

NUS Graduate School for Integrative Sciences and Engineering Research Project Write-up

I direct the University wide institute called SINAPSE (www.sinapseinstitute.org). The Institute is funded by the University, A*STAR and Defence, and is located in Center for Life Sciences and houses both experimental and technologically oriented research faculty and facilities. The Institute's strategic location between engineering and medicine is meant to bridge the two divisions of the University and signal research that is both basic and applied, technological and clinically motivated. Research projects are carried out in collaboration with numerous engineering, basic science and clinical faculty.

Title of Project : Neurotechnology

Name of Supervisor : Nitish V. Thakor

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Short Description

Our research focuses on building neurotechnologies, from brain monitoring devices to implantable neuroprosthetic systems. The specific project areas are

- Neurodiagnostics – building brain monitors for intensive care and operating room
- Neurotherapeutics – building implantable peripheral nerve and cortical neuroprosthesis
- Neuroimaging – optical brain imaging using laser speckle imaging and photoacoustic imaging
- NeuroChip Project – designing and building microfabricated (microfluidic) system for single neuron and neural network studies
- Implantable Neurotechnologies – design of implantable neuroprosthetic devices
- Brain machine Interface – brain machine interface for cognitive sciences

Title of Project : Experimental Neuroengineering

Name of Supervisor : Nitish V. Thakor

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Short Description

Our research focuses on carrying out basic experimental neuroscience in support of neurotechnology development and clinical translation.

- In vivo Neurophysiology – Recording of cortical neural activity in experimental models of brain and spinal cord injury and neuroprosthesis
- Optogenetic Modulation – Using optogenetic technology to alter functional brain activity and behavior in animal models (to overcome injury, enhance function)
- Functional Neuroimaging – Imaging brain blood flow and tumor angiogenesis using novel laser speckle and photoacoustic imaging methods
- Stem Cell Engineering – Application of various stem cell technologies to treat spinal cord injury
- Peripheral Nerve Repair and Prosthesis – Development of peripheral nerve repair conduits and electric interface to restore nerve-muscle function
- Spinal cord injury and repair – Contusion model of spinal cord injury and therapy with stem cells and hypothermia

Title of Project : Cognitive Neuroengineering

Name of Supervisor : Nitish V. Thakor

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Short Description

In the field of Cognitive Engineering, our researchers study various areas or brain function, connectivity, performance measures and enhancement, and development of neuromorphic and biologically inspired machines. Projects include

- Brain machine interface, virtual reality, sensory (vision, touch) integration
- Brain function analysis using network and connectivity methods
- Brain function enhancements using cognitive function analysis, cortical stimulation using transcranial DC and magnetic stimulation
- Neural network or brain based model are used to develop “neuromorphic” models of touch and vision with potential
- Applications to neuroprosthesis.

Title of Project : Clinical and Translational Neuroengineering

Name of Supervisor : Nitish V. Thakor

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Short Description

We are interested developing technologies and applications to brain monitoring in intensive care environments. Focus is to take the laboratory research to clinical practice and translation.

- Electrical monitoring (EEG, evoked potentials) and optical imaging in intensive care and operating rooms.
- Surgical tools and technologies for minimally invasive, robotic surgeries.
- Prosthetic limb development - upper limb dexterous prosthesis and lower limb exoskeleton and assist device.
- Translating laboratory development into commercialization