UNNC – SIAT, CAS Doctoral Training Partnership

Available PhD topics

Formal applications should follow the instructions in the 'How to apply' section.

PhD topic	**Additive manufacturing and its application in the field of medicine**
SIAT Supervisor	Yuxiao Lai
UNNC Supervisor(s)	Sze Shin Low
Short introduction & description of PhD project	Biomaterials are used to engineer functional restoration of different tissues to improve human health and the quality of life. Biomaterials can be natural or synthetic. Additive manufacturing (AM) is a novel materials processing approach to create parts or prototypes layer-by-layer directly from a computer aided design (CAD) file. The combination of additive manufacturing and biomaterials is very promising, especially towards patient specific clinical applications. Challenges of AM technology along with related materials issues need to be realized to make this approach feasible for broader clinical needs. This approach is already making a significant gain towards numerous commercial biomedical devices. Tissue engineering provides the possibility of regenerating damaged or lost osseous structures without the need for permanent implants. Within our research, **3D printing biodegradable and bioresorbable** scaffolds can provide structural and biomechanical stability until the body's own tissue can take over their function. Additive biomanufacturing makes it possible to design the scaffold's architectural characteristics to specifically guide tissue formation and regeneration.
Contact points	Informal inquiries may be addressed to Dr Sze Shin Low (SzeShin.Low@nottingham.edu.cn) and Prof Yuxiao Lai (yx.lai@siat.ac.cn).
PhD topic	**Application of machine learning in finding therapeutic targets for rheumatoid arthritis**
SIAT Supervisor	Peng Zhang
UNNC Supervisor(s)	Huan Jin
Short introduction & description of PhD project	Use machine learning and other artificial intelligence methods to screen relevant early warning biomarkers, new prevention targets and drug regulatory molecules of rheumatoid arthritis.
Contact points	Informal inquiries may be addressed to Prof Peng Zhang (peng.zhang@siat.ac.cn) and Dr Huan Jin (huan.jin@nottingham.edu.cn).
PhD topic	**Artificial intelligence assisted intervention and surgical navigation**
SIAT Supervisor	Prof. Shoujun Zhou

UNNC Supervisor(s)	Prof. Sean He
Short introduction & description of PhD project	Artificial intelligence assisted intervention therapy is the trend of clinical development, but accurate navigation is still one of the clinical difficulties. In order to break through the technical bottleneck of interventional surgery, the key is to solve the core scientific problems such as accurate path planning, real-time navigation and safe operation. Therefore, the research of artificial intelligence methods for medical image big data and related conditions is of great significance.
Contact points	Informal inquiries may be addressed to Prof Sean He (Sean.He@nottingham.edu.cn) and Prof Shoujun Zhou (sj.zhou@siat.ac.cn).
PhD topic	**Assessment of Drug Effectiveness and Safety Using Data from Shenzhen Electronic Health Records Platform**
SIAT Supervisor	Prof. Jinling TANG
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	Electronic health records have been used to assess the effectiveness and safety of drugs. Unlike clinical trials, of which the sample size and follow-up are usually limited, observational studies using electronic health records can cover millions of patients and follow them for decades. Therefore, those studies can answer clinical or public health questions that are too expensive or not feasible to be addressed by clinical trials. The Shenzhen Electronic Health Records Platform includes the information from patients seeking healthcare from any hospital in Shenzhen since 2016. Although it provides rich information for research, its data structure is too complicated for traditional epidemiological methods. Mathematical modelling of assessment of drug effectiveness and safety using Electronic Health Data is a relatively new area, which plays an important role in clinical and public health research. Our goal in this project is to develop and analyse a mathematical model along with laboratory experiments for a specific assessment of drug effectiveness and safety using Electronic Health Data. This project will combine both mathematical/computational modelling and clinical approaches to the problem discussed above. The mathematical modelling will be undertaken under the supervision of Professor Mainul Haque at the School of Mathematical Sciences and the clinical investigations will be performed under the supervision of Prof. Jinling TANG at the SIAT. The latter will train the applicant to do the necessary clinical experiments and his laboratory has all the necessary facilities to perform the experimental part of the programme. One explicit aim of this project would be to train the applicant in some of the appropriate clinical laboratory techniques combining big data and artificial intelligence technology via mathematical/computational/statistical modelling to address clinical or public health questions of interest.
Contact points	Informal inquiries may be addressed to Prof. Weihua Meng (Weihua.Meng@nottingham.edu.cn) and Prof. Jinling Tang (jltang@siat.ac.cn).
PhD topic	**Biodegradable polymer materials applied in the field of electronic packaging**
SIAT Supervisor	Prof Rong Sun
UNNC Supervisor(s)	Dr Kok-Hoong Wong

Short introduction & description of PhD project	With the popularity and rapid upgrading of mobile phones and computers and other electronic appliances, a large number of electronic wastes needs to be disposed of. According to the United Nations, an average of 7.6 kg of e-waste was generated per person in 2021, meaning that more than 57.4 million tons of e-waste has been generated globally in 2021. If this e-waste is not properly dealt with, it will seriously endanger human survival, so it is an inevitable trend to develop environmentally friendly materials with degradable characteristics in the field of electronic packaging. This project will focus on biodegradable polymer materials through molecular design. After being utilized, the polymer materials can be decomposed in a mild acid environment such as acetic acid and soil, without causing environmental pollution, and alleviate the ecological pollution caused by e-waste from the source.
Contact points	Informal inquiries may be addressed to Prof. Rong Sun (rong.sun@siat.ac.cn) and Dr Kok-Hoong Wong (kok-hoong.wong@nottingham.edu.cn)
PhD topic	**Biological and mathematic analysis of the transcranial magnetic/electric stimulation in treating Alzheimer's disease**
SIAT Supervisor	Bing Song
UNNC Supervisor(s)	Weihua Meng Mainul Haque
Short introduction & description of PhD project	Transcranial magnetic/electric stimulation (TMS/TES) has been used clinically to treat neurological disorders, including neuropathic pain, depression, epilepsy, Alzheimer's disease, etc. Although TMS/TES stimulation may substantially enhance the plasticity between different brain regions and networks, it might also lead to a subsequent impairment of the treated brain tissues depending on the magnitude of the stimulation. Therefore, it is critical to systematically model the magnetic/electric parameters at various brain regions under TMS/TES treatment to link up the TMS/TES-triggered cellular response in vitro with the in vivo functional recovery, and guide the clinical treatments in the future therapeutic application. The project is a multidisciplinary team effort combining three sets of expertise from UNNC and SIAT supervisors. Our goal is to identify potential biological mechanisms or impacts under the supervision of Professor Weihua Meng (UNNC), combined with the mathematical modelling expertise of Professor Mainul Haque (UNNC), to systematically reveal the spatial parameters of magnetic/electric exposure at different brain areas. Subsequently, this shall be further tested in the laboratory of Professor Bing Song (SIAT) using tissue/organoids in vitro and animal models in vivo. Meng and Haque labs at UNNC shall offer systematic training in biology, bioinformatics and genetics and mathematical modelling at the biomedical interface for the PhD candidate. Song lab at SIAT will train the PhD candidate to conduct the TMS/TES experiments on neural stem cells in vitro and neurologically dysfunctional animal models in vivo, including Alzheimer's disease, neuropathic pain etc. Our explicit aims of this project would be to train the PhD candidate to master systems biology modelling skills and be experienced in the mechanistic analysis of TMS/TES treatment of neurological disorders.
Contact points	Informal inquiries may be addressed to Prof Bing Song (bing.song@siat.ac.cn) and Dr Weihua Meng (weihua.meng@nottingham.edu.cn).
PhD topic	**Biomaterials by Additive manufacturing**

SIAT Supervisor	Yuxiao Lai
UNNC Supervisor(s)	Yong Ren
Short introduction & description of PhD project	Biomaterials are used to engineer functional restoration of different tissues to improve human health and the quality of life. Biomaterials can be natural or synthetic. Additive manufacturing (AM) is a novel materials processing approach to create parts or prototypes layer-by-layer directly from a computer aided design (CAD) file. The combination of additive manufacturing and biomaterials is very promising, especially towards patient specific clinical applications. Challenges of AM technology along with related materials issues need to be realized to make this approach feasible for broader clinical needs. This approach is already making a significant gain towards numerous commercial biomedical devices. The growing interest in multi-functional metallic biomaterials for bone substitutes challenges the current additive manufacturing (AM, =3D printing) technologies. It is foreseeable that advances in multi-material AM for metallic biomaterials will not only allow for complex geometrical designs, but also improve their multi-functionalities by tuning the types or compositions of the underlying base materials, thereby presenting unprecedented opportunities for advanced orthopedic treatments. AM technologies are yet to be extensively explored for the fabrication of multi-functional metallic biomaterials, especially for bone substitutes. Progress on the **Mg、Mn based 3D printing biomaterials**, including the utilization of multi-material additive manufacturing, are our main research contents.
Contact points	Informal inquiries may be addressed to Dr Sze Shin Low (SzeShin.Low@nottingham.edu.cn) and Prof Yuxiao Lai (yx.lai@siat.ac.cn).
PhD topic	**Combining Deep Learning and Ontology Reasoning for Medical Image Semantic Segmentation**
SIAT Supervisor	Prof Shuqiang Wang
UNNC Supervisor(s)	Dr Heshan Du
Short introduction & description of PhD project	Generative artificial intelligence refers to new technologies that employ existing data including images, text, and audio files to create new content. This new content has a similar underlying pattern of real-world data and has great potential applications in many areas. Synthetic data from generative AI can train machine learning models to be less biased and help robots to learn more abstract concepts both in the real and virtual world. An ontology refers to an explicit specification of a shared conceptualization and plays an important role in establishing a common vocabulary for people who need to share information. It defines the meanings of concepts and relations explicitly, and these definitions can be read and interpreted by machines automatically. Consider the image segmentation problem as an example. To improve the interpretability and reliability of deep learning-based image semantic segmentation methods, it is promising to represent domain knowledge and inference rules defined by human beings as ontologies and incorporate ontology reasoning into the deep learning framework. This research will explore (1) the advances, challenges, and prospects of brain image computing and brain network computing techniques using generative artificial

