# UNNC – SIAT, CAS Doctoral Training Partnership

## Available PhD topics

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| **PhD topic 1** | **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** | 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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 2** | **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** | 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 |

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| | 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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 3** | **Advanced energy storage materials and devices** |
| **SIAT Supervisor** | Prof Huiming Cheng |
| **UNNC Supervisor(s)** | Dr Yong Shi |
| **Short introduction & description of PhD** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 4** | **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** | 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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 5** | **Autonomous driving** |
| **SIAT Supervisor** | Prof Huiyun Li |
| **UNNC Supervisor(s)** | Prof Ruibin Bai |

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| **Short introduction & description of PhD** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 6** | **Biomimetic Synthesis of Mandapamate, Isomandapamate and Rameswaralide** |
| **SIAT Supervisor** | Prof Jiahai Zhou |
| **UNNC Supervisor(s)** | Dr Bencan Tang |
| **Short introduction & description of PhD** | Mandapamate, isomandapamate and rameswaralide are polycyclic marine natural products with complex structure and interesting bioactivity. Their total synthesis is yet to be accomplished. It was proposed that these natural products may be derived from furanocembranoid macrocycles in nature *via* oxidation and dearomatization of the furan ring, followed by intramolecular [4+2] and/or [4+3] cycloaddition reactions. However, literature reported preliminary experimental studies suggested these transannular reactions could happen with diverse reaction pathways and unpredictable selectivity, which may be realised *via* enzyme catalysis. This project aims at the biomimetic synthesis of these polycyclic structures using enzymatically catalysed pericyclic reactions. Firstly, the project involves the application of known enzymes in the selected substrates leading to the core structures of natural products; secondly, the promising enzymes will be evolved to better suit these desired pericyclic reactions for the synthesis of these natural products. This research may serve as the first total synthesis of these natural products. |
| **Contact points** | Informal inquiries may be addressed to Dr Bencan Tang (bencan.tang@nottingham.edu.cn) and Prof Jiahai Zhou (jiahai@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 7** | **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** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 8** | **Computational Intelligence and Combinatorial Optimisation** |
| **SIAT Supervisor** | Prof Shuqiang Wang |
| **UNNC Supervisor(s)** | Prof Ruibin Bai |

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| **Short introduction & description of PhD** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 9** | **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** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 10** | **Design, Control and Application of Soft Medical Robots** |
| **SIAT Supervisor** | Prof Zeyang Xia |
| **UNNC Supervisor(s)** | Dr Dunant Halim |
| **Short introduction & description of PhD** | 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.<br><br>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.<br><br>References:<br><br>[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.<br><br>[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. |

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| | [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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 11** | **Development of Radiomics Methods for Validation in Multimodal-Guided Cervical Tumour Treatment Plan** |
| **SIAT Supervisor** | Dr Wenjian Qin |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | Cervical cancer ranks second among the tumours that cause women's death, which are approximately 493,200 new cases of cervical cancer worldwide each year, and the death toll is as high as 273,500. Therefore, the treatment of cervical cancer has a large demand, and effective and efficient treatment will reduce the mortality and recurrence risk of cervical cancer patients.<br><br>Radiotherapy is one of the commonly used treatments for cervical cancer, which is suitable for all stages of cervical cancer. Radiotherapy for cervical cancer includes external radiotherapy and brachytherapy. Under normal circumstances, the external radiotherapy is performed first, and then the brachytherapy is performed. Among them, brachytherapy is a key component of radical treatment of cervical cancer. However, before implementing brachytherapy, doctors and physicists need to manually delineate target volume (Clinical tumor volume (CTV) and Gross tumor volume (GTV)) and organs-at-risk (OARs), and constantly adjust the parameters for designing a plan that meets the requirements, which is quite time-consuming and laborious. Therefore, our project plans to assist the rapid and accurate treatment of cervical cancer by target segmentation and radiomics model development in multimodal images, achieving real-time adaptive internal irradiation treatment for cervical cancer.<br><br>During the period of the project, it is expected to:<br><br>1. Design and plan the experiments using suitable model and methods.<br><br>2. Prepare a review of literature of current research activities related to this project.<br><br>3. Be skilled at machine learning and deep learning modelling and calculating ability.<br><br>4. Be capable of multi medical imaging processing skills and data statistical analysis. |
| **Contact points** | Informal inquiries may be addressed to Dr Jianfeng Ren (jianfeng.ren@nottingham.edu.cn) and Dr Wenjian Qin (wj.qin@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 12** | **Electromagnetic computation and advanced technology in ultra-high field MRI** |
| **SIAT Supervisor** | Prof Ye Li |
| **UNNC Supervisor(s)** | Dr Shun Bai |
| **Short introduction & description of PhD** | Ultra-high field MRI offers unique opportunities for revealing new insight into the relationship between structure, function and metabolism of the human body. However, MR systems operating at fields of above 3 tesla pose a series of technical challenges for reaching the full potential of the systems, such as ultra-high field magnet, homogeneous RF distributions and specific absorption rate (SAR) issues. Electromagnetic (EM) computation is used extensively during the development of ultra-high field scanners. This project will focus on two major dimensions on (i) ultra-high field magnet development using $Nb_3Sn$ wire; (ii) advanced RF technologies such as multi-channel transmission and SAR evaluation in ultra-high field MRI. |

