

INTERDISCIPLINARY GRADUATE SCHOOL PROJECT LIST

Research Institutes – Thematic Programme in Sustainable Earth		Email
Earth Observatory of Singapore (EOS)		SKTEE@ntu.edu.sg
Energy Research Institute of NTU (ERI@N)		lilylimsk@ntu.edu.sg
Nanyang Environment and Water Research Institute (NEWRI)		yskhoo@ntu.edu.sg
Singapore Centre on Environment Life Sciences Engineering (SCELSE)		sanjay@nus.edu.sg
Complexity Institute		NgBW@ntu.edu.sg
Research Institutes – Thematic Programme in New Media		
Centre Of Social Media Innovations for Communities (COSMIC)		sfoo@ntu.edu.sg
Institute for Media Innovation (IMI)		danielthalmann@ntu.edu.sg
Active Living for the ElderLY (LILY)		ASCYMiao@ntu.edu.sg
Multi-PIAtform Game Innovation Centre (MAGIC)		ASHSSEAH@ntu.edu.sg
Rapid-Rich Object SEArch Lab (ROSE)		EACKOT@ntu.edu.sg
Thematic Programme in Future Healthcare		
Nanyang Institute of Technology in Health & Medicine (NITHM)		nithm@ntu.edu.sg

Research Institutes – Thematic Programme in Sustainable Earth

(1) EARTH OBSERVATORY OF SINGAPORE (EOS)

Seismology, Marine geophysics, Volcanology, Landscape processes / geomorphology, Hydrogeology, Chemical oceanography / environmental geochemistry, Geophysical modelling :

Please contact Ms Christina Tee, SKTEE@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://www.earthobservatory.sg/> for more information about EOS.

1.1 Volcanologic studies using microprobe

- In collaboration with MSE – investigating textures and minerals of volcanic rocks using the TEM. A new field “nanopetrology” might lead to really new discovery’s related to the magma ascent and/or cooling at the earth’s surface

1.2 GeoTouch or its next generation

1.3 Hydrodynamics in Tsunamis

1.4 Earthquake engineering projects

- In collaboration with CEE, studying the effectiveness of vertical evacuation facilities and other evacuation strategies for urban areas facing earthquake hazards from both strong motion and tsunami and contribute to novel designs of vertical evacuation facilities suitable for Southeast Asia environment and culture

1.5 Economics and Economics Policy of Sustainability

1.6 Geodetic projects

- In collaboration with SCE, begin to visualize very large datasets. In collaboration with CEE, the design of new geodetic instruments, such as sea floor geodesy or ocean bottom pressure recorders for sea-level studies

1.7 Earth-Science related topics

1.8 Atmospheric science

- In collaboration with MAE, investigating urban-scale atmospheric circulation and harnessing wind energy and/or characterizing the dispersion of pollutants with cumulus convection

1.9 Communication of earth science

1.10 Connecting EOS with economics and policy through ICRM

1.11 Geoarcheology in Myanmar and Aceh

(2) ENERGY RESEARCH INSTITUTE @ NTU (ERI@N)

Energy storage, Fuel cells, Green/Smart buildings, Maritime energy, Solar energy/fuels, Marine/Wind renewables, Electromobility

Please contact Ms Lily Lim, lilylimsk@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://erian.ntu.edu.sg/Pages/Home.aspx> for more information about ERI@N.

2.1 Battery and Storage Energy:

- Nanomaterials for advanced lithium ion battery, flow batteries, and supercapacitors
- Cell level and system level battery performance and modeling

- Flexible, printable battery – materials, architectures, and processing
- Thermodynamics of electrode processes – improving battery safety (anode, cathode and electrolyte, full cell)

2.2 Fuel Cells Energy :

- Advanced materials for alkaline fuel cells: the development of hydroxide membrane with high conductivity and low fuel crossover, cathodic electrocatalyst development for oxygen reduction reaction, anodic catalyst for fuel oxidation, investigation and improvement of fuel cell durability
- High Performance Portable Micro Fuel Cells : Super-conducting ceramic electrolyte, Nano engineering of catalytic electrodes, Inkjet printing for efficient micro patterning, Scalable nanoscale thin film electrolyte membrane, On chip integratable micro fuel cells
- Bio fuel cells : Materials study (performance & efficiency), investigation on limiting processes, modelling, design of fuel cell (membrane vs membrane-less), exploration of biological fuels

