ShanghaiTech Summer Research Project Plan

<table>
<tr><td>Mentor's Name:

WU Tao</td><td>Research Period:

☐ 6 weeks ☑ 8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:

You can choose one of following three projects
1. Lamb wave acoustic device simulation and analysis
2. PMUT ultrasonic device design and characterization
3. RaspberryPi based transducer system development</td></tr>
<tr><td colspan="2">Research Expectation:

Each project has following focus respectively:
1. Learn COMSOL simulation
2. Ultrasonic transducers and signal analysis
3. PCB electronic board and system development</td></tr>
<tr><td>Literature Preview/Technique Required:

Physics & Electrical Engineering

Students are encouraged to read following book before arrival
Piezoelectric MEMS Resonators
https://www.springer.com/us/book/9783319286860</td><td>Lab mate/ Assistant:

Shao Shuai</td></tr>
<tr><td colspan="2">Weekly Schedule:

To be discussed before arrival</td></tr>
</table>

ShanghaiTech Summer Research Project Plan I

<table>
<tr><td>Mentor's Name:
Sören Schwertfeger</td><td>Research Period:
☒ 6 weeks ☒ 8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:
Title: SLAM dataset collection and evaluation
Simultaneous Localization and Mapping (SLAM) is a very important topic in mobile robotics. Usually, the main sensors are laser range scanners or cameras, but other information is sometimes also used, such as IMU, ultrasound, WiFi signals and others. Each of those sensors can be configured with different attributes (e.g. resolution and frequency) and be mounted differently on the mobile robot. All this will have impact on the different SLAM algorithms. Thus research on what combination is best for mapping, w.r.t. certain requirements, is to be conducted.</td></tr>
<tr><td colspan="2">Research Expectation:
Prof. Schwertfeger's lab (https://robotics.shanghaitech.edu.cn) has an advanced mapping robot for collecting SLAM datasets with very advanced sensors. Together with other students of the lab, the visiting student is expected to:
1) Help with the collection of robot mapping datasets in various environments (indoor, underground parking garage, campus, outdoor, city, …)
2) Help with the management and the pre-processing of the collected data
3) Get familiar with one open source SLAM algorithm and apply it to the datasets
4) Help with the evaluation of the performance of said SLAM algorithm.
Help with the writing of the according paper (and become co-author).</td></tr>
<tr><td>Literature Preview/Technique Required:
• CS background
• Adequate programming skills (C++ or Python)
• Basic ROS skills (finish the beginner tutorials: http://wiki.ros.org/ROS/Tutorials)
• Try to understand: https://arxiv.org/pdf/1606.05830.pdf</td><td>Lab mate/ Assistant:
Project partners master students:
• Xiting Zhao
• Zhenpeng He
Co-supervision:
Senior PhD student:
• Qingwen Xu</td></tr>
<tr><td colspan="2">Weekly Schedule:
Week 1) Get familiar with the mapping robot hardware and software; learn how to collect datasets; learn about the already collected datasets; learn about the pre-processing; (at any time later help collecting datasets)
Week 2) Learn about open source SLAM algorithms; Select and familiarize with "your" algorithm;
Week 3) Learn about evaluation of SLAM algorithms; Apply datasets to "your" SLAM algorithm; Evaluate the result of "your" algorithm
Week 4-5) Find different good configurations for "your" algorithm; Deeply understand "your" algorithm
Week 6) Proper scientific experiments with different dataset on "your" algorithm with proper evaluation
Week 7) Write according sections in the paper and your project report
Week 8) Explore other SLAM algorithms; Buffer if above points need more time</td></tr>
</table>

ShanghaiTech Summer Research Project Plan II

Mentor's Name: Sören Schwertfeger	Research Period: ☒ 6 weeks ☒ 8 weeks

Research Theme & Significance:

Title: The remote-control manipulation system

Remote-control is an essential technology under some extreme fields, for example rescue after earthquakes, aerospace and underwater. In these cases, it is dangerous or impossible to on-site control the robots. An easy and direct way is remote-control, which is also the main research topic in the project. Therefore, we propose to build such a verification system in the lab to evaluate specific functions.