	intelligence; (2) the effectiveness of combining deep learning and ontology reasoning for medical image segmentation, object detection and classification, etc.
Contact points	Informal inquiries may be addressed to Prof Shuqiang Wang (sq.wang@siat.ac.cn) and Dr Heshan Du (heshan.du@nottingham.edu.cn).
PhD topic	**Computer-Aided Drug Design Based on Machine Learning**
SIAT Supervisor	Dr Jijun Tang
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	Traditional drug research and development is a time-consuming and laborious process. From target discovery to lead compound generation to candidate drugs, it requires a lot of human and financial resources. Computer-aided drug molecular design can accelerate the process of drug molecular research and development. The molecular design aims to generate molecular compounds with high affinity for certain receptor targets, and also have good biological function characteristics. According to the different representations of molecular compounds, the existing drug research and development directions can be roughly divided into three categories: molecular generation based on one-dimensional molecular description, molecular generation based on two-dimensional molecular description, and molecular generation based on three-dimensional molecular description. In addition, molecular generation tasks can be divided into two types according to the molecular generation tasks. The first type is molecular generation based on a single target, and the second type is molecular generation based on multiple targets, indicating that the generated molecules need to target more than two targets at the same time. The student will gain relevant research experience in the design of drug-like molecules. The student would cultivate the skills of study design, analysis of molecular data (one-dimensional representation, two-dimensional representation of drug-like molecules, etc.), constructing deep learning model architectures, and drug-related experimental processing methods. Molecule analysis, programming, and academic writing will be provided. The student will be supported to publish papers as the lead author during the Ph.D. The ideal candidate should have a Master's degree in Bioinformatics or computer science. Proficiency with Python is essential.
Contact points	Informal inquiries may be addressed to Dr Jijun Tang (jj.tang@siat.ac.cn) and Dr Weihua Meng (Weihua.meng@nottingham.edu.cn).
PhD topic	**Deep learning-based method for phenotype prediction with multi-modal features and interaction detection**
SIAT Supervisor	Dr Peng Yin
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	Complex traits such as diabetes, pain, HDL are polygenetic heritable. GWAS has successfully identify many associated loci and polygenetic risk score has been applied to calculate the cumulative genetic risks. Other non-genetic risk factors include lifestyle and environment variables. To predict the phenotype accurately with high-dimensional & multi-modal data is challenging. Machine learning (particularly deep learning) is very useful to solve such complex problems with non-linear feature learning and it has been popular for complex traits prediction. This project will 1) develop a novel method using multi-modal features and

	by integrating prior knowledge (e.g., annotation) to improve the power, and 2) apply the method to disease phenotype prediction and interpret the feature importance and feature interactions.
Contact points	Informal inquiries may be addressed to Dr Peng Yin (peng.yin@siat.ac.cn) and Dr Weihua Meng (weihua.meng@nottingham.edu.cn)
PhD topic	**Deep Multimodal Representation Learning for Mental Health Diagnosis**
SIAT Supervisor	Dr. Wenjian Qin
UNNC Supervisor(s)	Prof. Ruibin Bai
Short introduction & description of PhD project	Mental disorders, such as depression, schizophrenia, attention-deficit hyperactivity disorder (ADHD), and autism spectrum disorder (ASD), etc, are highly prevalent and have been shown to harm to an individual's physical and mental health. Moreover, mental health illnesses have also been one of the most serious and prevalent public health problems, leading to an increased risk for suicidal ideation and suicide attempts. However, the mechanisms of mental disorders are complexity and heterogeneity. It makes difficulty to identify precision diagnosis markers from single source and unimodality. Consequently, there is no unique and efficient clinical characterization of mental disorders. Therefore, to utilize multimodal data including multimodal neuroimaging, electroencephalography (EEG) et.al. for large-scale screening, detection, early finding and precision diagnosis of mental health problems might be a promising solution. Artificial intelligence (AI) technologies are being applied to improve our understanding of mental health conditions and have been engaged to assist mental health providers for improved clinical decision-making. Especially, deep multimodal representation learning has benefited various applications involving screen, diagnosis, treatment plan and prognosis. However, one of the great challenges we are confronted with is the heterogeneity gap in multimodal data. This project will focus on three challenges:(a) Multimodal neuroimaging image processing and registration algorithm design. (b) EEG signals feature information extraction. (c) Deep multimodal representation learning model for screening, detection, early finding and diagnosis of mental illnesses to extract a representation from multimodal neuroimaging image, EEG signals and electronic health records information.
Contact points	Informal inquiries may be addressed to Dr Wenjian Qin (wj.qin@siat.ac.cn) and Prof Ruibin Bai (Ruibin.bai@nottingham.edu.cn).
PhD topic	**Design of high performance low dielectric polymer composites for integrated circuit packaging materials**
SIAT Supervisor	Prof. Shuhui Yu
UNNC Supervisor(s)	Dr. Yong Ren
Short introduction & description of PhD project	With the development of 5G and 6G high-speed communication technology, the demand for high-speed data transmission has increased tremendously.This has put forward extremely high performance requirements for electronic packaging media materials, from physical properties to process suitability and reliability. The key technical issues include: reducing high frequency signal transmission loss, reducing

	package warpage, and improving high temperature resistance. This requires dielectric materials for packaging to have low dielectric constant (D_k), low dielectric loss (D_f), low coefficient of thermal expansion (CTE) and high glass transition temperature (T_g) in high frequency applications. This project will regulate the rheological, thermal, mechanical and electrical properties of resin composites by means of molecular structure design and modification of fillers. Meanwhile, the correlation between the microstructure and macroscopic properties will be investigated deeply to achieve the balance of D_k, D_f, CTE and T_g.
Contact points	Informal inquiries may be addressed to Prof Shuhui YU (sh.yu@siat.ac.cn) and Dr. Yong Ren (Yong.Ren@nottingham.edu.cn).
PhD topic	**Design Space Exploration for Embedded TPU-GPGPU-based Heterogeneous System-on-Chip**
SIAT Supervisor	Dr. Zheng Wang
UNNC Supervisor(s)	Dr. Heng Yu
Short introduction & description of PhD project	The state-of-the-art embedded system exploits TPU (Tensor Processing Unit) to accelerate the execution of neural networks on the edge. Current TPUs mostly adopt fixed-point algorithmic implementation which leads to precision degradation for the inference of advanced vision-based networks such as Yolo-v5 and non-vision-based networks such as Transformer. A flexible and embedded GPGPU (General Purpose Graphical Processing Unit) engine with SIMD (Single-Instruction-Multiple-Data) execution model and efficient floating point support is essential to support evolving algorithm kernels. However, designing embedded TPU-GPGPU-based System-on-Chip (SoC) face several challenges which will be addressed in this PhD topic. Potential fields of investigation include but are not limited to the micro-architecture for efficient data sharing and transfer between embedded TPU and GPGPU, the trade-off between quality of service (e.g. precision level and performance) and physical constraints (e.g. area and power). Furthermore, the design space exploration techniques for such a heterogeneous system will be examined.
Contact points	Informal inquiries may be addressed to Dr. Zheng Wang (zheng.wang@siat.ac.cn) and Dr. Heng Yu (Heng.Yu@nottingham.edu.cn).
PhD topic	**Design, Control and Application of Soft Medical Robots**
SIAT Supervisor	Prof Zeyang Xia
UNNC Supervisor(s)	Dr Dunant Halim
Short introduction & description of PhD project	Soft robots have high flexibility and continuous deformability that can cover complex task spaces by using soft materials, and therefore have a wide range of applications in medical science. However, there are still several challenges in soft medical robots. First, a well-designed structure can reduce the control difficulty of soft robots and improve the accuracy and performance. However, traditional example-oriented methods are not capable to satisfy the requirement of design optimization. Second, traditional control strategies also need to be improved due to the high flexibility of soft medical robots in order to avoid organ damage and improve treatment prediction. Finally, application of soft medical robots requires a methodology of customization that satisfies patient specific requirements.