2.3 Smart Grid Technology and Energy efficiency in Green/Smart Buildings:

2.3.1 Simulation of smart grid optimization:

- Energy source/storage/load optimization in the future grid environment
- Island micro-grid optimization
- Electric vehicle/charge station optimization in smart grid
- Demand response with inter-agent collaboration game theory
- Power reliability in smart grid

2.3.2 Energy efficiency in green building with smart meter:

- Sensor network for green building
- Building (HDB or Condo) energy control with smart meter
- Energy optimization for green building with smart meter

2.4 Maritime Energy (Green Ship/Port) :

- Emissions Management
- Alternative Fuels and Energy Systems
- Advanced Energy Storage
- Smart Ship
- Antifouling Technologies for Ship Structure

2.5 Wind & Marine Renewable Energy:

- Wind/wave/tidal interaction simulation
- Design of marine and wind turbines
- Flexible grouts/sub-structures

- Advanced composites for wind turbines: carbon fibre composites, nanocomposites, reliability of adhesives
- Manufacturing, reliability, multi-axial loading studies

2.6 Offshore Renewable Energy:

- Design of Power Generators to maximize the conversion of ocean renewable energy to electrical energy while minimizing cost and meeting safety and durability requirement
- Design of Sub-structures to maximize structural stability and duration while minimizing the cost of materials, manufacturing, transportation, and installation
- Development of power systems to maximize power availability, quality, and stability while minimizing cost through innovation in transmission, grid connection and system integration
- Development of marine engineering to maximize the speed of installation (transportation, site surveying, cable laying; etc.) while minimizing the risks (safety, damage of device and equipment) and the cost of operation

2.7 Electro-mobility:

- Light weight frame design
- Aerodynamics
- Power transmission system

2.8 Micro Energy Harvesting/Scavenging for Green Electronics, Sensors and Communications:

2.8.1 Renewables conversion material or mechanism

- Wind (direct and indirect: HWT and VWT)
- Mechanical vibration (fabric-based dielectric and piezoelectric materials, electromagnetic converter for MEMS)
- Thermal gradient (thermoelectric and thermomechanical converter)
- Wireless power transfer (Inductive, RF)
- Bio fuel cell

2.8.2 EH-compatible energy storage

- Hybrid supercapacitor and battery: printable and flexible
- Intelligent SOH and/or SOC energy storage control circuit

2.8.3 Energy management and system optimization

- Microelectronic conversion circuits
- Multi-Source Interface: intra-domain (vibration) combination – piezoelectric and electromagnetic transducers or inter-domain (AC and DC, TEG or PV and Vibration) – hybrid interfacing

- Optimize and miniaturize form factor : area (footprint), costs (area, less devices), higher efficiency (saves control power – can be used for interfacing several/numerous generators), higher reliability and flexibility : intermittent sources can be better handled by more/different sources
- Through-layer optimization/tailoring: a total use-case scenario/model ensures a coordinated/aligned design and optimization from “Ambient Energy Source and Energy Harvester”-Layer to “WSN”-Layer
- Mixed signal circuits for micro-system applications for energy-autonomous systems
- Energy management of power system with renewable sources-V2G application

2.8.4 Sensors and Communications

- Energy-aware wireless sensor network
- Intelligent sensors and their interfaces

(3) NANYANG ENVIRONMENT AND WATER RESEARCH INSTITUTE (NEWRI)

NEWRI ecosystem comprises a number of Centre of Excellences and Supporting Units.

Please contact Mr Khoo Soon Sheng, Jacky, ykhoo@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://newri.ntu.edu.sg/Pages/default.aspx> for more information about NEWRI.

