Research Exchange at Beihang University

Academic Year 2021-2022

International Division
Beihang University

List of Research Projects

Notes: These projects are all in English and based at 12 schools.

21F01-02: School of Automation Science and Electrical Engineering
21F03: Beihang Advanced Innovation Center for Big Data-Based Precision Medicine
21F04: School of Space and Environment
21F05: School of Physics
21F06-10: School of Instrumentation and Opto-Electronic Engineering
21F11: School of Computer Science and Engineering
21F12: School of Cyber Science and Technology

How to apply:

Applicants themselves should first contact prospective supervisors by sending a CV and a motivation letter. Please copy international@buaa.edu.cn when you contact a professor.

For detailed application procedures and assistance, please visit:
http://global.buaa.edu.cn

21F01 - Robotics and Actuation Technology

Supervisor

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School

School of Automation Science and Electrical Engineering

SPECIALIZATION

My research focuses on robotics and high performance actuation technology. Specifically, our research interests are mainly centered on following topics:

(1) Robotics: Industrial robots, Parallel and serial robots, Capsule robots, Entertainment robots, Modular robots.

(2) Unmanned aerial vehicle (UAV): Ornithopter with different sizes.

(3) Actuation technology: Multi-DOF spherical actuators, Permanent magnet linear machines, Reluctance-switching linear machines, Rotary machines, Micro- actuators, Piezoelectric actuators.

PROJECT DESCRIPTION

The students can join several types of research projects, typically

(We may accept multiple candidatures if they are qualified.)

1. Development of hybrid robotic system: Parallel or serial robots are widely used in industries. Generally, parallel robot can achieve high-stiffness and high-precision motions. However, its workspace is relatively small. To solve this problem, we proposed one hybrid robot, i.e., combining both serial and parallel mechanisms. Coarse-fine manipulation technology will be employed for the control purpose. We also concern the development of other types of robots, such as capsule robots, ornithopters etc.

2. Development of high-performance actuators: The output performance of electromagnetic machines is mainly determined by the magnetic flux density and current input in the system. The maximum current input is generally constrained by the thermal effect. Therefore, increasing flux density is one good option to achieve high force or torque output of electromagnetic devices.

Our target is to increase the system power density, i.e., we try to reorganize the magnet arrays in the machine so that the flux density can be increased in the same volume. We also concern other types of actuators, such as micro-actuators etc.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge topics in a multi-disciplinary environment, and will receive significant training on robotics and electric machines. Specifically, the candidate will learn how to use mechanical software to design robotic systems and analyze their motions in three-dimensional space (for projects on robot design), or finite element software to analyze magnetic field distribution and force torque output of electromagnetic machines (for projects on actuation design). Control algorithm could be considered to complete various tasks of the robotic systems, or improve the output performance of electric machines.

REQUIRED SKILLS

Fundamentals of mechanical design

Students interested in this project should have a basic knowledge in mechanical design, at least at the second year level (general mechanical design knowledge, introductory mechanical components and some laboratory work are typical at this stage). Students in mechanical, electrical or automation engineering usually have the necessary background. The project requires a strong work ethic and interest in learning a range of instrumentation.

21F02 - Smart sensor design based on polarization

Supervisor

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School

School of Automation Science and Electrical Engineering

SPECIALIZATION

My research focuses on the design and development of opto-electronical devices, involving in super-microscopy, nanophotonics, nanostructures and imaging processing (conventional algorithms and deep learning).

PROJECT DESCRIPTION

The successful candidate will develop a novel smart sensor for heartbeat using polarization. The corresponding applications will also be investigated.

STUDENT ROLES

The student will get involved in the principle investigation of the smart sensor. The student need to design the sensor and develop the related software.

REQUIRED SKILLS

The student needs to communicate with the supervisor and other students in fluent English. The English writing and reading is also required.