	This project will focus on three major objectives: (i) design (design optimization of soft actuator), (ii) control (control algorithms towards soft robots), and (iii) innovative applications of soft medical robots. References: [1] P.E. Dupont, B.J. Nelson, M. Goldfarb, et al. A decade retrospective of medical robotics research from 2010 to 2020, Science Robotics, 2021, 6(60): eabi8017. [2] T. G. Thuruthel, Y. Ansari, E. Falotico, et al. Control strategies for soft robotic manipulators: a survey, Soft Robotics, 2018, 5(2): 149-163. [3] Y. Chen, Z. Xia, Q. Zhao. Optimal design of soft pneumatic bending actuators subjected to design-dependent pressure loads. IEEE/ASME Transactions on Mechatronics, 2019, 24(6): 2873-2884.
Contact points	Informal inquiries may be addressed to Prof Zeyang Xia (zy.xia@siat.ac.cn) and Assoc. Prof Dunant Halim (dunant.halim@nottingham.edu.cn).
PhD topic	**Developing ultrasensitive diagnostics by combining directed evolution and surface plasmon resonance**
SIAT Supervisor	Dr Xiao Yi
UNNC Supervisor(s)	Dr Jing Wang
Short introduction & description of PhD project	Surface Plasmon Resonance (SPR) technology uses a surface-sensitive optical instrument to detect heavy metals, viruses or pathogenic bacteria by specific binding of these targets with probing molecules such as proteins. While a robust and versatile probe, naturally occurring proteins are usually insufficient in their binding affinity to the targets, thereby limiting the sensitivity of SPR based diagnostics. Directed evolution mimics the cycle of mutagenesis and natural selection in nature to evolve novel or improved protein functions, and have been serving a workhorse for engineering proteins for industrial and medical applications. Recent advances of this technology such as Targeted Artificial DNA Replisome (TADR) further boosts the capacity of optimizing protein functions. TADR is able to (i) target a region no less than a gene and show low off-target mutagenesis, (ii) carry out a high mutation rate that can be turned on and off, and (iii) work with any trait that can be screened. This project will focus on (i) constructing TADR in *Saccharomyces cerevisiae* and (ii) evolving probe proteins to be used in SPR sensor chips.
Contact points	Informal inquiries may be addressed to Dr Jing Wang (Jing.Wang@nottingham.edu.cn) and Dr Xiao Yi (xiao.yi@siat.ac.cn).
PhD topic	**Development of stretchable electronics for biomedical applications**
SIAT Supervisor	Prof. Zhiyuan Liu
UNNC Supervisor(s)	Dr Yong Ren
Short introduction & description of PhD project	Stretchable electronics has evolved with the synthesis of new soft materials and new device architectures that require significant deformability, therefore it has high application potentials in wide range of biomedical areas such as biosensors. This project will focus on study of the solid-liquid phase transition and plastic deformation of liquid metal alloy and fabrication of liquid metal alloy based flexible electronic devices which

	are composed of 3D circuits. Our work will lead to the development of 3D structured wearable sensor and a multilayer flexible circuit boards. It will provide a facile strategy for constructing highly integrated electronics of hierarchical structure involving complicated 3D circuits.
Contact points	Informal inquiries may be addressed to Prof. Zhiyuan Liu (zy.liu1@siat.ac.cn) and Dr Yong Ren (yong.ren@nottingham.edu.cn).
PhD topic	**Development, evaluation, and clinical trials of biomaterials & medical devices**
SIAT Supervisor	Prof. William Weijia Lu
UNNC Supervisor(s)	Dr Enrico Marsili
Short introduction & description of PhD project	1. 3D-bioprinted osteoblast-laden hydrogel constructs with induced microenvironments promote cell viability, differentiation, and osteogenesis both in vitro and in vivo 2. Drug& device modulates osteogenic activity of bone biomaterials for bone formations
Contact points	Informal inquiries may be addressed to Prof. William Lv (wwlu@siat.ac.cn) and Prof. Enrico Marsili (enrico.marsili@nottingham.edu.cn).
PhD topic	**Engineered Microorganism for Real-time Bioelectronic Sensing**
SIAT Supervisor	Prof. Ye CHEN
UNNC Supervisor(s)	Dr. Sze Shin LOW
Short introduction & description of PhD project	Engineered microorganisms, such as bacteria or yeast, can be used for real-time bioelectronic sensing. This involves modifying the microorganisms to produce proteins or other molecules that can detect chemicals and produce an electronic signal response. The microorganisms can then be used to sense the presence of these chemicals or conditions in real time, allowing for continuous monitoring and rapid detection. For example, engineered E. coli bacteria have been used to detect heavy metals in water. The bacteria are genetically modified to produce a protein that binds to the heavy metal, causing a change in the bacterial metabolism and resulting in the production of a detectable signal on monitor. This allows for rapid and sensitive detection of heavy metals in water, without the need for expensive or time-consuming laboratory analysis. Overall, engineered microorganisms have great potential for use in real-time bioelectronic sensing, providing a rapid, sensitive, and cost-effective way to detect a wide range of chemicals and environmental conditions.
Contact points	Informal inquiries may be addressed to Dr. Sze Shin Low (Sze-Shin.Low@nottingham.edu.cn) and Prof. Ye Chen (ye.chen@siat.ac.cn).
PhD topic	**High speed motor design and control**
SIAT Supervisor	Tianfu Sun
UNNC Supervisor(s)	Jing Li
Short introduction & description of PhD project	Motor is the prime mover for both industry and domestic applications. With the increasing performance of power electronics and micro-processor (MCU), higher speed becomes the trend of the motor technique. Increase of the motor rated speed can significantly enhance the motor power density and make the whole system lighter and more compact. Therefore, high speed motor could be wily applied in automobile

	industry, robotics, aerospace industry, etc. However, higher speed will also bring more changelings. This project will focus on two major dimensions: (i) high speed motor design, including multi-physical field simulation analysis, electromagnetic optimization, thermal and stress analysis of high-speed motor; (ii) high speed motor control, including design and prototype of wide-bandgap power module based motor drive, development of advanced sensor-less control strategy and etc.
Contact points	Informal inquiries may be addressed to Prof Tianfu Sun (tf.sun@siat.ac.cn) and Dr. Jing Li (Jing.Li@nottingham.edu.cn).
PhD topic	**High throughput screen and optimized design of the mRNA Capping enzymes via text-mining and deep learning approaches.**
SIAT Supervisor	Chunbo Lou
UNNC Supervisor(s)	Yuan Yao or Dr Heshan Du
Short introduction & description of PhD project	Regulatory part mining and design optimization by a high-throughput prediction and text-mining method for regulatory elements that effectively combines literature knowledge and biological big data information.
Contact points	Informal inquiries may be addressed to Prof Chunbo Lou (cb.lou@siat.ac.cn) and Dr Yuan Yao (Yuan.Yao@nottingham.edu.cn) or Dr Heshan Du (heshan.du@nottingham.edu.cn).
PhD topic	**Image-guided Radiation Therapy based on Machine Learning**
SIAT Supervisor	Yaoqin Xie
UNNC Supervisor(s)	Sean He
Short introduction & description of PhD project	Image Guidance is critical during radiation therapy, Medical imaging plays an essential role in cancer diagnosis, treating plan and radiotherapy. But during the treating course, tumors position would change caused by breathing and filling of hollow organs, and irregular movement caused by emotional stress. This my laed to target region inaccuracy and trouble on tumor track and the plan to continue treatment. Image processing techniques based on machine learning can improve these problems, by learning natural mark supervised learning the matching relation, or by learning multimodal fusion problem. These problems will be the main focus during the project.
Contact points	Informal inquiries may be addressed to Prof Sean He (sean.he@nottingham.edu.cn) and Prof Yaoqin XIE (yq.xie@siat.ac.cn).
PhD topic	**Impact of Expectation Bias on Results of Randomized Clinical Trials**
SIAT Supervisor	Prof. Jinling TANG
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	Evidence-based medicine relies heavily on the evidence produced by randomized clinical trials (RCTs). Ideally, RCTs should be designed, conducted, and reported neutrally to minimize bias. However, researchers usually have subjective expectations of the results when conceiving an RCT. They may manipulate the RCT to produce results consistent with such expectations, leading to expectation bias. It remains challenging to directly measure the impact of expectation bias on the results of RCTs. However, researchers may have diverting expectations on the same clinical question. If researchers manipulate the RCTs to drive the results toward their

