3 technologies take shape. These individuals will also help to foster broader dialogue about how to maximize societal benefit from those new technologies. Separately, proposers to N3 must also describe mechanisms for identifying and addressing potential ethical and legal implications of their work. As the research advances, published N3 results will further facilitate broad consideration of emerging technologies.

DARPA wants to connect human brains and machines

WASHINGTON — As unmanned platforms, cyber systems and human-machine partnering become more prevalent in 21st century war fighting, the effectiveness of combat units will be determined by how quickly information can be processed and transmitted between air-breathers and machines. To achieve the high levels of brain-system communication that will be required on future battlefields, the Defense Advanced Research Projects Agency has launched a new program to develop a noninvasive neural interface that will connect soldiers with technology.

The goal of the Next-Generation Nonsurgical Neurotechnology (N^3) program is to "pursue a path to a safe, portable neural interface system capable of reading from and writing to multiple points in the brain at once," according to Dr. Al Emondi, a program manager in DARPA's Biological Technologies Office.

"We're asking multidisciplinary teams of researchers to construct approaches that enable precise interaction with very small areas of the brain, without sacrificing signal resolution or introducing unacceptable latency into the N_3 system."

Although technologies that allow for high-quality brain system communications exist today, these invasive techniques are not a practical solution for ubiquitous man-machine communication.

Before soldiers can communicate with their R2-D2 units, DARPA scientists must overcome several significant scientific and engineering challenges.

The most significant challenge, according to a DARPA press release, will be overcoming the physics of scattering and weakening of signals as they pass through skin, skull and brain tissue. If this initial challenge is surmounted, the focus of the program will shift to developing algorithms for encoding and decoding neural signals, evaluating system safety through animal testing and ultimately asking human volunteers to test the technology.

While communication neurotechnology has a stronger foothold in science fiction than reality, Emondi believes devoting resources to the enterprise will spur breakthroughs. "Smart systems will significantly impact how our troops operate in the future, and now is the time to be thinking about what human-machine teaming will actually look like and how it might be accomplished," he said.

"If we put the best scientists on this problem, we will disrupt current neural interface approaches and open the door to practical, high-performance interfaces."

DARPA wants the four-year project to conclude with a demonstration of a bidirectional system being used to interface human-machine interactions with unmanned platforms, active cyber defense systems or other Department of Defense equipment.

Recognizing the potentially wide ethical, legal and social implications of such neurotechnology, DARPA is also asking independent legal and ethical experts to advise the program as N³ technologies mature.

1. Dr. Al Emondi - Defense Advanced Research Projects Agency
   https://www.darpa.mil/staff/**dr-al-emondi**
   Dr. Al Emondi joined DARPA in June 2017. His focus is on neurotechnology and exploring novel approaches in non-invasive or minimally invasive neural interfaces for …
2. Next-Generation Nonsurgical Neurotechnology
   https://www.darpa.mil/program/next-generation-nonsurgical-neuro...
   Dr. **Al Emondi** The Next-Generation Nonsurgical Neurotechnology (N 3) program aims to develop high-performance, bi-directional brain-machine interfaces for able-bodied service members.
3. [PDF]
   Space and Naval Warfare Systems Center Atlantic
   www.public.navy.mil/spawar/Atlantic/**Documents**/Technology_Exchange...
   SSC Atlantic is part of the Naval **Research** & Development Establishment (NR&DE) Space and Naval Warfare Systems Center Atlantic Technology Exchange . Statement A: Approved for Public Release. Distribution is unlimited (8 Mar 2017) ... **Dr**. **Al Emondi** . 8.0 . Corporate Operations . David Monahan . C4I /FR . Charlie Adams . EIS Bruce Carter .
4. D60 Breakout Session - Trajectory of Neurotechnology
   https://d60.darpa.mil/schedule/TrajectoryofNeurotechnology.html
   Founding BTO Director **Dr**. Geoff Ling will discuss DARPA's subsequent breakthroughs in restoring function resulting from the implantation of neurotechnologies in humans. BTO Program Manager **Dr**. **Al Emondi** will present a next generation vision for achieving direct neural interfaces without the …
5. Research Collaborations | Arm Dynamics
   https://www.armdynamics.com/**research**-and-technology/collaborations

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6. [PDF]
   Overview of Doing Business with Space and Naval Warfare ...
   www.public.navy.mil/spawar/News/**Documents**/Presentations/02.17.2017...
   The Small Business Innovation **Research** (SBIR) is a Congressionally-mandated and competitive program that allows small businesses to engage in Federal **Research** and Development (R&D) with the potential for commercialization.

7. CHIPS Articles: DARPA neurotechnology program aims to ...
   www.doncio.navy.mil/CHIPS/ArticleDetails.aspx?ID=10157