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| **Contact points** | Informal inquiries may be addressed to Dr Shun BAI (shun.bai@nottingham.edu.cn) and Prof Ye LI (liye1@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 13** | **Engineering living building material** |
| **SIAT Supervisor** | Dr Zhuojun Dai |
| **UNNC Supervisor(s)** | Dr Bo Li |
| **Short introduction & description of PhD** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 14** | **Food intake evaluation using artificial intelligence to help diabetes patients manage their glucose level using wearable device** |
| **SIAT Supervisor** | Prof Zedong Nie |
| **UNNC Supervisor(s)** | Dr Pushpendu Kar |
| **Short introduction & description of PhD** | The trend of eating a healthier diet is increasing day by day, particularly among diabetics, for whom keeping a record of food intake and blood glucose levels is an essential component for achieving a healthier diet. Obesity and diabetes have become major issues in recent years. To address these issues, it is critical to understand your intake of calories, carbohydrates, and sugar. We propose a deep learning system that can run on smart device which provides the appropriate nutritional estimates and glucose prediction to users after passing a food intake as input.<br><br>This project will focus on three major dimensions on (i) the sensors of record of food intake, (ii) the calories calculation based on artificial intelligence algorithm and optimization, and (iii) the prediction of glucose level base on food intake. |
| **Contact points** | Informal inquiries may be addressed to Prof Zedong Nie (zd.nie@siat.ac.cn) and Dr Pushpendu Kar (pushpendu.kar@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 15** | **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** | 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 |

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| | 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..<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 16** | **Image-guided Radiation Therapy based on Machine Learning** |
| **SIAT Supervisor** | Prof Yaoqin Xie |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | 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 may lead 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 Dr Jianfeng REN (jianfeng.ren@nottingham.edu.cn) and Prof Yaoqin XIE (yq.xie@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 17** | **Image Processing for HREM** |
| **SIAT Supervisor** | Prof Xiaokang Zhang |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | Cryo-electron microscopy (cryo-EM) is a rapidly developing technique in structural biology wherein the biological sample of interest is flash frozen under cryogenic conditions. The utility of cryo-electron microscopy stems from the fact that it allows specimens to be observed under "near-to-native" conditions without the need for staining or fixation. This is in contrast to X-ray crystallography, which requires crystallizing the specimen, which can be a long and challenging process, which often involves the introduction of biomolecules into non-physiological environments that can occasionally lead to functionally irrelevant conformational changes. Cryo-EM is now routinely applied to study the structures of viruses, ribosomes, ion channels, transcription and splicing machinery, and many other protein and nucleo-protein complexes. The spiraling number of publications that incorporate cryo-EM methodologies is evidence of this technique's importance to the structural community: Since 2017, single particle Cryo-EM has been used to solve the structures of more than 1800 molecules, nearly half of which are resolved to better than 4 Å resolution. The resolution of single particle cryo-EM maps is improving steadily, with recent improvements in processing methodologies yielding structures at better than 2 Å resolution. This powerful technique additionally enables researchers to study the conformational landscape of a biological specimen from a single flash-frozen sample, in order to deduce the mechanism by which it works. |