Research Expectation:

Prof. Schwertfeger's lab (https://robotics.shanghaitech.edu.cn/) has several advanced robotic arms equipped with cameras. Together with other students of the lab, the visiting student is expected to:

1) Help with the development of the vision tracking system
2) Help with the development of the visual measurement algorithm
3) Help with the system integration and its tests

Help with the writing of the according paper (and become co-author).

Literature Preview/Technique Required:

- CS background
- Adequate programming skills (C++ or Python)
- Basic ROS skills (finish the beginner tutorials: http://wiki.ros.org/ROS/Tutorials)
- Basic OpenCV skills (https://opencv.org/)

Lab mate/ Assistant:

Project partners master students:

- Jiadi Cui
- Yijun Yuan

Co-supervision:

Senior PhD student:

- Jiawei Hou

Weekly Schedule:

Week 1) Get familiar with basic ROS and literature review; get familiar with the robotic arms hardware and software; learn how to control the robotic arms;

Week 2) Get familiar with the camera which is mounted on the arm, especially how to use it;

Week 3-4) Develop visual tracking algorithms and apply it on the system; proper evaluation on the performance of the tracking algorithm;

Week 5-6) Learn basic computer vision knowledge; develop and evaluate the visual measurement algorithm;

Week 7) System evaluation and sufficient tests;

Week 8) Write according sections in the paper and your project report.

ShanghaiTech Summer Research Project Plan

<table>
<tr><td>Mentor's Name:
GAO Fei</td><td>Research Period:
☐ 6 weeks ✓ 8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:

Our Hybrid Imaging System lab (www.hislab.cn) focuses on system development of photoacoustic imaging technology, including fundamental physics, hardware and sensor's design, and deep learning based imaging algorithms.</td></tr>
<tr><td colspan="2">Research Expectation:

We expect the student perform solid research and try to generate some innovative ideas and publications.</td></tr>
<tr><td>Literature Preview/Technique Required:

Major in EE, CS, BME, is preferred</td><td>Lab mate/ Assistant:

Gao Feng</td></tr>
<tr><td colspan="2">Weekly Schedule:
Week 1
Literature review and determination of specific research topic.

Week 2-4
Perform simulation study

Week 5-7
Perform experimental validation

Week 8
Summarize research outcome and write paper.</td></tr>
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ShanghaiTech Summer Research Project Plan

<table>
<tr><td>Mentor's Name:
ZHAO Ziping</td><td>Research Period:
☐ 6 weeks ☑8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:
The financial portfolio optimization method pioneered by H. M. Markowitz in 1952 opened the door to scientific investment in the financial world, which was later developed into the modern portfolio theory. In the financial markets, there are various types of assets and the number of assets available to invest is increasing. How to design an optimal portfolio with a small number of assets within the investment universe has become an interesting topic to study. Recent years, the deep learning methods have shown their promising performance in many engineering fields, but their potential in financial engineering, especially in portfolio optimization, is still an open problem. The purpose of this project is to explore the application of deep learning methods for the large-scale data-driven portfolio optimization problem.</td></tr>
<tr><td colspan="2">Research Expectation:
By the end of the project, the student is expected to have proposed a deep learning method for portfolio design based on convolutional neural network and reinforcement learning, which can be amenable to the sophisticated investment environment.</td></tr>
<tr><td>Literature Preview/ Technique Required:
1. Markowitz, Harry. "Portfolio selection." The journal of finance 7.1 (1952): 77-91.
2. Mencarelli, Luca, and Claudia D'Ambrosio. "Complex portfolio selection via convex mixed-integer quadratic programming: a survey." International Transactions in Operational Research 26.2 (2019): 389-414.
3. Bengio, Yoshua, Andrea Lodi, and Antoine Prouvost. "Machine Learning for Combinatorial Optimization: a Methodological Tour d'Horizon." arXiv preprint arXiv:1811.06128 (2018).
4. Efficient in Python/R programming
5. Efficient in deep learning modeling and TensorFlow/PyTorch programming</td><td>Lab mate/ Assistant: Zepeng Zhang</td></tr>
<tr><td colspan="2">Weekly Schedule:
Week 1: Read papers on portfolio optimization and large-scale financial assets allocation.
Week 2: Read papers on mixed integer programming and combinational optimization and learn how to use solvers such as CVX, SCIP, and CPLEX.</td></tr>
</table>

Week 3: Implement mixed integer programming methods of portfolio design.
Week 4: Read papers on deep learning methods for mixed integer programming.
Week 5: Propose a deep learning framework for portfolio design.
Week 6: Apply the proposed framework to market data and evaluate its performance.
Week 7: Refine the deep learning network based on simulation results. Compare the performance of the proposed method and classic methods.
Week 8: Summarize the project and finish report. A research paper is targeted from this project.

