# Sangmin Lim, Ph. D.

Address: P.O. Box 335-2, 635 Danjae-ro, Namil-myeon, Sangdang-gu, Cheongju, Chungbuk, 28187, Republic of Korea
Email : lim_airforce@afa.ac.kr
Mobile: +82-10-9305-8962
Website: https://www.sangminlim.org/

## PROFESSIONAL EXPERIENCE

- Assistant Professor, Republic of Korea Air Force Academy (Current Position)
- Guest Scientist, Max Planck Institute for Intelligent Systems

## RESEARCH INTERESTS

- Computational Mechanics, Soft Robotics, Bioinspired Robots, Physics-based Machine Learning, Bacterial Motility

## EDUCATION

- **University of California, Los Angeles** — Los Angeles, CA
  - *Ph.D. , Mechanical Engineering; GPA: 3.91/4.00* — *Dec 2019 - June 2023*
  - *Master of Science, Mechanical Engineering* — *Aug 2018 - Dec 2019*
- **United States Air Force Academy** — Colorado Springs, CO
  - *Bachelor of Science, Aeronautical Engineering; GPA: 3.31/4.00* — *Aug 2012 - May 2016*

## RESEARCH EXPERIENCE

- **Ferromagnetic Soft Robot Simulation** — in collaboration with Max Plank Institute
  *Research Assistant (Supervisor : Prof. M. Khalid Jawed)* — *Jan 2021 - Present*
  - Developed a physics-based simulation for a ferromagnetic soft robot that couples elastic and ferromagnetic material properties using C++. The external magnetic field and magnetization profile are controllable as desired.

- **Machine Learning - Assisted Resistive Force Theory** — in collaboration with Charbel Habchi, Ph. D.
  *Research Assistant (Supervisor: Prof. M. Khalid Jawed)* — *Oct 2020 - Present*
  - Proposed neural ordinary differential equation method to learn the internal dynamics of high fidelity hydrodynamics model.
  - Developed a fast and accurate hydrodynamics model for rigid helices rotating and translating at low Reynolds numbers using a deep neural network.

- **Bacteria-Inspired Soft Robot**
  *Research Assistant (Supervisor: Prof. M. Khalid Jawed)* — *Jul 2019 - Present*
  - Planned an automated desktop experiment to systematically investigate artificial bacterial flagella interaction (bundling, tumbling, unbundling).
  - Investigated existing bacteria-, cilia- robots and mathematical models for the robots. Various scale and actuation methods (magnetic, optical, chemical, and acoustic) were investigated.
  - Designed and tested a centimeter-scale soft robot with two elastic flagella to investigate the propulsive effect of bundling behavior under low Reynolds number flow.
  - Developed and verified a physics-based simulation that couples elasticity, hydrodynamics, and contact for the bacteria-inspired soft robot. Discrete Elastic Rods, Regularized Stokeslet Segment, and penalty-based contact method are integrated.

- **Wind Induced Forces on a Hemispherical Observatory Dome with Open Shutter Doors**
  *Undergraduate Researcher (Supervisor: Mr. Timothy Siefers)* — *Sep 2015 - Dec 2016*
  - Induced load coefficients to analyze the mission capability of GEODSS during inclement weather (high wind) by using a 1:35 scale model observatory dome in two configurations, a partially and a fully open configuration in a low-speed wind tunnel.
  - Planned research, calibrated measurement tools (moment balance, pressure transducers), built scaled dome model and conducted data acquisition in a low-speed wind tunnel.

- **Flight Test Technique Lab**
  *Undergraduate Researcher (Supervisor:Lt Col Joffrion, Lt Col Kyle Kolsti, Lt Col Timothy Jung)* — *Sep 2015 - Dec 2015*
  - Planned, conducted flight test in T-41D (4 sorties) and T-38 (1 sortie).
  - Obtained and analyzed the flight test data on static/dynamic characteristic of the aircrafts
  - Evaluated the flying qualities of the aircraft based on MIL-HDBK-1797A specification.

## Publications

1. Suitu Wang, **Sangmin Lim**, Seelay Tasmim, Manivannan Sivaperuman Kalairaj, Laura K Rivera-Tarazona, Mustafa K Abdelrahman, Mahjabeen Javed, Sasha M George, Yoo Jin Lee, M Khalid Jawed, Taylor H Ware (2024) Reconfigurable growth of engineered living materials. *Advanced Materials*

2. **Sangmin Lim**, Achyuta Yadunandan, M. Khalid Jawed (2022): Bacteria-inspired Robotic Propulsion from Bundling of Soft Helical Filaments at Low Reynolds Number. *Soft Matter*

3. **Sangmin Lim**, Yayun Du, Yongkyu Lee, Shivam Kumar Panda, Dezhong Tong, M. Khalid Jawed (2022): Modeling, Control, and Fabrication of Robots Inspired by Flagella and Cilia. *Bioinspiration & Biomimetics*

4. **Lim, S.**, Habchi, C., Jawed, M. K. (2023). Machine learning assisted resistive force theory for helical structures at low Reynolds number. *Journal of Fluids and Structures*

5. Zhuonan Hao, **Sangmin Lim**, Jawed, M. K. (2023). Modeling, Characterization, and Control of Bacteria-inspired Bi-flagellated Mechanism with Tumbling. *IROS* 2023

6. Timothy M. Siefers, Randy J. Frost, **Sangmin Lim**, and Thomas E. McLaughlin (2017): Wind Induced Forces on a Hemispherical Observatory Dome with Open Shutter Doors. *AIAA* 2017-1216

## Presentations

1. Zhuonan Hao, **Sangmin Lim**, Siddharth Zalavadia, Darren Chin, Sumukh Johri, Vinay Nagappala, Khalid Jawed (2024) Mechanical characterization of bio-inspired flagella interaction *American Physical Society March Meeting*

2. M. Khalid Jawed, **Sangmin Lim**, Zhuonan Hao (2023) Modeling and Characterization of Bi-flagellated Robot with Tumbling *American Physical Society March Meeting*

3. M. Khalid Jawed, **Sangmin Lim**, Zhuonan Hao (2022): Resistive Force Theory vs. Slender Body Theory as Hydrodynamic Models in Simulation of Bacterial Flagella. *American Physical Society March Meeting*

4. M. Khalid Jawed, Zhuonan Hao, **Sangmin Lim** (2022): Bacteria-inspired Bi-flagellated Soft Robot with Bundling and Tumbling Behavior. *American Physical Society March Meeting*

5. **Sangmin Lim**, Achyuta Yadunandan, and M. Khalid Jawed (2020): Bacteria Inspired Multi-Flagella Propelled Soft Robot at Low Reynolds Number *IROS 2020, Robotics-Inspired Biology Workshop* (Poster)

## Software & Programming Skills

- **Programming**: C++, Python
- **Software**: Matlab, Mathematica, SolidWorks, Inventor, ABAQUS, ANSYS, OpenSim, ROS, PyTorch, TensorFlow

## Teaching Experience

- Republic of Korea Air Force Academy - Thermodynamics
- Republic of Korea Air Force Academy - Automation system research
- Republic of Korea Air Force Academy - MicroUAV design and manufacturing
- Republic of Korea Air Force Academy - Bionics and Biomimetics

## Mentorship

- Sumukh Johri, Applied Materials
- Vinay Nagappala, UCLA
- Saptarshi Joshi, UIUC graduate student
- Achyuta Yadunandan, Space X
- Changdae Kim, Texas A&M graduate student