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| | We are looking for highly motivated, passionate and competitive candidates for full time PhD positions, The successful applicants will be working in multidisciplinary research teams and specialized in image processing of 2D, 3D, and correlative light and electron microscopy data, and also develop and apply machine-learning approaches to the analysis of life science EM data with an emphasis on improving quantification methods and providing feedback for optimal image acquisition. |
| **Contact points** | Informal inquiries may be addressed to Dr Jianfeng Ren (jianfeng.ren@nottingham.edu.cn) and Prof Xiaokang Zhang (xk.zhang@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 18** | **Knowledge graph based deep learning algorithms and their applications to health informatics** |
| **SIAT Supervisor** | Dr Hongyan Wu |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | With the growing emergence of graph-structured data such as social networks and biological networks, the algorithms to analyze graph data have attracted significant attention, such as Graph Convolutional Networks (GCNs) and Graph Attention Networks (GAT), etc.<br><br>On the other hand, the data in life sciences and public health fields are of graph-structure, e.g., protein-protein interaction, and complex characteristics, such as high-dimensional, sparse, noisy, etc.. We aim at design our own deep learning algorithms and apply them to perform the detailed tasks, such as cancer prognosis analysis, in life science field. |
| **Contact points** | Informal inquiries may be addressed to Dr Jianfeng Ren (jianfeng.ren@nottingham.edu.cn) and Dr Hongyan Wu (hy.wu@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 19** | **Mathematical/Computational Modelling of Assessment of Drug Effectiveness and Safety Using Data from Shenzhen Electronic Health Records Platform** |
| **SIAT Supervisor** | Prof Jinling TANG |
| **UNNC Supervisor(s)** | Dr Mainul Haque |
| **Short introduction & description of PhD** | 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.<br><br>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. This project will focus on combining big data and artificial intelligence technology and traditional epidemiological methods to address clinical or public health questions of interest.<br><br>Mathematical modelling of assessment of drug effectiveness and safety using Data is a relatively new area, which plays an important role in clinical medicine investigations. Our goal in this project is to develop and analyse a mathematical models along with laboratory experiments for a specific assessment of drug effectiveness and safety using 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 SIMM. 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 |

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| | 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 Dr Mainul Haque (Mainul.haque@nottingham.edu.cn) and Prof Jinling Tang (jltang@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 20** | **Mathematical/computational modelling of the screen and verification of biomarkers in building the forewarning model for intelligent assistant diagnosis of depressive disorder** |
| **SIMM Supervisor** | Prof Zhijun Zhang |
| **UNNC Supervisor(s)** | Dr Mainul Haque |
| **Short introduction & description of PhD** | 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 Dr Mainul Haque at the School of Mathematical Sciences (UNNC) and the eexperimental 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 21** | **Mathematical/computational modelling the central nervous systems process external information is key for cognitive processes: based on experimental data** |
| **SIAT Supervisor** | Prof Yang Zhan |
| **UNNC Supervisor(s)** | Dr Mainul Haque |
| **Short introduction & description of PhD** | 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. 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 under diseased conditions.<br><br>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. Our goal in this project is to develop and analyse a mathematical/computational models along with laboratory experiments for a specific neural populations in the brain that encode the relevant information and dysfunctions associated with the neural circuits leading to psychiatric diseases. This project will combine both mathematical/computational modelling and 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 investigations will be performed in the laboratory of Professor Yang Zhang at the SIAT. The latter will train the applicant to do the necessary experiments and his laboratory has all the necessary facilities to perform the experimental part of the |