ShanghaiTech Summer Research Project Plan

Mentor's Name: **Andre Rosendo**	Research Period: ☐ 6 weeks ✓ 8 weeks
Research Theme & Significance: **Proximal Policy Optimization algorithms for a competitive Reinforcement Learning experiment with robots**	
Research Expectation: **Understand the theory behind reinforcement learning and policy-search.** **Understand influences of Covariance Matrix Adaptation on PPO.** **Perform experiments with new code, obtain results** **Plot figures with those results**	
Literature Preview/Technique Required: Background in Computer Science https://arxiv.org/abs/1810.02541 Familiarity with ROS	Lab mate/ Assistant: Master 2nd year students: Zhang Yizheng Huang Jingyi
Weekly Schedule: **1st and 2nd week: Literature review, run current code on Python (with Zhang Yizheng)** **3rd week: Test current code on robots (with Huang Jingyi)** **4th and 5th week: Replace CMA from code with another probabilistic approach (Bayesian learning, with Zhang Yizheng)** **6th and 7th week: Test new algorithm on robots (with Huang Jingyi)** **8th week: Wrap up results and figures** **Upon return to home country it would be preferable if the student could make him/herself available to write a manuscript in partnership with the lab mates.**	

ShanghaiTech Summer Research Project Plan

Mentor's Name:	Research Period:
Winnie Shum	☐ 6 weeks ✓ 8 weeks

Research Theme & Significance:

Epithelia are formed by a well-organized three-dimensional-mosaic of different cell types and work as a barrier to separate the body from either the outside world or the lumen and cavities of organs. Complex intercellular architecture in specialized epithelium allows specific unique set of different cell types to operate in a concerted manner for the biological function of in multicellular organs and organisms. Defects in the epithelial cellular function are associated with a broad range of diseases, from minor disorders such as dry mouth, to severe health problems including cancer and infertility. The epithelium lining along the epididymis is the frontline barrier for sperm maturation and male fertility. Occludin (Ocln) is known as a necessary component of tight junction complex and barrier integrity of epithelium. Interestingly, one major phenotype of conventional *Ocln* knockout mice is male infertility, but not lethality as speculated. Our recent study showed that *Ocln* mutant male sterility was due to defective epididymal function but not spermatogenesis. Our further investigations revealed that occludin is involved in a previous unreported physiology function in epididymal epithelium for sperm maturation and male fertility. In order to better characterize the functional role and underlying cellular mechanism of Ocln, we have generated *Ocln* HA-tag mouse model as a tool to study its physiological function in combination of other technologies, including fluorescent-assisted confocal imaging, immune-precipitation of Ocln interacting proteins, and proteomic mass-spectrometry analysis.

Research Expectation:

We expect the production of a transgenic mouse that expresses HA-tag ocln in a subset of epithelial cells that are involved in formation of a specific luminal microenvironment enclosed by the epithelium by active reabsorption and secretion of various nutrients. With the use of this new mouse model, we could gain insight into the specific spatial cellular localization and functional mechanism of occluding. This study is expected to help us to understand the previously unresolved physiological function of occludin in epithelial cells. We would not only focus on occludin function in epididymis, but also the spatial expression pattern of ocludin in other organs, including kidney, lungs, intestine etc.

Literature Preview/Technique Required:	Lab mate/ Assistant:
General background about epithelial cell physiology; gross organ anatomy. 1. Perfusion fixation of organs from rodent animals; 2. Cryosectioning; 3. Immunofluorescent labeling; 4. Normal epi-fluorescence microscopy 5. Confocal imaging; 6. High resolution image processing; 7. Western blotting	Bao Ying LIU

Weekly Schedule:

Week-1:
Tissues harvest from mice using Perfusion fixation technique.