Potential PhD projects include the following broad areas:

3.1 DHI-NTU Centre

- Development and application of hydrodynamic and water quality models to improve planning and management of water resources in urban centres
- Deriving environmentally friendly technologies and solution to enable effective water management in industrial facilities
- Knowledge creation and tools to facilitate the assessment of environmental impact by human activities in the water and environment domain

3.2 Singapore Membrane Technology Centre (SMTC)

- New membrane materials
- Water production – water treatment and desalination
- Water reclamation – pre-treatment and reverse osmosis
- Wastewater membrane bioreactors – conventional and novel approach
- Energy issues including life cycle analysis
- Special needs – chronic and acute issues and decentralisation of membrane systems
- Development of sensors and monitors for membrane system

3.3 Residues & Resource Reclamation Centre (R3C)

- Waste to materials – converting wastes into useful new materials
- Waste to energy – harnessing energy from urban biomass, sewage sludge. Agricultural residues and micro-algae
- Contaminated site remediation – developing solutions and technologies for remediating contaminated sites

3.4 Advanced Environmental Biotechnology Centre (AEBC)

- Molecular biology: cell-cell signalling and enzymes for biomass morphology and activity control
- Microbiology: biogranulation, bioaugmentation, enrichment, inhibition, and population profiling
- Biotreatment process: Cyclic processes, SNDPR inhibition and biokinetics, anaerobiosis, phase separation, energy/resource recovery and process control
- Reactor and process modelling, design, and operation protocols
- Marine science: coral and algal bloom

3.5 Environmental Chemistry and Materials Group

- Development of novel functional materials for environmental applications
- Development of sensitive analytical methods for the detection and quantification of emerging contaminants in urban waters and reclaimed waters
- Integration of systems for water treatment and used water reclamation
- Effective measures for sustainable water resource management and protection of environment and public health.

(4) SINGAPORE CENTRE ON ENVIRONMENTAL LIFE SCIENCES ENGINEERING (SCELSE)

Environmental Microbial Engineering, Metagenomics & Systems Biology, Biofilm Biology, Public Health & Biofilm Control.

Complex microbial biofilms are found in both natural and man-made environments where they have important biological functions. The Singapore Centre on Environmental Life Sciences Engineering (SCELSE) aims to link new insights from the life sciences with skills and emerging technologies in engineering and natural sciences to understand, harness and control microbial biofilm communities.

Please contact A/P Sanjay Swarup, sanjay@nus.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://www.scelse.sg/> for more information about SCELSE.

The research programs listed below, within each of the four topics, will include several PhD student projects.

4.1 Environmental Microbial Engineering

- Effect of physicochemical and operational parameters on structure and activity of microbial communities in water treatment systems
- Enhanced electroconductivity of complex microbial communities for effective bioremediation of environmental pollutants
- Resilience of microbial biofilm communities for river ecosystem function
- Functional dynamics and modelling of biofilms in used water treatment

4.2 Metagenomics & Systems Biology

- Metatranscriptomics of microbial communities in environmental engineered bioprocess systems
- Systems biology of highly diverse microbial communities in the urban water cycle
- Metabolomics of environmental biofilm communities
- Next generation sequencing of microbial biofilms

4.3 Biofilm Biology

- Gradients and functionality of the extracellular matrix of bacterial biofilms
- Understanding the biofilm life cycle using defined mixed species experimental systems
- High resolution sensing and imaging to explore gradients and signalling in microbial biofilm communities
- Role of phage and predators in shaping and controlling complex biofilm communities

4.4 Public Health & Biofilm Control

- Chemical biology for developing environmentally friendly biofilm control agents
- Novel in vivo models for prevention and dispersal of pathogenic biofilms
- Mechanism of resilience against stress and predation by the biofilm shield
- Concealed and resistant microbial pathogens in the environment

(5) Complexity Institute

The Complexity Institute offers Doctor of Philosophy (PhD) programmes and scholarships in interdisciplinary research challenges:

Please contact Ms Ng Bee Wee, NgBW@ntu.edu.sg, for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://www.complexity.ntu.edu.sg/> for more information about Complexity.

The research programs listed below, within each of the four topics, will include several PhD student projects.

5.1 Critical Transitions in Man-Made and Natural Systems

Many complex systems, man-made or naturally occurring, exhibit critical transitions and tipping points. Understanding the tell tales of these transitions is crucial. We study these critical transitions in coupled human and natural systems, in epidemics and in socio economic systems.