	expectations, we will observe discrepancies in the effect estimates. Such discrepancies can be measured to estimate the impact of expectation bias on the results of RCTs. This project aims to compare the results of RCTs with diverting expectations on the same clinical question to assess the impact of expectation bias. We will select RCTs from bibliographic databases and trial registries, abstract their initial expectations, and compare the results between those with similar research questions but diverting expectations. Multi-level general linear and Bayesian-adjusted models will be used to control confounders and explore effect modifiers associated with expectation bias. This project can potentially promote reform in the design, conduct, and reporting of RCTs to minimize bias.
Contact points	Informal inquiries may be addressed to Prof. Weihua Meng (Weihua.Meng@nottingham.edu.cn) and Prof. Jinling Tang (jltang@siat.ac.cn).
PhD topic	**In-situ and non-contact ultrasonic testing method for laminated electronic packaging devices**
SIAT Supervisor	Prof Shifeng Guo
UNNC Supervisor(s)	Dr Jian Yang
Short introduction & description of PhD project	Electronic packaging serves major functions in the performance of electronic systems and therefore a reliable technique to ensure its quality and stability is highly demanded. However, some bottleneck problems are encountered in existing non-destructive testing technologies for laminated electronic packaging devices, such as offline and ex-situ measurement of mechanical properties, low quality of two-dimensional imaging, and low-level automation of defect interpretation. Therefore, a new technology for in-situ and non-destructive testing of materials' mechanical properties and micromorphology using ultrasound is proposed. The research focuses on "ultrasound propagation mechanism and control strategy for multilayer heterostructure materials", "high quality and multi-mode ultrasonic waves' excitation and reception", "mechanical property inversion using multi-mode and multi-path ultrasound", and "three-dimensional imaging and intelligent interpretation of micromorphology of typical defects". The ultimate objective is to realize continuous monitoring of the dynamic evolution behaviour of mechanical properties and micromorphology of packaging materials and core components in in-service chips, which can provide a basis for revealing the micro-scale heat dissipation mechanism and material properties degradation mechanism, and thus provide guidance on high-performance packaging materials development and advanced packaging processes optimization.
Contact points	Informal inquiries may be addressed to Prof Shifeng Guo (sf.guo@siat.ac.cn) and Dr Jian Yang (jian.yang@nottingham.edu.cn).
PhD topic	**Intelligent analysis of multi-omics data and its biomedical application**
SIAT Supervisor	Yanjie Wei
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	For the past decade, the development of high-throughput omics technologies such as genomics, epigenomics, transcriptomics, proteomics across all facets of biology have generated huge amount of data deposited in several data centers (NCBI, UK Biobank,

	DDBJ and CNCB), and the big data (HPC etc.) analytics and deep learning techniques has been playing an increasingly role for knowledge discovery in biomedicine research such as biomarker discovery, drug design etc. At the same time, the new AI models has also advanced biomedical research by the study of biomedical images. By integrating the genomic data with medical image data, more insight can be drawn in the field of biomedical research. Relying on the world class supercomputers and biological lab experiments, the project aims at developing novel methods/techniques and constructing the pipeline to study biologically and clinically important problems such as mental health disorders by analysing omics big data, and to study the phenotypic, genetic, and molecular characteristics of these important disease.
Contact points	Informal inquiries may be addressed to Prof Yanjie Wei (yj.wei@siat.ac.cn) and Dr Weihua Meng (weihua.meng@nottingham.edu.cn).
PhD topic	**Living Hybrid for Biosensing and Biomedical Applications**
SIAT Supervisor	Prof. Chao ZHONG
UNNC Supervisor(s)	Dr. Sze Shin LOW
Short introduction & description of PhD project	Natural materials possess many distinctive "living" attributes, such as self-growth, self-healing, environmental responsiveness, and evolvability, that are beyond the reach of many existing synthetic materials. The integration of functional synthetic materials and living biological entities, known as engineered living materials (ELMs) has emerged as a new and powerful approach to create adaptive and functional structures with unprecedented performance and functionalities. They take inspiration from nature and harnesses engineered living systems to realize many highly desired properties, which are usually only found in biological systems. The use of microorganisms and biological cells for sensing applications have been explored for decades, the rapid advance in synthetic biology enables disease diagnosis and treatment, environmental monitoring, and toxicological screening, based on the information-processing abilities of living cells. This project will focus on the development and utilization of ELMs in two main directions, which is (i) biosensing – detection of various important biomarker for disease diagnosis or monitoring; (ii) drug delivery – precise control of drug release at desired location for disease treatment.
Contact points	Informal inquiries may be addressed to Dr. Sze Shin Low (Sze-Shin.Low@nottingham.edu.cn) and Prof. Chao Zhong (chao.zhong@siat.ac.cn).
PhD topic	**Magnetic resonance imaging and medical Image Processing**
SIAT Supervisor	Na Zhang
UNNC Supervisor(s)	Sean He
Short introduction & description of PhD project	Magnetic resonance imaging (MRI) is an essential tool for medical diagnosis. We expect to develop new MRI techniques with clinical applications in cerebrovascular disease and tumor diagnosis. We also expect to carry out MRI image processing based on artificial intelligence technology and conduct research in combination with clinical data and imaging equipment.

Contact points	Informal inquiries may be addressed to Prof Na Zhang (na.zhang@siat.ac.cn) and Prof Sean He (Sean.He@nottingham.edu.cn).
PhD topic	**Magnetoelectric stimulation assisted metal-organic frameworks engineered hydrogels in treating bone injury repair**
SIAT Supervisor	Prof Bing Song
UNNC Supervisor(s)	Prof Dave Towey Dr Mainul Haque
Short introduction & description of PhD project	Clinically, bone defects caused by trauma, tumour resection, infection and degenerative diseases have been a major challenge. Bone grafting is a promising treatment which requires the following properties of the grafting materials to systematically restore the physiological function of the damaged site: 1. Establish osseointegration with recipient tissue; 2. Promote bone regeneration; 3. Activate angiogenesis; and 4. Regulate immunomodulation. High-performance polymers, including polyetherimide (PEI) and gelatin methacryloyl (GelMA), have excellent mechanical strength, good biocompatibility and is suitable for bone implants. However, the osseointegration, angiogenesis and immunomodulation properties need to be further improved. Metal-organic frameworks (MOF) assembled hydrogels have demonstrated bone repair function with anti-inflammatory and angiogenic properties. In this project, we proposed to combine MOF-PEI with magnetoelectric stimulation to synergistically enhance the osseointegration, angiogenesis and immunomodulation during bone repair. Computational modelling shall be conducted to quantify the untestable in vivo magnetoelectric effect of the grafted MOF-PEI-GelMA in bone repair. This project will also bring experimental and computational/mathematical modelling approaches to the abovementioned problem. The computational mathematical modelling will be undertaken under the supervision of Professor Dave Towey and Mainul Haque at the UNNC, and the experimental investigations will be performed in the laboratory of Professor Bing Song at the SIAT. The project will train the applicant to have interdisciplinary (computer science-biology and mathematics) minds to solve the problems in biophysics with a flavor of biomedical engineering alongside clinical applications.
Contact points	Informal inquiries may be addressed to Prof Bing Song (bing.song@siat.ac.cn) and Prof Dave Towey (Dave.Towey@nottingham.edu.cn).
PhD topic	**Medical Image Processing and Artificial Intelligence**
SIAT Supervisor	Zhanli Hu
UNNC Supervisor(s)	Sean He
Short introduction & description of PhD project	Artificial intelligence technology has gained widespread popularity in various fields. We expect to carry out medical image processing based on artificial intelligence technology, discover new imaging methods and means, and conduct research in combination with clinical data and imaging equipment.
Contact points	Informal inquiries may be addressed to Prof Zhanli Hu (zl.hu@siat.ac.cn) and Prof Sean He (Sean.He@nottingham.edu.cn).

PhD topic	**Methods for analyzing population level single cell genomics data**
SIAT Supervisor	Dr Hao Wu
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	The single cell genomic sequencing technology has revolutionized the biological and clinical research. The complexity of the single cell data requires specifically designed tools for analysis. There are many existing tools, but mostly design for data from single or small number of subjects. In this project, we aim to develop novel statistical and computational tools for the analysis of large-scale population level single cell data, with consideration of subjects' demographics and clinical conditions. Potentially questions include differential expression, cell type identification, novel cell type discovery, and molecular biomarker discovery for diseases. In addition, we will collaborate with local clinicians in China to recruit samples to perform single cell genomic sequencing and we will test our developed analysing tools using these sequencing data.
Contact points	Informal inquiries may be addressed to Dr. Hao Wu (wuhao@siat.ac.cn) and Dr. Weihua Meng (weihua.meng@nottingham.edu.cn).
PhD topic	**Modelling the screen and verification of biomarkers in building the forewarning model for intelligent assistant diagnosis of mental disease including depressive disorder**
SIAT Supervisor	Prof Zhijun Zhang
UNNC Supervisor(s)	Dr. Mainul Haque
Short introduction & description of PhD project	Mathematical modelling of biomarkers that assistant diagnosis of depressive disorder is a relatively new area, which plays an important role in clinical medicine and drug discovery investigations. Our goal in this project is to develop and analyse a mathematical/computational models along with laboratory experiments for a specific biomarkers in building the forewarning model for intelligent assistant diagnosis of depressive disorder. This project will combine both mathematical/computational modelling and Neuroscience laboratory approaches to the problem discussed above. The mathematical modelling will be undertaken under the supervision of Professor Mainul Haque at the School of Mathematical Sciences (UNNC) and the experimental research of neuroscience will be performed in the laboratory of Professor Zhijun Zhang at the SIAT. The latter will train the applicant to do the necessary experiments and her laboratory has all the necessary facilities to perform the experimental part of the programme. One explicit aim of this project would be to train the applicant in some of the appropriate laboratory techniques for measuring the effects of biochemical and genetic risk factors on the screen and verification of biomarkers by bioinformatics, machine learning, and in-depth learning.
Contact points	Informal inquiries may be addressed to Dr. Mainul Haque (Mainul.Haque@nottingham.edu.cn) and Prof. Zhijun ZHANG (zhang.zj@siat.ac.cn or janemengzhang@vip.163.com).
PhD topic	**Multi-agent decision making based on action recognition and intention prediction in future "intelligent space"**
SIAT Supervisor	Prof. Qieshi Zhang