Week-2:
Western blotting using anti-HA antibody

Week-3
Dehydration and cryosectioning of tissues.

Week-4
Testing the immunofluorescent labeling conditions.
Ordinary epi-fluorescence microscopy

Week 5-7
Confocal imaging of immunofluorescent-labelled cryosections.

Week-8
High resolution image processing

ShanghaiTech Summer Research Project Plan

Mentor's Name: FAN Gaofeng	Research Period: √ 6 weeks √ 8 weeks
Research Theme & Significance: Using CRISPR-Cas9 Based Gene Editing System to Perform Genetic Alteration in Ovarian Cancer Cell Lines. **（1~2 summer students）**	
Research Expectation: **Each trainee will be taught the essential technique for making single clone of KO cell line of selected gene.**	
Literature Preview/Technique Required:	Lab mate/ Assistant: Yanchun Zhang (张艳春)

Weekly Schedule:

1st ~ 2nd week – Construction of PX330-GeneA-sgRNA recombinant plasmid

1) Design sgRNA of GeneA based on the CRISPR sgRNA database developed by professor Feng Zhang.

2) Clone the sgRNA sequence of GeneA into the PX330 plasmid containing Cas9.

3) Transform, select single colony, and sequence.

3rd ~ 4th week – Delivery of PX330-GeneA-sgRNA recombinant plasmid into ovarian cancer cells

1) Extract the sequenced PX330-GeneA-sgRNA recombinant plasmid and prepare enough DNA for subsequent electroporation or lipisome-based transfection;

2) Culture ovarian cancer cells and make sure that the number of cells reach the condition of electrical transfection or lipid transfection;

3) Perform electroporation or lipisome-based transfection experiment and deliver the PX330-GeneA-sgRNA recombinant plasmid into ovarian cancer cells;

4) Count the cells expressing GFP fluorescent protein by flow cytometry, calculate the transfection efficiency and sort the single clone of cells with imported PX330-GeneA-sgRNA recombinant plasmid in 96-well plates.

5th ~ 8th week – Select GeneA knockout ovarian cancer cell lines

1) Select single clone of cells grown in the 96-well plates and transfer them to the 24-well plates for further culture.

2) After the cells grow enough in the 24-well plates, lyse some of the cells, extract the proteins and conduct the western blot experiments.

3) Verify the knockout effect of GeneA by western blot and transfer the cells with high knockout effect to 6-well plates for further culture.

4) After the cells grow to a sufficient number and freeze the cells for future experiment.

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<table>
<tr><td>Mentor's Name:
CANG Yong</td><td>Research Period:
☐ 6 weeks ✓ 8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:
Students will engage in research on understanding how cancer cells escape immune surveillance both during primary tumor development and cancer metastasis. Their research will help identify patients benefiting best from current immunotherapies and propose new combination therapies with immune checkpoint inhibitors.</td></tr>
<tr><td colspan="2">Research Expectation:

All students are expected to work full time, with close supervision provided by graduate students. We require final summary of their research at the end of their internship, and expect their results to be part of the lab discovery efforts. Students with a motive of a summer vacation in China are not advised to apply to the lab.</td></tr>
<tr><td>Literature Preview/Technique Required:

Basic knowledge of cell biology and genetics required. Experience in cancer biology is a plus.</td><td>Lab mate/ Assistant:

To be assigned</td></tr>
<tr><td colspan="2">Weekly Schedule:

Monday-Friday: bench research (details pending on the project assigned)
Saturday morning: lab meeting and journal discussion
Saturday afternoon: 1 on 1 with mentor and team members
Sunday: flexible</td></tr>
</table>

ShanghaiTech Summer Research Project Plan

<table>
<tr><td>Mentor's Name:
LIU Yanfen</td><td>Research Period:

✓ 6 weeks ☐ 8 weeks</td></tr>
<tr><td colspan="2">Research Theme & Significance:
Our laboratory is interested in the mechanism of protein quality control in cells, with a specific focus on the autophagy biogenesis. Previously, we have identified multiple proteins involved in the autophagy signal pathway to control autophagosome formation. We are currently using the CRISPR/Cas9 library to screen more potential factors that participate in autophagosome initiation and maturation. Because endoplasmic reticulum (ER) was recognized as the main membrane source for autophagosme formation, we would be very interested to know whether any client proteins from the screen assay help ER to modulate autophagy initiation. Our laboratory techniques include genetic screening, biochemistry, cell biology and data analysis.</td></tr>
<tr><td colspan="2">Research Expectation:
Student will be expected to start from reading related literatures and then discuss with PI/senior student to get the whole idea of the project. He or she will then learn the basic techniques such as cell culture, molecular cloning, protein purification, gel running, etc. He or she will then join the project team with the senior student to perform experiments and troubleshoot the potential problems. The student will also be expected to join the weekly lab meeting to discuss the literatures with other lab members. As part of the final evaluation, he or she will write a final report and present the work done for the program.</td></tr>
<tr><td>Literature Preview/Technique Required:

Be familiar with the fundamental biological concept.</td><td>Lab mate/ Assistant:
To be determined.</td></tr>
<tr><td colspan="2">Weekly Schedule:
Week 1: Preparation.
Week 2: Technique learning.
Week 3-6: Project learning.
Week 6: Final report.</td></tr>
</table>

ShanghaiTech Summer Research Project Plan

Mentor's Name: ZHANG Zhenbo	Research Period: ☐ 6 weeks ☑8 weeks

Research Theme & Significance:

High entropy alloys additive manufactured by selective laser melting

High entropy alloys (HEAs) show considerable promise in a variety of engineering applications, due to their exceptional mechanical properties, in particularly when using in some aggressive environments. Since HEAs are complex alloy systems, their implementation is naturally expected to be as complicate components in highly demanding environments. Additive manufacturing using selective laser melting (SLM) offers the freedom to fabricate complicate components with properties comparable or better than conventional melting and solidification methods. In this project, SLM will be employed to fabricate the CoCrFeNiMn high entropy alloy, which exhibits outstanding properties at low temperatures. The additive manufacturing parameters will be optimized, and the resulting microstructure and mechanical behaviors will be studied in details. The results from this project will be helpful to pave the way for future fabrication and application of HEAs components in different industrial sectors.

Research Expectation:

- ✓ Learn the selective laser melting technique
- ✓ Fabricate CoCrFeNiMn HEAs using SLM
- ✓ Characterize the HEAs microstructure using SEM (EBSD, BSE, EDS)
- ✓ Study the mechanical behavior (strength, ductility, work hardening, etc.) of the fabricated HEAs
- ✓ Write a scientific report

Literature Preview/Technique Required:	Lab mate/ Assistant:
Basic knowledge about physical metallurgy, in particular high entropy alloys; Basic knowledge about materials characterization techniques	Ziliang Huang (postgraduate) Yu Xuan (postgraduate)

Weekly Schedule:

Week **1#**:

- ✓ Literature review
- ✓ Learn the SLM additive manufacturing technique

Week **2#**:

- ✓ Characterize the HEAs powders
- ✓ Print HEAs blocks with different printing parameters

Week **3#**:

- ✓ Characterize the blocks and find the best parameters for printing
- ✓ Print rods/plates for mechanical testing using the optimized parameters

Week **4#**:

- ✓ Prepare samples for mechanical testing
- ✓ Prepare samples for microstructural characterization

Week **5#**:

Conduct the mechanical testing and analyze the results and compare with literature

Week **6#**:

Carry out microstructural characterization using SEM, EBSD and EDS to study the grain structure, texture and elemental distribution

Week **7#**:

Analyze the microstructure of the fabricate HEAs and compare with the literature, and start the report writing

Week **8#**:

Finalize the report

ShanghaiTech Summer Research Project Plan

Mentor's Name:	**Research Period:**
Yuu Kimata	☐ 6 weeks ✓8 weeks

Research Theme & Significance:

The coordination between cell proliferation and cellular differentiation is of critical importance for development and tissue homeostasis of metazoan organisms. However, how the coordination is regulated in a cell remains unclear. Using the powerful multicellular model Drosophila, we recently showed that a conserved protein complex essential for cell proliferation called APC/C regulates cell fate specification of retinal progenitor cells through regulation of Wnt signaling. This finding indicates that a subset of cell cycle-regulating proteins possess the ability to simultaneously regulate both cell cycle and differentiation processes, thereby acting as the intracellular coordinators between cell proliferation and differentiation. To explore this new role of cell cycle proteins, we have performed a genetic screen against conserved cell cycle proteins in the developing *Drosophila* eye and have found 56 genes that affect not only proliferation but also differentiation of retinal cells. Further investigation of these candidate genes will lead to identification of novel functions of conserved cell cycle proteins, which may also be implicated in human development and various diseases such as cancer and tissue degenerative disorders.

