

# YEONSU JUNG

---

Postdoctoral Fellow,  
School of Engineering and Applied Sciences,  
Harvard University, Cambridge, MA, USA

[jung@seas.harvard.edu](mailto:jung@seas.harvard.edu)  
[yeonsu-jung.github.io](https://yeonsu-jung.github.io)  
[Google scholar profile](#)

## EXPERIENCE

- 2021-  
Present Postdoctoral Fellow,  
Harvard School of Engineering and Applied Sciences,  
Cambridge, MA, USA  
Research: Entanglement of filaments and design principles of animal architecture.  
Supervisor: Prof. Lakshminarayanan Mahadevan
- 2020-2021 Postdoctoral Fellow,  
Rowland Institute, Harvard University  
Cambridge, MA, USA  
Research: Experimental fluid dynamics of texture surfaces (e.g., shark skin) for drag reduction  
Supervisor: Dr. Shabnam Raayai-Ardakani
- 2019-2020 Postdoctoral Fellow,  
Department of Mechanical Engineering, Seoul National University  
Seoul, South Korea  
Research: Physics of granular matter and design principles of mud nests.  
Supervisor: Prof. Ho-Young Kim

## EDUCATION

- 2014-2019 PhD in Mechanical Engineering  
Seoul National University, Seoul, South Korea  
Thesis: Optimal design principles in biological transport systems  
Supervisor: Prof. Ho-Young Kim
- 2012-2014 MS in Biomedical Engineering  
Gwangju Institute of Science and Technology, Gwangju, South Korea  
Thesis: Laser speckle decorrelation in living tissues  
Supervisor: Prof. Euiheon Chung
- 2008-2012 BS in Mechanical Engineering  
Pohang University of Science and Technology, Pohang, South Korea

## PUBLICATION (\*: CO-FIRST AUTHORS)

- 2024 Phase Transitions in Rolling of Irregular Cylinders and Spheres  
Daoyuan Qian, Yeonsu Jung, L. Mahadevan  
arXiv: 2407.19861
- 2023 Entanglement Transition in Rod Packings  
Yeonsu Jung, Thomas Plumb-Reyes, Hao-Yu Greg Lin, L. Mahadevan  
arXiv: 2310.04093, 2023  
Accepted for Publication in Proceedings of the National Academy of Sciences (As of Dec 12, 2024)  
This paper discusses our discovery and assessment of entangled phase of rod packings, like a bird's nest. I developed a highly sophisticated image processing scheme to obtain accurate and reliable rod geometry data from x-ray computerized tomography (x-ray CT) images. This novel discovery of entangled phase will give better insight on the evolutionary biology regarding animal architecture and on the design and manufacturing of soft robotics, textile technology, reconfigurable architecture, etc. **This work has drawn interests from my colleagues and I have been invited to give a colloquial talk by Bard College (Apr, 2023), Michigan Technological University (Sep, 2023), and Northeastern University (Sep, 2024).**
- 2022 Active Entanglement Enables Stochastic, Topological Grasping  
Kaitlyn Becker, Clark Teeple, Nicholas Charles, Yeonsu Jung, Daniel Baum, James C Weaver, L. Mahadevan, Robert Wood.  
Proceedings of the National Academy of Sciences **119**, e2209819119 (2022)  
This paper reports *robotic tentacles* that utilize active entanglement for stochastic, topological grasping. My contribution to this work was to process x-ray CT images of *tentacles* to get the curvature information, and to calculate measures of entanglement to explain how physical entanglement helps with grasping actuation. Contrary to conventional grasping robots, our robotic tentacles are capable of collect soft and fragile objects, which can be more useful in deep sea exploration and sample collection. **This work has drawn public interest and has been introduced in media including** The Verge (<https://www.theverge.com/2022/10/26/23424420/robot-tentacle-gripper-rubber-filaments-mr-jelly-hands>), CNET (<https://www.cnet.com/science/bizarre-tentacle-robot-looks-like-it-emerged-from-the-matrix/>), and Popular Science (<https://www.popsci.com/technology/harvard-tentacle-robot/>).
- 2022 Thermodynamics of Hygroresponsive Soft Engines: Cycle Analysis and Work Ratio  
Beomjune Shin, Yeonsu Jung, Munkyeong Choi, Ho-Young Kim  
Physical Review Applied **18**, 044061 (2022)  
This paper studies thermodynamic aspects of humidity-driven soft engines. We initiated establishing a model for the ideal thermodynamic cycle for humidity-driven engines, like Carnot engine for heat engines, to provide a theoretical framework to assess thermodynamic efficiency of naturally-occurring and man-made hygroscopic actuators. **This work has been introduced in APS News on Dec, 2022** (<https://www.aps.org/publications/apsnews/202212/plants.cfm>).
- 2022 Evaporative Capillary Rise  
Jungtaek Kim, Yeonsu Jung, Ho-Young Kim  
Physical Review Fluids **7**, L032001 (2022)  
This paper studies a capillary, open-channel flow in the presence of severe evaporation. We investigated the contact angle-dependent evaporative flux and its effect on the hydrodynamics of the evaporative fluid in an open channel. The theoretical model constructed here can lay a foundation for understanding the evaporative capillary rise dynamics occurring in biological porous media (e.g., skin micro-wrinkles, leaf stomata) as well as simple open channels adopted in heat pumps.