21F03 - Ultrafast pulsed fiber laser and its applications based on the emerging 2D nanomaterials

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School

Beihang Advanced Innovation Center for Big Data-Based Precision Medicine, Interdisciplinary Innovation Institute of Medicine and Engineering

SPECIALIZATION

Research fields (including but not limited to the following):
1. Ultrafast fiber laser and its applications, supercontinuum, optical frequency comb.
2. Application of two-dimensional (2D) materials such as graphene, carbon nanotubes (CNTs), topological insulators (TIs), transition metal dichalcogenides (TMDs), black phosphorus (BP), and MXenes in ultrafast optics.
3. Photonic crystal fiber, fiber optics.
4. Interdisciplinary of Medicine and Engineering, such as laser thrombolysis and laser photonics etc.

PROJECT DESCRIPTION

Mode-locked lasers are a common method to obtain ultrashort pulses. The pulse width obtained after laser mode-locking can be less than 100 femtoseconds (10-15 seconds). According to the type of gain medium, lasers can be divided into semiconductor lasers, solid-state lasers, and fiber lasers. Fiber lasers, because of their simple and compact structure, high stability, good heat dissipation, no cooling, have a high tolerance to dust, shock, shock, humidity, temperature, and do not need to be collimated and high quality of the output beam, etc. Has been widely favored by people.

Saturable absorbers are important mode-locked devices of lasers. In recent years, saturable absorbers based on nanomaterials such as graphene, carbon nanotubes (CNTs), topological insulators (TIs), transition metal dichalcogenides (TMDs), black phosphorus (BP), and MXenes etc, have shown excellent mode-locking performance.

This project intends to build ultrafast pulsed fiber lasers by

nanomaterials-based saturable absorbers in different regions. The bands cover Yb-doped (1 micron), Er-doped (1.5 micron), and Tm-doped (2 micron).

STUDENT ROLES

The student will be actively engaged in working on build ultrafast pulsed fiber lasers by nanomaterials-based saturable absorbers (i.e., graphene, CNTs, TIs, TMDs, BP, and MXenes) in different regions from Yb-doped (1 micron) and Er-doped (1.5 micron) to Tm-doped (2 micron).
Getting excellent pulsed laser output and writing SCI papers based on the results.

REQUIRED SKILLS

Having a certain understanding of optics, laser, optoelectronics, nonlinear optics or fiber optics.
Build fiber lasers, master the usage of common equipment such as oscilloscopes, spectrometers, RF spectrum analyzers, autocorrelators (pulse measuring instruments), fiber fusion splicers, etc. Draw pictures based on obtained experimental data by softwares such as Origin/Matlab etc. Able to write English papers under the guidance of supervisor.

21F04 - Design of novel zeolites for biomass conversion

Supervisor

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School

School of Space and Environment

SPECIALIZATION

My research focuses on the design of multi-functional Nanostructured Materials for Clean, Renewable Energy technologies. Specifically, our research interests are mainly centered on four topics:
(1) biomass conversion: the application of core-shell hierarchical zeolites/hollow zeolites for the catalytic fast pyrolysis of biomass.
(2) the adsorption of heavy metals from sea water: the application of water stable metal organic frameworks (MOFs) or MOF/GO films for the adsorption of heavy metals from the aqueous solution.

PROJECT DESCRIPTION

Biomass is the only current sustainable source of organic carbon, and biofuels---fuels derived from plant biomass---are the only current sustainable source of liquid fuels. Fast pyrolysis is one useful method to transform biomass into liquid products. However, the fast pyrolysis oil has the major drawback of instability caused by high oxygen content and acidity, thereby rendering it unsuitable for incorporation into existing petroleum based infrastructure. Incorporation of zeolite catalysts into the pyrolysis reaction is an effective way to reduce the reactive oxygenated compounds into aromatics and increase the C/O ratio. However, although 238 zeolite frameworks are available, zeolite-catalyzed processes use only about 10 different framework types. Up to now, the ZSM-5 catalyst is the most effective catalyst at producing aromatic hydrocarbons from the oxygen-rich vapors. Therefore, the synthesis of novel zeolite catalysts has become an area of great interest.