UNNC Supervisor(s)	Dr. Yuan Yao
Short introduction & description of PhD project	The ability of autonomous systems to achieve their design objectives and to interact with other agents and humans is becoming a critical issue in a world in which transport, distribution and manufacture are increasingly automated. In conventional industrial automation, cooperation is typically achieved using a central controller, that dictates the order in which actions are performed so as to ensure effective synchronisation of the individual systems. This works well in a predictable and repetitive environment. However, in future "intelligent spaces", e.g., "smart cities", "smart roads", etc., where there are full of uncertainty and incomplete information, this approach is no longer practical. Rather systems must recognise and predict the actions performed by other agents or humans, and then decide what to do next in order to achieve their goals and ensure safe operation. The aim of this project is to investigate the theoretical underpinnings of techniques to allow autonomous systems to act and cooperate safely and effectively in future "intelligent spaces". This overall aim will be broken down into three key objectives: 1) recognising the actions performed by other agents and humans via computer vision techniques; 2) predicting the intention of other agents and humans based on the recognised actions; and 3) deciding how to act given these predictions.
Contact points	Informal inquiries may be addressed to Dr. Yuan Yao (Yuan.Yao@nottingham.edu.cn) and Prof. Qieshi Zhang (qs.zhang@siat.ac.cn).
PhD topic	**Multimodal medical imaging**
SIAT Supervisor	Zhanli Hu
UNNC Supervisor(s)	Ruibin Bai
Short introduction & description of PhD project	Medical imaging technology plays an irreplaceable role in clinical practice. This project focuses on multimodal medical image processing methods such as PET/CT and PET/MR and combines with artificial intelligence technology to achieve high quality and fast medical image processing methods.
Contact points	Informal inquiries may be addressed to Prof Zhanli Hu (zl.hu@siat.ac.cn) and Prof Ruibin Bai (Ruibin.bai@nottingham.edu.cn).
PhD topic	**Nanomaterials for bone tissue engineering**
SIAT Supervisor	Yuxiao Lai
UNNC Supervisor(s)	Xiaolei Fan
Short introduction & description of PhD project	Bone is a specialized form of connective tissue that forms the skeleton of the body and is built at the nano and microscale levels as a multi-component composite material consisting of a hard inorganic phase (minerals) in an elastic, dense organic network. Mimicking bone structure and its properties present an important frontier in the fields of nanotechnology, materials science and bone tissue engineering, given the complex morphology of this tissue. There has been a growing interest in developing artificial bone-mimetic nanomaterials with controllable mineral content, nanostructure, chemistry for bone, cartilage tissue engineering and substitutes. The significance and basic process of bone tissue engineering along with different bionanomaterial bone scaffolds made of nanocomposites and nanostructured biopolymers/bioceramics and the prerequisite biomechanical functions are significant research directions.

Contact points	Informal inquiries may be addressed to Prof Xiaolei Fan (Xiaolei.Fan@nottingham.edu.cn) and Prof Yuxiao Lai (yx.lai@siat.ac.cn).
PhD topic	**One-step-ahead: Accurate Viral Mutation Prediction for Early Preparedness of Government Policies and Pharmaceuticals**
SIAT Supervisor	Prof Jinyan Li
UNNC Supervisor(s)	Prof Vladimir Brusic
Short introduction & description of PhD project	In the battle against COVID-19, we are always acting behind the mutation and evolution pace of the SARS-CoV-2 virus. We are jabbing Pfizer and Modena mRNA vaccines for Delta strain-infected populations, which were actually designed using the spike gene template of the original strain and were trial-tested on the population infected by the original strain as well. As the mutations from the original strain to the Delta strain of the virus is significant, the efficacy of the mRNA vaccines is remarkably sacrificed (from 95% to 65%) for the Delta-strain infected patients to prevent death. If the mutations in the Delta strain have had been accurately predicted at the emerging time of COVID-19, the design of the mRNA vaccines would be considering both the original sequence and the predicted Delta-strain sequence to get early preparedness to fight against the pandemic. Computational Challenges: Although there are millions of sequences of different strains of the virus publically available at the NCBI and GISAID sars-cov-2 databases, the time stamps and series of these sequences are hardly known, causing difficulties in the training data construction for advanced machine learning and prediction models. Without the prediction model, it's challenging to answer questions such as what's the next strain, it's a mild mutation or virulent or deadly? Potential impacts: We will use bioinformatics methods to investigate the epitope sites and receptor-binding sites at the spike gene of the predicted strains. If the predicted strain is virulent, we will collaborate with pharmaceutical companies for the design of future mRNA vaccines to win a one-step-ahead time to effectively control next waves of viral infections. We also investigate the therapeutic target sites of miRNA or siRNA drugs at the predicted spike mRNA sequences in an aim for effective treatment of future patients. We will also collaborate and discuss with Health Departments to discuss government policy adjustments to prevent and control future infectious diseases.
Contact points	Informal inquiries may be addressed to Prof Jinyan Li (jinyan.li@siat.ac.cn) and Prof Vladimir Brusic (Vladimir.brusic@nottingham.edu.cn).
PhD topic	**Photosynthetic biohybrid system based on metal-organic-frameworks and *Escherichia coli* for sustainable solar energy conversion and valuable chemical production**
SIAT Supervisor	Dr. Bo Wang
UNNC Supervisor(s)	Prof. Xiaolei Fan
Short introduction & description of PhD project	Photosynthetic biohybrid systems integrating light-harvesting semiconductor nanomaterials with highly specific whole-cell biocatalysts, represent a new trend for artificial photosynthesis with remarkable capabilities in solar-to-chemical conversion. The development of such systems is still in the early stages, and their applications have been hindered by limited conversion efficiency and product value. As one of the widely

	used industrial workhorse microorganism, *E. coli* has mature genetic engineering tools to expand the product spectrum. Moreover, engineered *E. coli* have been successfully integrated with different nanomaterials to produce valuable products including glucose, l-malate, l-tert-leucine, farnesyl and threonine. MOFs are a new class of porous crystalline materials constructed from organic ligands and metal ions/clusters. They have attracted much attentions in recent years and numerous studies have revealed their great potential in various applications. Excellent cytoprotective function of MOFs has already been demonstrated, however, their roles as photosensitizer to microbial cells have not yet been deeply investigated in biohybrid system. Therefore, design and construction of a MOF-*E. coli* biohybrid system for efficient light-driven valuable chemical production is of great significance. This project will focus on (1) synthesis and screening MOFs with excellent photoelectrochemical property and cytoprotective function against reactive oxygen species, (2) constructing a MOF-*E. coli* biohybrid system with highly efficiency electron transfer interface, (3) genetic engineering *E. coli* to achieve light-driven biosynthesis of different valuable production (such as amino acids and alcohols), (4) studying the underlying mechanism of material-cell energy transfer and intracellular energy conversion.
Contact points	Informal inquiries may be addressed to Prof. Xiaolei Fan (Xiaolei.Fan@nottingham.edu.cn) and Dr. Bo Wang (bo.wang@siat.ac.cn).
PhD topic	**Plasma catalysis for CO2 conversions or environmental remediation**
SIAT Supervisor	Prof Zhitong Chen
UNNC Supervisor(s)	Prof Xiaolei Fan
Short introduction & description of PhD project	As the fourth state of matter, plasma's unique properties and interactions with other states of matter offer many promising opportunities for investigation and discovery. In particular, cold atmospheric plasma (CAP), operating at atmospheric pressure and room temperature, has remarkable potential applications for catalysis, biomedicine, environment, materials, energy, and so on. In this project, we will co-supervise PhD students working on developing plasma technology for environmental remediation and waste valorization. In addition, we also can supervise PhD students developing plasma technology to assist in the rational design of new catalysts for CO_2 conversions.
Contact points	Informal inquiries may be addressed to Dr Xiaolei Fan (Xiaolei.Fan@nottingham.edu.cn) and Dr Zhitong Chen (zt.chen1@siat.ac.cn).
PhD topic	**Polypharmacy and medication reduction in patients with type 2 diabetes**
SIAT Supervisor	Dr Zhirong Yang
UNNC Supervisor(s)	Dr Weihua Meng
Short introduction & description of PhD project	Polypharmacy is common in older adults, especially those with multiple chronic diseases, and has been associated with adverse health outcomes, including hospitalization and death. Previous studies showed that the prevalence of polypharmacy were more than 60% in older people with type 2 diabetes. However, it is unclear how the patterns of polypharmacy in these patients changed over time, such as drug combination, switching, addition, adherence and reduction, and whether medication reduction is associated with the risk of adverse health outcomes. In this