Research Expectation:

Summer students will take part in further investigations of the eye differentiation phenotypes caused by knockdown or over-expression of 56 candidate genes in cooperation of a senior student. The students are expected to perform Drosophila crossing to generate specific genotypes, to examine phenotypes of adult flies, to perform dissection and immunostaining of developing eye tissues, to conduct microscopic analyses using a confocal microscope, and to analyse image data. Students are expected to communicate results with the PI and other lab members and to be actively involved in other group activities of the lab, including progress discussions, journal clubs and lab chores.

Literature Preview/Technique Required:	**Lab mate/ Assistant:**
Fly pushing (textbook) Baker N 2007 Current Opinion in Gen Dev Treisman J 2013 WIREs Dev Biol Martins T et al 2017 Developmental Cell Kimata Y 2019 Trends in Cell Biology	Rusong Ding (M2) Qian Zhang (M3) Yusanjiang Abula (Research Assistant)

Weekly Schedule:

Week1: Practice Drosophila handling and sex and genotype determination, project discussion and planning with the supervisors, collect flies and set up initial crosses

Week2: Practice dissection and inmmunostaining of eye imaginal discs,

Week3: Perform immunostaining eye imaginal disc 1st group; collect flies and set up 2nd crosses

Week4 Perform confocal microscopy and image analysis with 1st group, present a paper in a lab journal club

Week5 Perform immunostaining eye imaginal disc of 2nd group; collect flies and set up 3rd crosses

Week6 Perform confocal microscopy and image analysis with 2nd group

Week7 Perform immunostaining eye imaginal disc 3rd group,

Week8 Perform confocal microscopy and image analysis with 3rd group, presentation of the report

ShanghaiTech Summer Research Project Plan

Mentor's Name: YANG Haitao	Research Period: √ ☐ 6 weeks √ ☐ 8 weeks

Research Theme & Significance:

Tuberculosis (TB) is the leading cause of fatalities amongst all the infectious diseases. The situation continues to be exacerbated by the emergence of multi-drug resistant and extensively drug-resistant Mycobacterium tuberculosis (Mtb) strains. In addition, TB accounts for one-quarter of AIDS deaths worldwide and is one of the most common causes of morbidity in people living with HIV. Thus, there is an urgent need to identify new targets and develop new therapies/drugs for this disease. Bacterial membrane proteins and the large molecular machines often play crucial roles in the survival of the Mtb, and therefore attract attention for drug development. Our major research objectives include investigations of the membrane proteins for cell wall biosynthesis, transport/secretion system machinery and supercomplexes in energy metabolism, with a goal to revealing their precise functional roles in the life cycle of Mtb. Employing such structural knowledge on the mycobacterial targets, development of anti-tuberculous drugs is our central research goal.

Research Expectation:

1. Please contact us directly to discuss your interests and available projects.
2. Students are expected to be engaged full-time in laboratory research.
3. At the end of the research period, the students are required to present their research work.

Literature Preview/Technique Required: TBD	Lab mate/ Assistant: PI: Prof. Haitao Yang Email: yanght@shanghaitech.edu.cn

Weekly Schedule:

TBD

ShanghaiTech Summer Research Project Plan

Mentor's Name:	Research Period:
YANG Bei (on behalf of Prof. Wilson)	☐ 6 weeks ■ 8 weeks

Research Theme & Significance:

The Lab of Antibody Structure (LAS) is keen to understand the complex interplay between the host and diverse types of pathogen. Embracing a variety of interdisciplinary techniques and mutually beneficial collaborations, we currently focus our research on serval high-risk infectious diseases and their causative microbes, including human immunodeficiency viruses (HIV) and *Plasmodium*. Through unraveling the interplay between host and these microbes at molecular level, we are devoted to uncover novel drug targets against the infection of these pathogens and related drug candidates' discovery.