Zeolites can be synthesized under a wide range of different conditions, giving rise to different crystal sizes, morphologies, and elemental compositions. This flexibility allows for an effort to study

some of the factors affecting the aromatic yield from biomass pyrolysis in detail to develop a better understanding of biomass catalytic fast pyrolysis and to create a better zeolite based pyrolysis catalyst. Our research will focus on the application of novel zeolites in the catalytic pyrolysis of lignocellulosic biomass. The proposed research project is to fabricate new zeolite for this purpose.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge topics in a multi-disciplinary environment, and will receive significant training on the synthesis, characterization, and catalytic properties of zeolites. Specifically, the candidate will learn how to use this green chemistry technology to synthesize novel zeolites and further to control their morphology and how to perform microscopic characterizations, including scanning electron (SEM), X-ray diffraction (XRD), Gas Chromatography-Mass Spectrometer (GC-MS) analysis, etc.

REQUIRED SKILLS

Inorganic chemistry, and/or environment.

Students interested in this project should have a basic knowledge in chemistry, at least at the second year level (general chemistry, introductory thermodynamics and some laboratory work are typical at this stage). Students in chemistry or environmental science usually have the necessary background. The project requires a strong work ethic and interest in learning a range of instrumentation.

21F05 - Experimental nuclear reaction, nuclear technology and medical physics

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School

School of Physics and Nuclear Energy Engineering

SPECIALIZATION

My research focuses on the research of experimental nuclear physics including detector design and check as well as readout circuit and control system. Specifically, our research interests are mainly centered on four topics:
(1) Fusion reaction induced weakly bound nuclei: reaction mechanisms, reaction channels and reaction dynamics.
(2) Elastic scattering and breakup induced by exotic nuclei: angular distribution of elastic scattering and breakup on radioactive ion beam line.
(3) Design and development of all kinds of radiation detectors including readout circuit and high voltage power.
(4) Design and development of technology for medical physics （radiation oncology）including software.

PROJECT DESCRIPTION

Fusion reaction induced by weakly bound nuclei is one of hot topic in the world. We use direct nuclear reactions such as elastic scattering, breakup and fusion to explore the reaction mechanisms. First, unstable nuclei which are from stable line are explored by elastic scattering and breakup. The angular distribution of elastic scattering is measured, then optical model are used to obtain the interaction parameters and the reaction cross section, and continuum-discretized-coupled channel (CDCC) are used to study the breakup, in comparison with that of stable nuclei, the nuclear reaction mechanism and nuclear structure can be studied. Secondly, the reaction dynamics of fusion process induced by weakly stable nuclei is studied by gamma spectroscopy in coincidence with light charged particles. The complete fusion (CF), incomplete fusion (ICF) and transfer processes can be distinguished. Whether the suppression of CF cross sections depends on the target charge number above Coulomb barrier can

be studied. At present a method is found to distinguish ICF and transfer processes for the first time. It is valuable to deeply explore, a experiment will be performed in Italy. The successful candidate will take part in the data analysis and obtain the experimental results.

The detector technology, nuclear electronics and automatic control are developed for experimental nuclear physics, nuclear technology and medical physics. The ionization chamber is made to measure the intensity of proton beam, the simulation software needs to be developed to simulate the parameters of chamber. The finger-type chamber is developed to measure the radiology in radiation oncology. X/ radiation meter and weak current amplifier are planned to develop the nuclear electronics including the amplifier circuit, high voltage and single chip as well as control program. The successful candidate will take part in hardware/software design and training plan for medical physics in hospital.

The student will be actively engaged in working on cutting-edge topics in nuclear reactions and nuclear technology, and will receive significant training on nuclear detectors, physics analysis, design circuit, compile control program. Specifically, the candidate will learn how to use physics and nuclear technology to obtain the physics results, make detectors and design the circuit as well as software. And further to test the detector by source, observe the signal by oscilloscope, test the current by multimeter and compile the program to control the single chip, etc. Also the student will go to hospital to receive the training for radiation oncology how to make a operation plan for sick people.