5.2 Foundations of Complex Adaptive Systems

There is no theory of complex systems, many interesting results have been obtained using concepts from thermodynamics but no full theory that can support predictive modelling exists. In this research we focus on an Information Theoretical approach to describing the non-linear interactions in deeply connected systems. Using novel information metrics such as Tsallis Entropy and Natural Information as well as Geometrical Information we explore the fundamentals of the dynamics of complex systems. The goal is a comprehensive, testable theory of Complex Adaptive Systems.

5.3 Urban Adaptive Dynamics

Since about 2007 the majority of the world population is living in an Urban environments. Yet we hardly understand the concept of a 'city'. We do know however that cities are pretty stable constructs that show remarkable scaling behaviour. In addition to being an environment in which new opportunities are abundant, a city also is a source of increased crime, pollution and diseases. Using open data we build Agent Based models to better understand the interplay between the social and physical infrastructure of cities.

5.4 Health Systems Complexity

Demographic challenges such as an ever increasing population density or an aging population require novel models to measure, predict, and mitigate the devastating effects these challenges pose. Using novel machine learning techniques and modelling methods such as complex networks, cellular automata and agent based models, we build predictive models to run what if scenarios that can result in decision support for medical doctors and health care policy.

(6) CENTRE OF SOCIAL MEDIA INNOVATION FOR COMMUNITIES (COSMIC)

The Centre aims to empower communities, specifically those in the informal economy who are typically underserved by existing technology vendors and telecom service providers through social media innovations that improve the way they live, work and play.

Please contact Prof. Schubert Foo, sfoo@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

5.1 MoBuzz (Socially-Mediated System for Malaria-Dengue Public Health Surveillance, Communication and Engagement)

- Health Communication (theory-based message design and dissemination)
- Predictive surveillance (interactive hotspot mapping)
- Civic engagement (participatory epidemiology and social media-based crowd sourcing)
- Visual Communication (integrated website and mobile interface design of the above components)

5.2 Enhanced Patient Care

- Human-Computer Interaction
- Cognitive User modelling or Agent-Based Modelling
- Interactive Digital Media
- Simulation and Data Visualization
- Social and Collective intelligence
- Patient Care, Well-Being and wellness
- Health Literacy
- Health Communication and Messaging
- Health Informatics and Quality

5.3 Social Media and Assistive Technology for Underserved Community

- Social media innovations for underserved communities (elderly, disabled)
- Assistive technology
- Wearable user interfaces

(7) [INSTITUTE FOR MEDIA INNOVATION \(IMI\)](#)

Virtual reality, Crowd simulation, 3D fashion and virtual beauty concepts, Medical simulation and education, Virtual human behaviour, and Social robotics.

Please contact Prof. Daniel Thalmann, danielthalmann@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

Please visit <http://imi.ntu.edu.sg/Pages/Home.aspx> for more information about IMI.

6.1 Virtual Reality

- 3D Tele-presence
- Perception of virtual environment
- Virtual sports training
- Virtual physical rehabilitation, Treatment of phobia
- Serious games and game special effects
- Digital heritage, Virtual 3D museums/theatre/cinema

6.2 Crowd Simulation

- Social interaction in crowd simulation
- Treatment of agoraphobia through Virtual Reality
- Augmented Reality in crowds
- Cultural crowds
- Immersion in crowds
- Path planning and collision avoidance

6.3 3D Fashion & Virtual Beauty Concepts

- Virtual-try-on
- 3D hairstyling
- Virtual body shaping
- Virtual aesthetical surgery

6.4 Medical Simulation and Education

- Segmentation of Medical Data
- 3D reconstruction from MRI
- Multi-scale modelling and simulation of human articulation
- Sensor-based medical coach
- Modelling of soft tissues
- Models of locomotion and grasping for disable people

6.5 Virtual Humans Behaviour

- Avatars and agents : a seamless transition
- Intelligent virtual humans
- Modelling of senses for Virtual Humans
- Gesture coordination, Integration of gestures and speech
- Autonomous virtual teachers and personal coaches
- Virtual Presenter (e.g. of PowerPoint presentations)

6.6 Social Robotics

- Interactive and emotional social robots
- Action recognition
- Modelling of emotions, personality, intention, memory
- Decision making processes

(8) Active Living for the ElderLY (LILY)

Focus on multi-disciplinary research to create a new paradigm of age-friendly computing, design and technologies to help the 21st Century aging populations achieve better quality of life.