Research Expectation:

The summer students will work together with graduate students in LAS on selected research projects. The summer students are expected to perform experiments under the guidance of graduate students. The summer students would be required to give journal club at least once during the 8 weeks, at the end the project, the students should also give a work report on the lab meeting.

Literature Preview/Technique Required:	Lab mate/ Assistant:
Biochemistry or Structural Biology education background is preferred; familiarity with Linux system and python coding is a big plus.	Jiangchao Xiang; Jun Niu

Weekly Schedule:

1st -3rd week: get familiar with the lab members and the school, read related papers to understand the background of selected research projects, learn related experimental techniques from lab mates.

4th week: The summer students are expected to deliver a journal club in this week, the paper of choice should be related to his/her selected research projects. The summer students should be able to independently perform some easy experiment on his/her own by this week.

5-7th week: The summer students are expected to independently perform assigned expeirments under the supervision of mentor or lab mates.

8th week: The summer students are expected to deliver a work report on the lab meeting, in which he/she should summers his/her experimental work in a logical manner, discuss the problems encountered and how he/she solved these problems. Some considerations on his/her gains during the 8 weeks are also expected.

ShanghaiTech Summer Research Project Plan

Mentor's Name: Raymond Stevens / LIU Yan	Research Period: ☐ 6 weeks ■ 8 weeks

Research Theme & Significance:

Exploring the functions of mitochondria in pancreatic beta cells via super-resolution microscopy.

Diabetes, the silent killer, is one of the most frequent and severe metabolic disorders all over the world. An increasing number of studies have showed that mitochondrial dysfunction is observed in diabetes, however the detailed mechanisms are rarely understood. With the recently developed super-resolution microscopy, which overcomes the diffraction limitation (200nm) and provides enhanced resolution than conventional optical imaging methods, we are aiming to chase the real-time morphological and functional changes of mitochondria in the whole process of insulin exocytosis in pancreatic beta cells under physiological / pathological conditions.

Research Expectation:

Get familiar with basic optical imaging skills (confocal, super-resolution, live cell imaging), pancreatic beta-cell culture, be able to conduct morphological & functional analysis of data obtained.

Literature Preview/Technique Required:	**Lab mate/ Assistant:**
Literature preview: "Structured Illumination Microscopy" "Live cell imaging of mitochondria" "Insulin granule dynamics in pancreatic beta cells" Technique required: Cell culture / Fluorescent microscopy;	Zhuang Lu

Weekly Schedule:

Week 1:

i. Cell Culture Room SOP training.
ii. Get familiar with medium preparation, cell passage, plating cells.
iii. Literature research about the background of the mini-project.

Week2:

i. Culture/passage/plate pancreatic beta-cells by yourself.

ii. Formulate the detailed plan for the mini-project.

Week3:

i. Study fluorescent imaging operations.
ii. Install and study analyzing software, e.g. Image J/ Fiji.
iii. Communicate with the assistant about the detailed plan of your mini-project.

Week4:

i. Image analysis of the obtained data;
ii. Keep recording the experiment notes.

Week5:

i. Continue experiments & problem solving;
ii. Keep recording the experiment notes.

Week6:

i. Improve data collecting & analyze of experiments;
ii. Read articles and talk with the assistant.
iii. Keep recording the experiment notes.

Week7:

i. Perform the detailed plan and data analysis.
ii. Talk with the assistant about any questions.
iii. Prepare PPT and other files for your presentation.

Week8:

i. Report your presentation.

ShanghaiTech Summer Research Project Plan

Mentor's Name: YANG Yong	Research Period: ☐ 6 weeks ✓ 8 weeks

Research Theme & Significance:

In situ characterization of high temperature catalytic reactions by XPS, XRD and MS

Research Expectation:

With the obtained information and newly developed lab technologies, including *in situ* XRD and XPS coupled with online MS, we plan to further observe the nature of active centers on a catalyst surface which are responsible for both positive (desired reaction) and negative (total oxidation, coking and catalyst poisoning) processes. Such fundamental details allow to modify and develop the catalysts in the related process achieving the goal of high conversion and selectivity in a promised more environmental friendly process replacing the indirect industrial path of methane conversion to syngas followed by a Fischer-Tropsch. The main goal is focused on the experimental evidence of the long time puzzled surface active oxygen species and describe its direct role in the reaction.