STUDENT ROLES

Physics, Analogous/Digital circuit, Automatic control.

Students interested in this project should have a basic knowledge in physics, at least at the second year level (general physics and some laboratory work are typical at this stage). Students in physics or control engineering usually have the necessary background. The

project requires a strong work ethic and interest in learning physics, electronics and automatic control.

REQUIRED SKILLS

Physics, Analogous/Digital circuit, Automatic control.

Students interested in this project should have a basic knowledge in physics, at least at the second year level (general physics and some laboratory work are typical at this stage). Students in physics or control engineering usually have the necessary background. The project requires a strong work ethic and interest in learning physics, electronics and automatic control.

21F06 - Smart probe for deep brain stimulation

Supervisor

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School

School of Instrumentation and Opto-Electronic Engineering

SPECIALIZATION

My research focuses on photonics devices. Specifically, our research interests are mainly centered on three topics:

(1) fiber lasers

(2) specialty fiber sensors

(3) laser/fiber optics for neurophotonics applications

PROJECT DESCRIPTION

Electrical and magnetic probes have been used in clinical applications for deep brain stimulation (DBS), to cure Parkinson or Alzheimer diseases. Another new area named neurophotonics is exploring the third approach for DBS. It uses the optical probes to manipulate the brain cell functions.

Mice model with Parkinson disease and the probe implantation procedures have been developed in our lab. To clinical use, the capability of combining stimulation function with other medical practices has become an area of great interest. For example, a single implantable probe which combines the function of optical stimulation as well as liquid medicine injection, or electrical signal detection.

The proposed research project is targeting to design and fabricate a multi-modality probe for animal implantation.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge neurophotonics topics in a multi-disciplinary environment, and will receive significant training on optical and mechanical design, characterization and measurement, animal study and test. Specifically, the candidate will learn how to design and test an effective "optrode."

REQUIRED SKILLS

Students interested in this project should have a basic knowledge in photonics, at least at the second-year level. Students in physics or biomedical/chemical engineering usually have the necessary background. The project requires a strong work ethic, team work attitude, and interest in learning a range of instrumentation.

21F07 - Non-invasive probe for deep brain stimulation

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School

School of Instrumentation and Opto-Electronic Engineering

SPECIALIZATION

My research focuses on photonics devices. Specifically, our research interests are mainly centered on three topics:

(1) fiber lasers

(2) specialty fiber sensors

(3) laser/fiber optics for neurophotonics applications

PROJECT DESCRIPTION

Electrical and magnetic probes have been used in clinical applications for deep brain stimulation (DBS), to cure Parkinson or Alzheimer diseases. Another new area named neurophotonics is exploring the third approach for DBS. It implants the optical probes to manipulate the brain cell functions. Mice model with Parkinson disease and the probe implantation procedures have been developed in our lab.

However, to clinical use, the capability of non-invasive stimulation has become an area of great interest. The proposed research project is targeting to design and fabricate a non-invasive infrared laser probe for brain stimulation. The effectiveness will be compared with the invasive probes.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge neurophotonics topics in a multi-disciplinary environment. He/She will receive significant training on optical and mechanical design, characterization and measurement, animal study and test. Specifically, the candidate will learn how to design and test an effective "optrode" based on infrared technology.

REQUIRED SKILLS

Students interested in this project should have a basic knowledge in photonics, at least at the second-year level. Students in physics, mechanical engineering or biomedical/chemical engineering usually have the necessary background. The project requires a strong work ethic, team work attitude, and interest in learning a range of instrumentation.