Please contact Prof. Miao Chun Yan, ASCYMiao@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

7.1 Affective Computing

7.2 Ageing Technology

7.3 Artificial Intelligence

7.4 Big Data Analytics

7.5 Cloud Computing

7.6 Crowdsourcing/ Crowd-sensing

7.7 E-commerce

7.8 Human-based Computation

7.9 Human Factors

7.10 Machine Learning

7.11 Nature User Interface

7.12 Rehabilitation Games

7.13 Ubiquitous Computing

(9) Multi-Platform Game Innovation Centre (MAGIC)

Focus on disciplinary research on next generation games and related research areas, developing effective translation of research findings into innovative products and services to enhance local game community in game development & commercialization.

Please contact Prof. Seah Hock Soon, ASHSSEAH@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

8.1 **Game Design**

- Social signal processing
- Visual Characterization and Interaction
- Unique Visuals & Gameplay Concepts
- Original and Appealing Game Content
- Futuristic Gaming

8.2 **Game Technology**

- Infrastructure & system support for MMOG and mobile games
- Artificial Intelligence support for Multi-Player Role Playing and Social Mobile Games
- Game-oriented 3D technologies for content creation & processing
- Secure Multiplayer Cloud Gaming: Platforms, Technologies and Applications
- Game Analytics

8.3 **Gamification and Serious Game**

- Social Serious Games for Understanding Policy
- Personalized and Continuous Rehabilitation via Serious Games

8.4 **Game Impact**

- Game Usability, Playability and Sociability
- Gaming Experience Evaluation
- Psychological, Physical and Societal Impact of Games

(10) Rapid-Rich Object Search Lab (ROSE)

Focus: mobile object search platform upon cloud services

- Large-scale object database and analytics
- Scalable Mobile Object Search with Contextual Mobility
- Media Cloud Innovation Platform

5-year collaboration with Peking University and industrial partners.

Please contact Prof. Alex Kot, EACKOT@ntu.edu.sg for more information on research projects from prospective advisors in the research areas outlined below.

9.1 Large-scale media object database and analysis

- Media object database design
- Semi-supervised and unsupervised data collection
- Social media-driven data aggregation
- Database indexing and maintenance
- Database optimization for search
- Multi-modal data management
- Consumer behavior analysis

9.2 Scalable mobile object search with contextual mobility

- Visual object representation and understanding
- Fast object retrieval and recognition
- Goal-driven media search
- Media pattern discovery
- Context-aware mobile visual search
- Contextual mobility analysis
- Mobile augmented reality

9.3 Media Cloud Innovation Platform

- Cloud platform design and API
- Cloud platform optimization for search and media services
- Cross-platform service delivery
- Scalable cloud resource management
- Cloud-centric multi-media processing and production
- cCloud-centric application design

9.4 Media Processeing

- Video analytic
- Image and video coding
- Quality measure
- Digital right management

Thematic Programme in Future Healthcare

(11) NANYANG INSTITUTE OF TECHNOLOGY IN HEALTH & MEDICINE (NITHM)

Building on the growing interest in research related to health and medicine, NITHM aims to provide a cross-disciplinary platform for engineers, scientists and clinicians to work together and develop new technologies that provide solutions to key problems in human health and medicine.

Please visit <http://nithm.ntu.edu.sg> for more information about NITHM. For more information on research projects from prospective advisors in the research themes outlined below, please write to nithm@ntu.edu.sg.

Potential PhD projects include the following broad areas:

- 10.1 Sensing and Diagnostics**
- 10.2 Therapeutic Medical Devices**
- 10.3 Tissue Engineering**
- 10.4 Nanomedicine**
- 10.5 Systems Biology and Medicine**
- 10.6 Medical Imaging and Signal Analysis**
- 10.7 Chemical Biology**
- 10.8 Health Systems Complexity**
- 10.9 Skin Research**

Notes

**INTERDISCIPLINARY
GRADUATE SCHOOL**
GRADUATE RESEARCH PROGRAMME

INTERDISCIPLINARY GRADUATE SCHOOL

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