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| | programme. One explicit aim of this project would be to train the applicant in some of the appropriate laboratory techniques to know how the neural information is processed in specific neural circuits and to understand the mechanistic alterations of the neural representations under diseased conditions. |
| **Contact points** | Informal inquiries may be addressed to Prof Yang Zhan (yang.zhan@siat.ac.cn) and Dr Mainul Haque (Mainul.Haque@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 22** | **Mathematical/computational modelling the central nervous systems process external information is key for cognitive processes: based on laboratory data** |
| **SIAT Supervisor** | Prof Shixiong Chen |
| **UNNC Supervisor(s)** | Dr Mainul Haque |
| **Short introduction & description of PhD** | Seizure detection is a routine process in epilepsy units requiring manual intervention of well-trained specialists. Electroencephalogram (EEG) is an effective and non-invasive technique commonly used for monitoring the brain activity and epileptic seizures. The non-stationary and complex nature of EEG signals this task rather time-consuming. Hence, it is essential to develop automatic epilepsy detection techniques to ensure an appropriate identification and treatment of this disease.<br><br>Mathematical/computational modelling of the epilepsy using Electroencephalogram (EEG) is a relatively new area, which plays an important role in clinical medicine and neuroscience. Our goal in this project is to develop and analyse a mathematical/computational models along with laboratory experiments to understand the automatic epilepsy detection techniques to ensure an appropriate identification and treatment of this disease. This project will focus on how to develop intelligent neural networks for automatic seizure detection based on high density EEG signals. This project will combine both mathematical/computational modelling and 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 investigations will be performed in the laboratory of Professor Shixiong Chen at the SIAT. The latter will train the applicant to do the necessary 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 laboratory techniques to know how the neural information is processed in specific neural circuits and to understand the mechanistic alterations of the neural representations under diseased conditions. |
| **Contact points** | Informal inquiries may be addressed to Dr Mainul Haque (Mainul.haque@nottingham.edu.cn) and Prof Shixiong Chen (sx.chen@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 23** | **Medical Image Processing and Deep Learning** |
| **SIAT Supervisor** | Prof Zhanli Hu |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | Multimodality imaging combining positron emission tomography (PET) with other anatomical modalities, e.g., Computed tomography (CT) and magnetic resonance imaging (MRI), has become commonplace in routine clinical practice.<br><br>This project will focus on two major dimensions on (i) Artificial intelligence-based multimodal imaging technology and (ii) Multimodal image processing technology based on anatomical and functional images. |
| **Contact points** | Informal inquiries may be addressed to Prof Zhanli Hu (zl.hu@siat.ac.cn) and Prof Jianfeng Ren (jianfeng.ren@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |

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| **PhD topic 24** | **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** | 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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 25** | **Optimizing adaptive AI applications on edge computing devices** |
| **SIAT Supervisor** | Dr Zheng Wang |
| **UNNC Supervisor(s)** | Dr Heng Yu |
| **Short introduction & description of PhD** | Adaptive applications form an important computing paradigm for embedded or edge computing, given its runtime flexibilities on the trade-off between application execution quality and system resource consumed. Many contemporary AI models, such as neural networks, exhibit obvious adaptability on its output accuracy given different system resources. Investigating the strategy of runtime managing such applications could thus be essential to realize the edge AI paradigm.<br><br>In this proposed project, we aim at studying how to model and manage the adaptive application for edge computing devices. Our investigation covers several abstraction levels of computer design, namely algorithm, system, and circuit levels, respectively. Specifically, (1) at the algorithm level, we study the characteristics of adaptive NN models, which would help save device resources by avoiding low-gain execution; (2) at the system level, we study the quality-resource trade-off that exists in many adaptive applications, including the NN, and develop the associated tool chain, to realize high efficient run-time quality management; and (3) at the circuit level, we design and implement hardware blocks that significantly reduces the resource consumption. This project is expected to usher systematic innovations beyond the state-of-the-art AI paradigm, and potentially leads to high quality scientific contributions, as well as civilian/commercial values. |
| **Contact points** | Informal inquiries may be addressed to Dr Heng Yu (Heng.Yu@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 26** | **Quantitative optical imaging of physiological dynamics** |
| **SIAT Supervisor** | Prof Baoqiang Li |
| **UNNC Supervisor(s)** | Dr Jianfeng Ren |
| **Short introduction & description of PhD** | 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 |

