STARnet Call for Research
Augmenting Humans and Human/Machine Interaction
Needs Document

Objective:

Provide humans with enhanced situational awareness (of themselves and their environment) as well as enhance the capability of humans to perform tasks from factory automation to warfare through technology that acts together with or augments the functions/capabilities provided by the body. This would be extended to human/machine interactions and collaboration through interactive control systems, machine vision, machine learning, and communication technology. It is expected that this technology would enable the growing field of telemedicine through the development of wearable electronics and infrastructure for non-intrusive in-patient monitoring and support. As a result, solutions must be unobtrusive and extremely energy efficient (e.g., using energy from its environment). This would be a circuits and processing based program addressing the expanding application space in this area, as opposed to the multi-scale systems level program addressed by TerraSwarm.

Expected Areas of Research:

Sensors and Actuators: Draw on existing research in sensors and actuators on-going in other centers (TerraSwarm, SONIC), to drive new modules for the exoskeletons, medical monitoring and wearable electronics. We expect these sensor modules to cover a range from electrical and light based sensors (THz, electrostatic, electromagnetic, optical 3D, time-of-flight), to MEMS based sensors. Using these sensors for enhancing machine vision, machine learning, and machine-machine interactions will be areas of research. Circuit drivers and controllers for new types of actuators (e.g. piezoelectric, ultra-low power motors, nanomotors) are important for automation and augmentation. Circuits in these areas need to address high resolution for fine granularity data acquisition and control, embedded intelligence, and ease of use for the applications.

Computation and Processing: We see neuromorphic technologies as being a significant enabler in this area and research using neuromorphic chips to understand and expand application into these areas would be important. For example, in collecting, processing and managing sensor information for improved situational awareness (for medical, civilian, homeland security and DoD applications)

Power Optimization, Generation, and Delivery: These systems will require extremely low-power and no-power capabilities. In addition to energy harvesting and intelligent power management, processing techniques (e.g. Game Theoretic Resource Management) that reduce computational power would also be important. Analog design techniques, both circuit and system-level, and intelligent power management that reduces analog power by at least two orders of magnitude would be the target.

Connectivity: High performance connectivity throughout the network both within the human as well as between humans, human to robots and humans to cloud or other networks will be critical. It is expected that the research will explore low power and low latency interfaces, both wired and wireless whichever is more optimal, together with high data rates.

General Information Mosaics: Construction and visualization of space-time extents for situational understanding, context and discovery: The Internet, while originally intended as a communication and collaboration tool, is arguably the most extensive and complete sensor ever realized. As an intelligence, surveillance, and reconnaissance (ISR) sensor the Internet is essentially untapped. By combining information from the continuous 24x7 Internet of things with traditional ISR capabilities we expect understanding and context resolution to leapfrog current state-of-the-art.