	project, we will examine these questions. We will systematically review randomized controlled trials and observational studies to summarize previous relevant evidence and identify the important gaps for future research. We will conduct cohort studies using real-world clinical data from Shenzhen and the UK to assess polypharmacy and medication reduction in patients with type 2 diabetes. Advanced methods of causal inference and machine learning will be used. The student will gain experience in pharmacoepidemiology research and analysis of large-scale real-world data. The student will develop skills in conducting systematic literature reviews, study design, statistical programming, and data analysis. The student will be supported to publish peer-reviewed papers as the lead author during the PhD. Training in epidemiological methods, advanced statistics, programming, and academic writing will be provided. The ideal candidate should have a Master degree in epidemiology, data science, public health, or clinical medicine. Proficiency with STATA, R or SAS is essential.
Contact points	Informal inquiries may be addressed to Dr Zhirong Yang (zr.yang@siat.ac.cn) and Dr Weihua Meng (weihua.meng@nottingham.edu.cn)
PhD topic	**Quantitative optical imaging of physiological dynamics**
SIAT Supervisor	Baoqiang Li
UNNC Supervisor(s)	Jianfeng Ren
Short introduction & description of PhD project	Joint PhD program and scholarships between Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences and University of Nottingham Ningbo China. Biologist and life scientists can achieve tremendous advantages by using advanced optical imaging tools and computational methods to understand the biological and physiological phenomena at a sufficient spatiotemporal resolution, as well as diagnose disease with accuracy and efficiency. Optical imaging combined with advanced image processing algorithms is capable of detecting and quantifying the optical signature of disease or detecting cellular/molecular activities to improve the understanding of biological mechanisms. The candidate will take on a research project collaborated between Prof. Baoqiang LI (SIAT) and Prof. Jianfeng Ren (UNNC), to 1) develop novel optical microscopic imaging technologies and 2) image processing methods, as well as apply these techniques to study the mechanisms of physiological dynamics of living organisms (primarily but not limited to mammalian brain). Applicants should have Master degree in biomedical engineering, physics, optics, computer science, electrical engineering & electronics, or other related disciplines.
Contact points	Informal inquiries may be addressed to Prof. Baoqiang Li (bq.li@siat.ac.cn) and Prof. Jianfeng Ren (Jianfeng.Ren@nottingham.edu.cn).
PhD topic	**Robot assisted automatic preparation of functional materials**
SIAT Supervisor	Prof. Haitao ZHAO
UNNC Supervisor(s)	Prof. Tao WU
Short introduction & description of PhD project	The PhD topic aims to develop an Industry 4.0 approach, revolutionizing the conventional material R&D method using advanced Human-AI-Robots collaboration technologies, which enable the Functional Materials Automation Platform (FAP) that

	equipped with Functional Materials Interfaces Genome (FIG) continuous learning, increasing in confidence, knowledge and R&D efficiency over time, from previous iterations. FAP can unlock the rapidly development of novel functional materials for cross-applications in the fields of electronic information (IT) and biomedical technologies (BT).
Contact points	Informal inquiries may be addressed to Prof Haitao ZHAO (ht.zhao@siat.ac.cn).
PhD topic	**The Investigation of Wearable Sensor for the Simultaneous Detection of Multiple Pulse Wave Velocities and Its Clinical Application**
SIAT Supervisor	Dr. Yishan Wang
UNNC Supervisor(s)	Dr. Jing Wang
Short introduction & description of PhD project	Cardiovascular diseases contribute to considerable mortality in modern society. It has been proven that the risk of cardiovascular diseases is related to the degree of arterial stiffness. Arterial stiffening can cause a rise in aortic systolic pressure, a fall in diastolic pressure and a higher risk in heart diseases with increased age. In order to identify the early-stage arterial diseases so to perform early intervention, there is an increasing need to monitor the arterial stiffness in a convenient, reliable and non-invasive way. Pulse wave velocity (PWV), the propagation velocity of blood waves/pulses via the circulatory system, is a strong indicator of arterial stiffness and can improve cardiovascular event prediction. This project proposes a method of simultaneous measurement of both local PWVs and regional PWVs based on Fiber Bragg Grating (FBG) technique. The algorithm of synchronizing the pulses at various locations is one of the research content, while the other is to investigate the PWV network features based on the data collected from patients with cardiovascular diseases, hypertension, and arteriosclerosis.
Contact points	Informal inquiries may be addressed to Dr. Yishan Wang (ys.wang@siat.ac.cn) and to Dr. Jing Wang (Jing.Wang@nottingham.edu.cn).
PhD topic	**Thermoelectric-based thermal management design for lithium-ion battery**
SIAT Supervisor	Ruiheng Liu
UNNC Supervisor(s)	Yong Shi
Short introduction & description of PhD project	With the rapid development of new energy vehicles, thermal management of Lithium-ion battery pack has become one of the most important issues related to the security, endurance and energy efficiency. Thermoelectric can realize the bothway temperature control through electricity, and also features static, miniaturization and high response speed. This PhD project will focus on designing and developing intelligent battery thermal management systems, by taking advantage of advanced thermoelectric materials and devices, for low-carbon electric vehicles.
Contact points	Informal inquiries may be addressed to Dr/Prof Ruiheng Liu (Rh.liu@siat.ac.cn) and Dr/Prof Yong Shi (Yong.Shi@nottingham.edu.cn).
PhD topic	**Ultrasound-mediated biofilm expression and application**
SIAT Supervisor	Prof. Fei Yan
UNNC Supervisor(s)	Prof. Enrico Marsili

Short introduction & description of PhD project	Bacteria-mediated tumor therapy has recently attracted considerable attention. The ability of bacteria to colonize tumor is one of the main factors affecting the therapeutic effect. Interestingly, some bacteria have shown good adhesion to host tissues because they often express biofilms on their surface. The introduction of synthetic biological technologies (e.g., promoter engineering and smart genetic circuits) into tumor-targeted bacteria could lead to the over-expression of such biofilms, such strategy may largely improve their selective colonization of tumor, enhancing the convenience of tumor drug delivery. To date, many techniques have been developed for studying inducible gene expression in bacteria, including chemical induction, physical stimulation and biological methods. Ultrasound-mediated gene expression has many advantages on account of their properties of non-invasiveness, safety and tissue penetration. It can provide ideal remote regulations of bacterial gene expression. The adhesion of bacteria to tumours and the formation of biofilm can be investigated with electrochemical methods, such as impedance spectroscopy. Further, local electrochemistry with sub-µm resolution, which is available at UNNC, can be couple with microscopy to determine the local properties of biofilms. These techniques complement classical biochemical and microscopy methods to characterize the complex interactions between inducible biofilms and host cells. Therefore, this project mainly focuses on four aspects: 1) constructing the gene circuit of ultrasound-mediated bacterial biofilm expression; 2) ultrasound activating the biofilm expression of the engineered bacteria; 3) electrochemical characterization of the adhesion ability of the engineered bacteria to tumor tissue; 4) exploiting the engineered ultrasonic-controllable tumor-targeted bacteria in tumor therapy.
Contact points	Informal inquiries may be addressed to Prof. Fei Yan (fei.yan@siat.ac.cn) and Prof. Enrico Marsili (enrico.marsili@nottingham.edu.cn).
PhD topic	**Understanding altered neural information processing under diseased conditions**
SIAT Supervisor	Prof. Yang Zhan
UNNC Supervisor(s)	Dr. Mainul Haque
Short introduction & description of PhD project	Understanding how the central nervous systems process external information is key for cognitive processes. Neural populations in the brain can encode the relevant information and dysfunctions associated with the neural circuits can lead to psychiatric diseases. Mathematical/computational modelling of the central nervous systems for cognitive processes is a relatively new area, which plays an important role in clinical medicine and neuroscience. The project aims to investigate the how the neural information is processed in specific neural circuits and to understand the mechanistic alterations of the neural representations for neuropsychiatric diseases. We are looking for PhD candidates who have computational or biological background who have strong motivations in studying the information processing within specific neural circuits using multidisciplinary approaches. We are employing a range of state-of-the-art methods including virus-based neural circuit manipulation, behavioural paradigms, multi-channel in vivo electrophysiology. This project will also bring mathematical/computational modelling approaches to the problem discussed above. The mathematical modelling will be undertaken under the supervision of Professor Mainul Haque at the School of Mathematical Sciences (UNNC) and the experimental investigations will be performed in the laboratory of Professor Yang Zhan at the SIAT.