21F08 - Nanofabrication of metasurface on smart fiber probe

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School

School of Instrumentation and Opto-Electronic Engineering

SPECIALIZATION

My research focuses on photonics devices. Specifically, our research interests are mainly centered on three topics:

(1) fiber lasers

(2) specialty fiber sensors

(3) laser/fiber optics for neurophotonics applications

PROJECT DESCRIPTION

Electrical and magnetic probes have been used in clinical applications for deep brain stimulation (DBS), to cure Parkinson or Alzheimer diseases. Another new area named neurophotonics is exploring the third approach for DBS. It uses the optical probes to manipulate the brain cell functions.

Mice model with Parkinson disease and the probe implantation procedures have been developed in our lab. To clinical use, the capability of precision targeting for deep brain stimulation has become an area of great interest.

The proposed research project is targeting to fabricate a meta-surface based focusing probe on fiber facet for animal implantation.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge neurophotonics topics in a multi-disciplinary environment, and will receive significant training on nanofabrication. Specifically, the candidate will learn how to fabricate and characterize an effective “optrode”. He/She need to work very closely with the team members working on optical design and animal study.

REQUIRED SKILLS

Students interested in this project should have a basic knowledge in photonics. Students in physics or biomedical/chemical engineering usually have the necessary background. The project

requires a strong work ethic, team work attitude, and interest in learning a range of nanofabrication and measurement instruments.

21F09 - Design of metasurface on smart fiber probe

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School

School of Instrumentation and Opto-Electronic Engineering

SPECIALIZATION

My research focuses on photonics devices. Specifically, our research interests are mainly centered on three topics:

(1) fiber lasers

(2) specialty fiber sensors

(3) laser/fiber optics for neurophotonics applications

PROJECT DESCRIPTION

Electrical and magnetic probes have been used in clinical applications for deep brain stimulation (DBS), to cure Parkinson or Alzheimer diseases. Another new area named neurophotonics is exploring the third approach for DBS. It uses the optical probes to manipulate the brain cell functions.

Mice model with Parkinson disease and the probe implantation procedures have been developed in our lab. To clinical use, the capability of precision targeting for deep brain stimulation has become an area of great interest.

The proposed research project is targeting to design and fabricate a meta-surface based focusing probe on fiber facet for animal implantation.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge neurophotonics topics in a multi-disciplinary environment, and will receive significant training on optical design. Specifically, the candidate will learn how to design an effective “optrode”.
He/She need to work very closely with the team members working on nanofabrication, characterization and animal study.

REQUIRED SKILLS

Students interested in this project should have a basic knowledge in photonics. Students in physics or biomedical/chemical engineering usually have the necessary background. The project requires a strong work ethic, team work attitude, and interest in learning optical simulation tools, such as Lumerical (FDTD based).

21F10 - Implantation of smart fiber probe for deep brain

Supervisor

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School

School of Instrumentation and Opto-Electronic Engineering

SPECIALIZATION

Our research interests are mainly centered on three topics:

(1) fiber lasers

(2) specialty fiber devices

(3) laser/fiber optics for neurophotonics applications

PROJECT DESCRIPTION

Electrical and magnetic probes have been used in clinical applications for deep brain stimulation (DBS), to cure Parkinson or Alzheimer diseases. Another new area named neurophotonics is exploring the third approach for DBS. It uses the optical probes to manipulate the brain cell functions.

Mice model with Parkinson disease and the probe implantation procedures have been developed in our lab. To clinical use, the capability of precision targeting for deep brain stimulation has become an area of great interest.

The proposed research project is targeting to living animal implantation. The implanted probe is a specially designed "optrode".

STUDENT ROLES

The student will be actively engaged in working on cutting-edge neurophotonics topics in a multi-disciplinary environment, and will receive significant training on optical design. Specifically, the candidate will learn how to design an effective "optrode". He/She need to work very closely with the team members working on nanofabrication, characterization and animal study.

REQUIRED SKILLS

Students interested in this project should have a basic knowledge in photonics. Students in physics or biomedical/chemical engineering usually have the necessary background. The project requires a strong work ethic, team work attitude, and interest in learning optical simulation tools, such as Lumerical (FDTD based).

