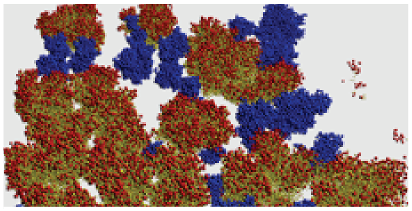
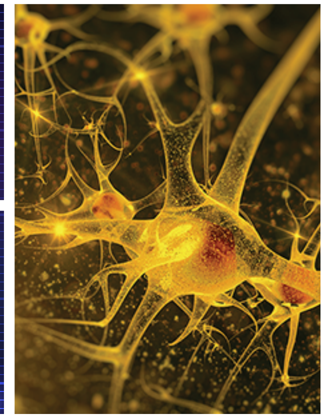
Healthcare & QoL

Electrical & Computer Engineering



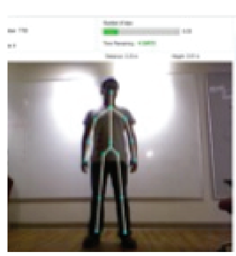


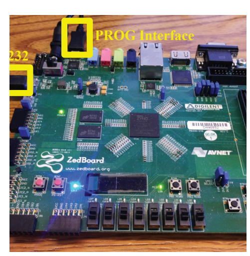
Scientific and medical advances are rapidly accelerating by the development of new technologies. We develop technologies for furthering basic biological knowledge, as well as for the diagnosis and treatment of disease. This includes novel engineered interfaces with biological systems, algorithms and analytics for biological big data, and personalized healthcare systems.

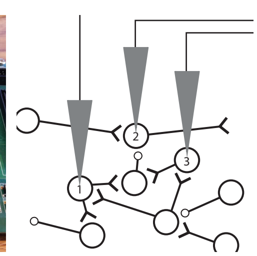
The intersection between engineering and biology is one of the fastest growing and exciting research areas today. The US Bureau of Labor Statistics projects a 27% growth of jobs in this area, relative to a 9% growth of all other areas of engineering combined. One of the reasons is demand for biomedical devices and procedures from the aging baby-boom generation. At the same time, there is a major need for basic scientific discoveries which can drive the development of biomedical devices. Research at the intersection of engineering and biology is at the forefront of the national research agenda with the federal BRAIN Initiative announced by President Obama in 2013. More locally, Carnegie Mellon announced the creation of the CMU BrainHub in 2014 as one of the major research initiatives of the university.

To enable basic scientific studies of biological phenomena and to develop biomedical devices to help human patients, there are many opportunities for innovative engineering. Specifically, we need to develop interfaces with biological systems that can both sense and stimulate with high spatiotemporal resolution and that are made of materials that are compatible with living tissue; low-power and light-weight implantable devices that can process biological signals; the appropriate software tools to organize large biological datasets in an accessible format; signal processing algorithms that can interpret large biological datasets; assistive technologies for rehabilitation from injury or disease; and more.

Current areas of focus in ECE include neural interface systems for recording and stimulation, wearable systems for personalized healthcare that respects security and privacy, brain-computer interfaces, and network modeling of biological processes. We collaborate closely with biologists and clinicians to apply our developed technologies in scientific studies and clinical practice.







Electrical & Computer ENGINEERING

Carnegie Mellon University

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ECE expertise

ECE has key expertise in several major areas at the intersection of health and technology. It leverages close ties with the Center for the Neural Basis of Cognition (a joint center between CMU and the University of Pittsburgh), Center for Bioimage Informatics, Quality of Life Technology Center, and CMU BrainHub.

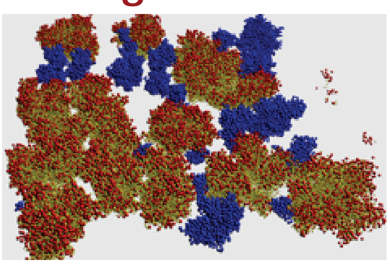
Biological sensing

We are designing biomedical devices and systems for multi-scale health monitoring to obtain the highest resolution information about biological events ranging from single cell activity to larger scale organ functions. We combine advancements in bio-electronics, bio-MEMs, bio-photonics, and bio-signal processing to build novel wearable and implantable biomedical systems for in-vivo, in-vitro, and ex-vivo bio-sensing that can be used in diagnosis, prognosis, and treatment of cancer, stroke, brain injuries, epilepsy, Parkinson's disease, as well as disorders of heart. Examples include (i) our recent breakthrough in obtaining a fundamentally new science of noninvasive imaging that has spurred the development of the highest-resolution portable and noninvasive brain imaging (EEG) systems ever built; (ii) the highest density opto-electrical neural interfaces for targeted recording and stimulation of neural activity in the central nervous system; (iii) super-resolution techniques for fluorescence imaging.
Contact: Pulkit Grover, Maysam Chamanzar, Shawn Kelly, Gary Fedder, Yuejie Chi

Biomedical data analytics

The explosion of data acquired in all areas of biology and medicine has created the need for distributed and integrated large biomedical images databases, as well as the necessary computing technologies that are tailored for biological computation. We strive towards creating clinical and diagnostic aids and mining meaningful information from these multi-modal datasets using a host of sophisticated tools from signal processing, machine learning, and scientific computing.
Contact: Jelena Kovačević, Franz Franchetti, Yuejie Chi, Pulkit Grover, Byron Yu

Biological networks



We seek to understand how biological networks operate and apply that knowledge to help human patients. We have two research thrusts in this area. First, we seek to understand and engineer communities at nanoscale, namely bacteria networks formation, dynamics, and control for healthcare applications. This research represents an important step towards personalized medicine. Second, we seek to understand how networks of neurons process information, from encoding sensory stimuli to guiding motor actions. This knowledge can be applied to develop treatments for diseases that are linked to brain function.
Contact: Radu Marculescu, Byron Yu, Pulkit Grover

Brain-computer interfaces

Brain computer interfaces (BCI) aim to assist disabled patients by translating neural activity into movements of a robotic limb or computer cursor. The development of BCI systems is a multi-disciplinary endeavor that requires the development of devices to record the brain's activity, as well as computing technologies and statistical algorithms to translate the brain's activity into desired movements. Ultimately, we seek to develop high-performance BCI systems that are fast, accurate, and can maintain this level of performance over years.
Contact: Byron Yu, Pulkit Grover, Maysam Chamanzar, Gary Fedder, Steven Chase

Quality of life technology

Quality of Life Technology (QoLT) maintains health and prevents or slows decline, compensates for diminished human capabilities and enhances intact ones. Our research and development approach emphasizes integrated prototype systems that are evaluated in the field and iterated upon to realize progressively greater capability and fit to end-use situations and constraints. For example, our work in Virtual Coaches explores the possibility of having computers behave like human coaches such as occupational therapists and personal trainers.
Contact: Dan Siewiorek, Asim Smailagic