	The project will train the applicant to have interdisciplinary minds to be able to solve the problems in neuroscience or clinical applications.
Contact points	Informal inquiries may be addressed to Dr. Yang Zhan (yang.zhan@siat.ac.cn) and Dr. Mainul Haque (Mainul.Haque@nottingham.edu.cn).
PhD topic	**Vibration and sound radiation analysis of boomer sound source in deep water**
SIAT Supervisor	Prof. Yifan Huang
UNNC Supervisor(s)	Dr Jian Yang
Short introduction & description of PhD project	Boomer sound source driven by high power pulse can generate broadband pulsed intense sound, which has important applications in underwater target detection, shallow seabed geological survey and other fields. Deep-sea exploration requires the boomer sound source load to be carried on the deep tractor, underwater vehicle and other platforms. Ultra-high hydrostatic pressure has an important impact on the electro-acoustic energy conversion process of conventional boomer sound sources. In order to overcome the influence of hydrostatic pressure, it is necessary to study the fluid-structure interaction and acoustic radiation characteristics of the transducer emission plate vibration by means of modeling, simulation and experimental testing. The structure design of the transducer is optimized to make the sound pulse generated by excitation conform to the required frequency and amplitude of detection.
Contact points	Informal inquiries may be addressed to Prof Yifan Huang (yf.huang@siat.ac.cn) and Prof Jian Yang (jian.yang@nottingham.edu.cn).
PhD topic	**Wearable RF sensor /biosensor and Artificial intelligence for health management**
SIAT Supervisor	Prof. Zedong Nie
UNNC Supervisor(s)	Dr. David Chieng
Short introduction & description of PhD project	Obesity, which leads to increasing diabetes cases is becoming more alarming in recent years. A multi-mode system for real-time human monitoring is seen as a promising solution to these problems. We propose an artificial intelligence-powered IoT wearable RF sensor /biosensor / physiological sensor, which provides continuous and non-intrusive nutritional estimates, glucose prediction, and activity monitoring and so on, for the target human subject. This project will focus on four major dimensions namely: (i) RF sensor/ biosensor / physiological sensor design, (ii) FPGA/embedded signal processing algorithms for biomedical sensing (iii) deep learning techniques and (Iv) IoT technologies for health management. We welcome the excellent PhD candidates with the following majors (including but not limited to) : 1) Mathematics/Physics/Chemical/Biomedical/Mechanical engineering; 2) Computer science, Computer/Software engineering; 3) Electrical/ Electronic Engineering; 4) Communications, Telecommunications, IOT.
Contact points	Informal inquiries may be addressed to Prof. Zedong Nie (zd.nie@siat.ac.cn) and Prof. David Chieng (David.Chieng@nottingham.edu.cn).

PhD topic	**A Novel Dynamic Body Weight Support Overground Walker based on Brain Computer Interface Powered Body Movement Recognition and Track Enabling Natural Gait training**
SIAT Supervisor	Prof Peng Shang
UNNC Supervisor(s)	Dr Zhuang Xu
Short introduction & description of PhD project	To assist patients suffering from lower limb disability caused by traumatic brain injury like stroke or cerebral palsy, dynamic body weight support (BWS) systems based on gait recognition and centre of mass (COM) tracking algorithm have been proposed to train the patients with walk ability. In recent years, robotic BWS systems which are fixed to the environment or in movable walker form have been widely studied, and the experiments have shown promising result on reducing walking load and make the patients support body weight by their own remaining strength. While, on the other hand, active COM tracing BWS walkers which allow patients walk overground and provide unloading force in vertical direction only are researched less, and relative studies have shown that walk rehabilitation in natural overground gait enhance the recovering effect most. To achieve the high efficiency by achieving natural gait of overground BWS walk, firstly we have built the body movement tracking walker which can move with the patients simultaneously in our previous work. In this study, we propose a novel active COM tracking BWS overground walker which tracks the patient movements, gait event by deep learning based on sensors like 3-axis force sensors and foot pressure distribution sensors. Then we use motion capture cameras and 9-axis IMUs to verify the tracking and dynamic body weight support performance. Brain computer interface approach to control of lower limb movement recognition and tracking. Fine walking event recognition and tracking by deep learning of multiple sensors. Research on control algorithm of body movement tracking. Dynamic body weight support based on gait phase and body movement recognition. Model built. Experiment on multiple gait training treadmills, walkers, and elastic cord frames, for validation.
Contact points	Informal inquiries may be addressed to Prof Peng Shang (peng.shang@siat.ac.cn) and Dr Zhuang Xu (zhuang.xu@nottingham.edu.cn).
PhD topic	**A synthetic biology approach using engineered bacteria to mitigate environmental pollution**
SIAT Supervisor	Prof Chenli Liu
UNNC Supervisor(s)	Prof Jun He
Short introduction & description of PhD project	Industries are the paramount driving force for the economic and technological development of society. However, the flourishing industrialization and unimpeded growth of current production unit's result in widespread environmental pollution due to increased discharge of wastes loaded with baleful, hazardous, and carcinogenic contaminants. Physicochemical-based remediation means are costly, create a secondary disposal problem and remain inadequate for pollution mitigating because of the continuous emergence of new recalcitrant pollutants. Due to eco-friendly, social acceptance, and lesser health hazards, microbial bioremediation has received considerable global attention for pollution abatement. Moreover, with the recent advancement in biotechnology and microbiology, genetically engineered bacteria with high ability to remove environmental pollutants are widely used in the fields of

	environmental restoration, resulting in the bioremediation in a more viable and eco-friendly way. This doctoral project intends to treat environmental pollutants such as synthetic dyes, heavy metals, petroleum hydrocarbons, polychlorinated biphenazines, herbicides, pesticides and fertilizers by synthesizing genetically engineered bacteria. Combining knowledge of microbiology, biology and ecology with field engineering design, recombinant bacteria are ideal characteristics for effective in situ bioremediation of hazardous waste contaminated sites.
Contact points	Informal inquiries may be addressed to Prof Chenli Liu (chenli.liu@siat.ac.cn) and Prof Jun He (Jun.He@nottingham.edu.cn).
PhD topic	**Advanced energy storage materials and devices**
SIAT Supervisor	Prof Huiming Cheng
UNNC Supervisor(s)	Dr Yong Shi
Short introduction & description of PhD project	Advanced energy storage devices play an important role in our daily life from the consumer electronics and electric vehicles to large scale energy storage plants, because they are the critical components in the shift from petrol (gasoline) powered vehicles to electric vehicles, and the use of renewable energy on the grid. Among which, lithium ion batteries (LIBs) have become one of the most popular rechargeable batteries due to its high energy density, long cycle life, none memory effect and low-self discharging. This project will focus on three dimension: (i) development of key electrode/electrolyte materials, (ii) understanding its charge transfer mechanism, (ii) thermal management design.
Contact points	Informal inquiries may be addressed to Dr Yong Shi (Yong.Shi@nottingham.edu.cn) and Prof Huiming Cheng (hm.cheng@siat.ac.cn).
PhD topic	**Application of microfluidics in intestinal pathogen infection and antimicrobial screening**
SIAT Supervisor	Prof Shuqiang Huang
UNNC Supervisor(s)	Dr Yong Shi
Short introduction & description of PhD project	Microfluidics is named from "micro", "fluidic", and "control", which can deal with biological samples in precise, flexible and high-resolution manners, as well as smaller volume, lower energy consumption and higher throughput etc. than conventional methods. There are several branches of microfluidics for biological applications, such as channel-based, droplet based, digital-based, paper-based and static array based microfluidics. As the rising of people attach to gut microbes, it demands more accurate manipulation to decipher microbial mysteries, not only at significantly improved resolution, throughput and flexibility, but to create in vivo-like platforms to simulate biological behaviours. Microfuidics/nanofluidics will provide necessary tools to solve these challenges, facilitating deeper biological understanding. This project will focus on exploiting intestine on chip system and devising intelligent droplet technology for high-throughput antibacterial material and drug screening.
Contact points	Informal inquiries may be addressed to Prof Shuqiang Huang (shuqiang.huang@siat.ac.cn) and Dr Yong Shi (Yong.Shi@nottingham.edu.cn).

PhD topic	**Autonomous driving**
SIAT Supervisor	Prof Huiyun Li
UNNC Supervisor(s)	Prof Ruibin Bai
Short introduction & description of PhD project	Nowadays, the industrialization and wide ranges of applications of autonomous driving technologies still face challenges. The computational complexity of conventional swarm intelligence algorithms increases exponentially with the increasing number of nodes. Significant research efforts are required to design the low-complexity expression of multi-vehicle interactions within a specially designed road network structure, and, to develop novel learning based systems to establish an organizational framework for self-learning and adaptation under various environments. A platform to test the robustness and safety of autonomous driving in an open and uncertain environment is also to be used.
Contact points	Informal inquiries may be addressed to Prof Ruibin Bai (Ruibin.bai@nottingham.edu.cn) and Prof Huiyun Li (hy.li@siat.ac.cn).
PhD topic 6	**Computational Intelligence and Combinatorial Optimisation**
SIAT Supervisor	Prof Shuqiang Wang
UNNC Supervisor(s)	Prof Ruibin Bai
Short introduction & description of PhD project	Combinatorial optimisation problems have extensive real-life applications. However, most of them are NP-Hard and finding the optimal solutions is normally computationally prohibitive for large-size instances. The problems become even harder when uncertainties are taken into account to improve the practicality of the solutions. The data driven methods often formulate the combinatorial problems as online optimisation problems and try to tackle the problem sequentially based on some policies or rules upon the realisation of random variables and the states of the partial solution at each decision point. One of the main drawbacks of these data driven methods is their inability to efficiently exploit the core structures and properties of the problem. More specifically, existing data driven methods primarily focus on the objectives to be optimised but often neglect various complex inter-dependencies among the decision variables and their collective influence on the objective. In this research, the students shall investigate integrating linear/integer programming methods with the latest deep learning methods, including but not limited to graph neural network based learning.
Contact points	Informal inquiries may be addressed to Prof Ruibin Bai (Ruibin.bai@nottingham.edu.cn) and Prof Shuqiang Wang (sq.wang@siat.ac.cn).
PhD topic	**Combinatorial Optimization for Bioinformatics Problems using Graph Neural Networks**
SIAT Supervisor	Prof Yunpeng Cai
UNNC Supervisor(s)	Prof Ruibin Bai
Short introduction & description of PhD project	Combinatorial Optimization (CO) has been a fundamental tool for solving many bioinformatic problems such as therapy planning, drug discovery, biomarker selection, phylogenetic analysis and biological network analysis. The high dimensional nature of biological applications posed a severe challenge to CO due to its NP-hard complexity. Recently, Graph neural networks provided a new heuristic approach for solving