21F11 - Performance optimization for scientific applications

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School

School of Computer Science and Engineering

SPECIALIZATION

My research focuses on high performance computing, parallel and distributed computing, computer architecture, performance optimization, performance analysis tool and energy efficiency. Specifically, my research interests are mainly centered on four topics:

(1) numerical algorithms: optimizing numerical algorithms on highly parallel architectures using parallel and distributed computing.

(2) runtime system: schedule task execution with improved system utilization, while ensuring fairness.

(3) performance analysis tools: fine-grained performance analysis tool at both source code and binary level to reveal software inefficiency and guide optimization.

(4) code transformation and compilation: automatic code transformation and compilation for better parallelism and efficiency.

PROJECT DESCRIPTION

Nowadays, production software in both industry and academia is becoming increasingly complex as they consist of a large number of library dependencies as well as sophisticated control and data flows. Such complexities can easily lead to unexpected inefficiency, which prevents the software from achieving optimal performance.

Our research will design various performance analysis tools to identify potential software efficiencies from both instruction and data perspectives. These performance analysis tools help programmers to locate the line-of-codes that lead to the software

efficiency, and apply code optimizations at fine-gained granularity with calling context awareness.

The successful candidate will develop fine-grained performance analysis tools to guide performance optimization and evaluate the effectiveness of such tools on real scientific applications.

STUDENT ROLES

The student will be actively engaged in working on cutting-edge topics in high performance computing, and will receive significant training on parallel programing and performance optimization. Specifically, the candidate will learn how to use performance analysis tools to identify performance bottlenecks of scientific applications and further to apply various optimization techniques for performance speedup on highly parallel processors such as CPU, GPU and FPGA.

REQUIRED SKILLS

Computer Science.

Students interested in this project should have a basic knowledge in computer architecture, operating system and C programming, at least at the graduate level in the major of computer science. The project requires a strong work ethic and interest in learning a range of advanced computer engineering techniques.

21F12 - Research on virus induced failure propagation suppression in industrial internet

Supervisor

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School

School of Cyber Science and Technology

SPECIALIZATION

Cyber science and technology, network situation awareness, intelligent operation and maintenance, network information technology and reliability engineering, cyber-physical systems (CPS) safe operation health monitoring and diagnosis technology, complex network analysis and management

We welcome candidates who are interested in computer network/Internet of things, artificial intelligence, big data analysis, cloud computing technology to apply for the graduate program.

PROJECT DESCRIPTION

At present, driven by the new generation of information technology, it has become the consensus of the world's industrial powers to lead the development of the manufacturing industry in the new era and shape the new advantage in international competition. Although the strategic plans of various countries have their own priorities, fundamentally speaking, they are all intelligent manufacturing changes driven by the industrial Internet. The Industrial Internet is the key path to realize the gestation and development of the Fourth Industrial Revolution, and forms the development cornerstone of the digital transformation.

Industrial Internet of each subsystem and its internal components characterized by multiple cross coupling, when one or a few components or viral induced joint failure occurs, partial failure within a single subsystem can by connecting the coupling relationship of the component diffusion, spread to other subsystems, cause other subsystem failure occurs. Therefore, according to the structure and functional characteristics of the industrial Internet, the successful candidate will study the transmission law of virus-induced fault in the network, and put forward the fault suppression method to prevent the industrial

Internet from suffering heavy losses due to the transmission of fault caused by the infection of the virus.

STUDENT ROLES

The student will be actively engaged in research on cutting-edge topics in a multidisciplinary environment and will receive important training in complex networks, virus propagation and failure propagation. Specifically, the candidate will learn how to model the topology of an industrial Internet, the propagation mechanism of virus-induced failure propagation, prevention and maintenance control strategies, etc.

REQUIRED SKILLS

Major in Computer Science, Internet of Things, or Cyber Science and Technology.

Students interested in this course should have a basic knowledge of complex networks. Students in Computer Science, Cyber Science and Technology usually have the necessary background knowledge. This program requires a strong work ethic and an interest in learning all kinds of things.