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| | algorithms is capable of detecting and quantifying the optical signature of disease or detecting cellular/molecular activities to improve the understanding of biological mechanisms.<br><br>The candidate will take on a research project collaborated between Prof Baoqiang LI (SIAT) and Dr. 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 Dr Jianfeng Ren (Jianfeng.Ren@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 27** | **Research on Visual Understanding and Human-computer Interaction** |
| **SIAT Supervisor** | Prof Qieshi ZAHNG |
| **UNNC Supervisor(s)** | Dr Jianfeng REN |
| **Short introduction & description of PhD** | Human-computer interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers. While initially concerned with computers, HCI has since expanded to cover almost all forms of information technology design.<br><br>In the process of HCI, man-machine safety and environmental understanding play an important role. Among many methods, visual technology, as the most intuitive and important way, has been widely and deeply studied. It mainly includes how to understand the environment, which involves target detection and analysis based on computer vision and deep learning technology, action behavior recognition and analysis, man-machine safety analysis, etc. This topic will rely on the subject for the above problems and technology, so as to achieve natural human-computer interaction technology research. |
| **Contact points** | Informal inquiries may be addressed to Dr Jianfeng REN (jianfeng.ren@nottingham.edu.cn) and Prof Qieshi ZHANG (qs.zhang@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 28** | **Robot assisted automatic preparation of functional materials** |
| **SIAT Supervisor** | Prof Xuefeng YU |
| **UNNC Supervisor(s)** | Prof Tao WU<br><br>Prof Cheng Heng PANG |
| **Short introduction & description of PhD** | 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 Dr Haitao ZHAO (ht.zhao@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 29** | **Robot assisted automatic preparation of functional materials** |
| **SIAT Supervisor** | Dr Haitao ZHAO |
| **UNNC Supervisor(s)** | Prof Tao WU<br><br>Prof Cheng Heng PANG |

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| **Short introduction & description of PhD** | 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 Dr Haitao ZHAO (ht.zhao@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 30** | **Robot-assisted interventional and surgical navigation** |
| **SIAT Supervisor** | Prof Shoujun Zhou |
| **UNNC Supervisor(s)** | Prof Ruibin Bai |
| **Short introduction & description of PhD** | Robot-assisted interventional therapy is the trend of clinical development, but accurate navigation is still one of the clinical difficulties. The key to the research of medical image big data and related issues based on artificial intelligence is to break through the technical bottlenecks and core scientific issues such as precise path planning, real-time navigation and safe operation in interventional surgery. |
| **Contact points** | Informal inquiries may be addressed to Prof Shoujun Zhou (sj.zhou@siat.ac.cn) and Prof Ruibin Bai (Ruibin.bai@nottingham.edu.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 31** | **The Management and Control Theory and Methods for Industrial Internet System** |
| **SIAT Supervisor** | Prof Kejiang Ye |
| **UNNC Supervisor(s)** | Dr Zhen Tan |
| **Short introduction & description of PhD** | At present, industrial production has gradually entered the era of automation, networking and intelligence, and the industrial Internet has entered a stage of rapid development. The number of devices and objects connected to the industrial Internet has been increasing, which makes the IoT a dynamic network of networks. Challenges such as heterogeneity, dynamicity, high velocity, and large volume of data, make Internet services produce inconsistent, inaccurate, incomplete, and incorrect results, which are difficult to manage and control. While, these results are critical for many applications especially in industrial Internet. This project will focus on two major dimensions on (i) Operation technology (OT) and information technology (IT) fusion theory and methods and (ii) End-Edge-Cloud collaborative control theory and optimization algorithms. |
| **Contact points** | Informal inquiries may be addressed to Dr Zhen Tan (zhen.tan@nottingham.edu.cn) and Prof Kejiang Ye (kj.ye@siat.ac.cn), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 32** | **Ultrasonic transducers and high-resolution imaging** |
| **SIAT Supervisor** | Prof Shifeng GUO |
| **UNNC Supervisor(s)** | Dr LAI Nai Yeen Gavin |
| **Short introduction & description of PhD** | 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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 33** | **Video based online abnormal object recognition in grid scene** |

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| **SIAT Supervisor** | Prof Yimin Zhou |
| **UNNC Supervisor(s)** | Prof Dave TOWEY |
| **Short introduction & description of PhD** | 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.<br><br>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.<br><br>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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |
| **PhD topic 34** | **Optimal design methods of electric devices based on artificial intelligence** |
| **SIAT Supervisor** | Prof Weinong Fu |
| **UNNC Supervisor(s)** | Dr Nadia Mei Lin Tan<br><br>Dr John Xu |
| **Short introduction & description of PhD** | 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.<br><br>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), but formal applications should follow the instructions in 'How to apply' section. |