Literature Preview/Technique Required: *ACS Catalysis* **2018,** *8* (12), 11761-11772 *PCCP* **2019,** *21* 22351 - 22358	Lab mate/ Assistant: Dr. Evgeny Vovk Jessica Cairu Guan

Weekly Schedule:

1. **Lab tour and group meeting**
2. **XPS lab**
3. **Online MS experiment**
4. **Online MS experiment**
5. **XPS with online MS**
6. **XRD with Online MS experiment**
7. **Data analysis**
8. **Report**

(subject to change)

ShanghaiTech Summer Research Project Plan

Mentor's Name: Franklin Kim	Research Period: ☐ 6 weeks ■ 8 weeks

Research Theme & Significance:

Title: Generation of electric power via streaming potential within PVA-based hydrogels

Significance:
Charge separation from flow of water within microchannels has been long investigated as a clean source for electrical energy generation. We have recently developed poly vinylalcohol (PVA) based hydrogels with inner channels in the submicrometer range. High surface charges and strong capillary force from the inner channels make the PVA hydrogels promising for such application in energy generation.

Research Expectation:

We are exploring various experimental configurations for efficient harvesting of the energy generated from the charge separation within the PVA hydrogels. At the moment, the hydrogel is molded into a cylindrical pillar structure, based on another ongoing project. However, we believe different types of structures could lead to improved results.

The candidate is expected to be responsible for exploring one particular configuration that is being considered. Initial studies will be focused on optimizing performance from the new configuration; however, fundamental understanding of how factors such as water flow and charge separation is influenced from the new configuration will also be investigated.

Literature Preview/Technique Required: Experience in chemistry lab experiments Lab safety training Some understanding of concepts related to polymer structures and properties, nanomaterials, and electrokinetic phenomena	Lab mate/ Assistant: Piao Wen (文飘)

Weekly Schedule:

(Prior to visit)
Discussion on experimental plans, reading literature related to the project

Week 1: Lab safety orientation, learning procedures for preparing and characterizing the PVA hydrogels and nanomaterials which will be added to the hydrogel

Week 2 – 3: Optimizing the new proposed experimental configuration, comparing results with those obtained by Piao Wen using the pillar-shaped hydrogels, some parameters that will be explored are as follows.

- Size of channels within the PVA hydrogel
- External structure of the hydrogel
- Connection of current collector to the hydrogel

Week 4 – 6: Identifying key parameters that influence the performance in the new configuration, formulating hypothesis on why such factors are important, verification of hypothesis by control experiments

Week 7-8: Organization of results, writing report, conducting additional experiments as needed

Candidate is expected to

- Submit weekly reports, discuss with host supervisor for each week
- Be able to organize experimental results in an easily understandable fashion
- Be able to explain results in a scientific fashion

ShanghaiTech Summer Research Project Plan

Mentor's Name: LI Jun	Research Period: ☐ 6 weeks ☑ 8 weeks
Research Theme & Significance: Low-dimensional superconducting devices	
Research Expectation: 1) To learn micro- and nano-fabrication of low-dimensional superconducting devices 2) To learn the thin film deposition technique 3) To learn the characterization of superconducting devices	
Literature Preview/Technique Required: "Solid State Physics"	Lab mate/ Assistant: Dr. Yueshen WU
Weekly Schedule: 1. Week 1, to learn the operation of transformation system for two-dimensional materials. i.e., some basic devices including graphene, MoS2, and superconducting NbSe2 devices. 2. Week 2-4, to learn the thin film deposition systems of magnetron sputtering deposition and atomic layer deposition systems, and to grow superconducting thin films of Nb and NbN, and conducting film of Au/Ti. 3. Week 5-6, to learn micro-fabrication technique, including photolithographic, and ion-beam etching. 4. Week 7-8, to learn the transport properties measurements systems, including the GM cryostat and physical properties measurement system – 14 T.	