	optimization problems within a machine learning framework. This project will aim to develop GNN-based algorithms for efficient solution of CO problems with applications to bioinformatic field, including (i) Reinforcement learning for CO on GNN; (ii) Supervised learning for CO on GNN; (iii) Solving typical bioinformatic CO problems (e.g., phylogenetic trees, biomarker selection or biological network analysis).
Contact points	Informal inquiries may be addressed to Prof Ruibin Bai (ruibin.bai@nottingham.edu.cn) and Prof Yunpeng Cai (yp.cai@siat.ac.cn).
PhD topic	**Control of Dual Permanent Magnet Synchronous Motors for an Indoor Navigation Robotic System**
SIAT Supervisor	Prof Yongsheng Ou
UNNC Supervisor(s)	Dr Zhuang Xu
Short introduction & description of PhD project	This research is intended to improve the performance of permanent magnet synchronous motors in indoor navigation robotic systems, including control optimisation in terms of low speed, braking capacity and differential drive of both wheels.
Contact points	Informal inquiries may be addressed to Prof Yongsheng Ou (ys.ou@siat.ac.cn) and Dr Zhuang Xu (zhuang.xu@nottingham.edu.cn).
PhD topic	**Engineering living building material**
SIAT Supervisor	Dr Zhuojun Dai
UNNC Supervisor(s)	Dr Bo Li
Short introduction & description of PhD project	Living building materials utilize microorganisms to produce construction materials that exhibit mechanical and biological properties. The resultant materials could have the capacity to self-repair and self-replicate, sense local and distant disturbances in their environment, and respond with functionalities for reporting, actuation or remediation. However, few engineered living materials are capable of both responsivity and use in macroscopic structures. Therefore, we proposed to engineer microbial consortia that can form mouldable, foldable and regenerative living structures. This living building material could be further strengthened and optimized by integrating with the nano-materials. By this strategy, we can facilitate the development of living biomaterials with new properties and functionalities.
Contact points	Informal inquiries may be addressed to Dr. Bo Li (bo.li@nottingham.edu.cn) and Prof Zhuojun Dai (zj.dai@siat.ac.cn).
PhD topic	**High adaptability and reliability of wearable device systems in Internet of medical Things dealing with the extremes of changing physical conditions and environment in special applications**
SIAT Supervisor	Prof Ye Li
UNNC Supervisor(s)	Prof Ruibin Bai
Short introduction & description of PhD project	Internet of Medical Things (IoMT) has been promoted in widespread digital health applications, with the technical development on wearable devices, Internet of Things, and artificial intelligence, etc.. Currently, the most common application scenarios are, for instance, daily healthcare and smart home. However, there are a variety of application scenarios to be covered, in which the environment differs extremely from

	normal use cases. For example, in the firefighting application, the safety of firefighters should be ensured with the use of wearable devices. Real-time health monitoring needs to be realized by collecting firefighters' physiological data, while accurate localization and mapping by integrating the fire ground environmental data. For such special applications, new wearable devices and systems are in need of development to deal with the interrupt and disturbance by the extremes of changing environment, such as signal lost, energy shortage and equipment fault caused by heat, smoke, damp, dust, etc.. The heterogeneous structure of Internet of Things and the substantial growth of communication and computation capacity provide an opportunity to wearable devices to exploit intelligent networking solutions merging with AI-assisted strategies. Therefore, the design and technology of wearable device equipment and system should address multi-factors of solving problems for special applications and other relevant issues. This project will focus on two major dimensions on (i) adaptive wearable device and system, looking at pre-warning and adaptable sensing in dynamic environment and (ii) accurate algorithms, including real-time processing and feedback and accurate decisions.
Contact points	Informal inquiries may be addressed to Prof Ruibin BAI (ruibin.bai@nottingham.edu.cn) and Prof Ye LI (ye.li@siat.ac.cn).
PhD topic	**Metallic matrix composite materials in advanced electronic packaging**
SIAT Supervisor	Prof Zhi-Quan LIU
UNNC Supervisor(s)	Dr Kok Hoong WONG
Short introduction & description of PhD project	Integrated circuit (IC) technology plays a role of cornerstone in advanced electronic manufacturing and provides the hardware infrastructure in modern electronic information industry. The surging of 5G, interconnect of things (IoT) and artificial intelligence (AI) technology waves drives chips of customer electronics to higher levels of miniaturization, integration, and multi-function. Since semiconductor processing is approaching the physical limits of Moore's Law, advanced packaging technologies gain considerable attention as an alternative strategy for continued improvement of chip performances. The use of metallic matrix composites (MMC) in advanced packaging arouses widespread research interests, because they are able to combine the advantages of metals and the strengthening phases and endow optimized or even new physical properties. This research topic centres on the design, preparation and characterization of high-performance MMC for advanced packaging applications. It aims to address the challenging problems about the mechanical, thermal, and electrical properties of MMC at the real end product, and bridge the gap between fundamental studies and industrial applications in this field.
Contact points	Informal inquiries may be addressed to Dr Kok Hoong WONG (kok-hoong.wong@nottingham.edu.cn) and Prof Zhi-Quan LIU (zqliu@siat.ac.cn).
PhD topic	**Optimal design methods of electric devices based on artificial intelligence**
SIAT Supervisor	Prof Weinong Fu
UNNC Supervisor(s)	Dr Nadia Mei Lin Tan

	Dr John Xu
Short introduction & description of PhD project	This research project will focus on the optimal design of electric motors for driving electric vehicles in system level. Numerical methods such as finite element method will be used to simulate the operation of the motors. Optimization methods will be employed to find the best designs, and artificial intelligence will accelerate the computing process. The machine learning methodologies will be investigated to achieve the global optimal control for the motor with control modules. Hardware experiments will be carried out to validate the proposed models and methodologies. The applicants may have the basic knowledge of electrical engineering.
Contact points	Informal inquiries may be addressed to Prof Weinong Fu (wn.fu@siat.ac.cn) and Dr Nadia Mei Lin Tan (nadia.tan@nottingham.edu.cn).
PhD topic	**Ultrasonic transducers and high-resolution imaging**
SIAT Supervisor	Prof Shifeng GUO
UNNC Supervisor(s)	Dr LAI Nai Yeen Gavin
Short introduction & description of PhD project	Ultrasonic transducers and high-resolution imaging: This project intends to develop high performance ultrasonic transducers and also algorithms for high resolution imaging for industry and medical applications.
Contact points	Informal inquiries may be addressed to Prof Shifeng Guo (sf.guo@siat.ac.cn) and Dr Gavin Lai (gavin.lai@nottingham.edu.cn).
PhD topic	**Video based online abnormal object recognition in grid scene**
SIAT Supervisor	Prof Yimin Zhou
UNNC Supervisor(s)	Prof Dave TOWEY
Short introduction & description of PhD project	With the rapid development of computer related technologies, UAVs and AI (Artificial intelligence) have become popular. Power grid monitoring equipment can be monitored and the data can be analysed of the line defects and abnormalities in real-time, and feedback and alarm to the control centre in time. It is no longer necessary for staff to take photos on site and then screen them one by one in a large number of original pictures or videos. There are some problems, such as high cost, high power consumption, which are unable to guarantee the timeliness of image transmission, weak image preprocessing ability and so on. Moreover, the image acquisition equipment is easy to receive electromagnetic wave interference, resulting in abnormal operation. Through this project, it can train a set of in-depth learning AI model possessing the ability to identify common external factors affecting the safe and stable operation of the power grid, such as bird's nest, pollution flashover, construction site and suspended objects, and integrate the model with the existing online video monitoring system. In order to facilitate the deployment of supporting image acquisition, it is necessary to study a miniaturized microphoto image acquisition device with solar power supply and low power consumption, and further upload the video data to the system via Internet of things, carrier, wired, optical fiber and so on. Through this project, it can realize the intelligent discovery and timely alarm of external hidden dangers,

	effectively improve the speed of hidden danger discovery, and is of great significance to ensure the social power continuity in Shenzhen.
Contact points	Informal inquiries may be addressed to Prof Dave TOWEY (Dave.Towey@nottingham.edu.cn) and Prof Yimin ZHOU (ym.zhou@siat.ac.cn).