- 2021 Soft Artificial Electroreceptors for Non-Contact Spatial Perception  
W. J. Song\*, Y. Lee\*, Yeonsu Jung\*, Y.-W. Kang, J. Kim, J.-M. Park, Y.-L. Park, H.-Y. Kim, J.-Y. Sun  
Science Advances 7, sciadv.abg9203 (2021)
- In this paper, we report a soft and wearable sensor inspired by stingray's electroreceptors. As a co-first author, I mainly worked on the development of theoretical research and computation for the optimal design and performance of the stingray-inspired wearable sensor. **This work has drawn public interest and has been introduced in media including Chosun Ilbo**, the largest media group in South Korea ([link](#)).
- 2021 Avian Mud Nest Architecture by Self-Secreted Saliva  
Yeonsu Jung, Sohyun Jung, Sang-im Lee, Wongjung Kim, Ho-Young Kim  
Proceedings of the National Academy of Sciences **118**, e2018509118 (2021)
- We report the design principles behind the structural stability of avian mud nests. From a mechanical testing with Barn Swallow's nests, we measured, with custom tensile tester for granular samples, the tensile strength of the nests is over 100 times larger than that associated with Barn Swallow's weight. The conclusion of this study explains the biophysical limit on mud nesters' weight and leads to possible applications in advanced 3D printing technology. **In addition, this work has drawn public interest and has been introduced in media including Chosun Ilbo**, the largest media group in South Korea ([link](#)).
- 2020 Ionic Spiderwebs  
Y. Lee\* W. J. Song\*, Yeonsu Jung, H. You, M.-Y. Kim, H.-Y. Kim, J.-Y. Sun  
Science Robotics **5**, eaaz5405 (2020)
- In this paper, we report an electroadhesive actuator using ionic hydrogel inspired by spiderweb's functionality. I mainly worked on mathematical modeling on how water drop is attached/detached from a string and on sensing and actuating objects by using electric fields. **This work has drawn public interest and has been introduced in media including Physics World Research Update** ([link](#)).
- 2019 Optimal Diameter Reduction Ratio of Acinar Airways in Human Lungs  
K. Park\*, Yeonsu Jung\*, T. Son, Y.-J. Cho, N. L. Jeon, W. Kim, H.-Y. Kim  
PLOS ONE **14**, eaaz5405 (2019)
- This paper studies the design principles in deep regions (acinar airways) of human lungs; the main question is how diffusive transport in those narrow airways in deep lungs can be optimized for maximal oxygen transport. As a co-first author, I worked on the development of mathematical formulation of the optimal operation of the human lungs collaborating with experimentalists and a medical doctor.
- 2018 Poro-Elasto-Capillary Wicking of Cellulose Sponges  
J. Ha, J. Kim, Yeonsu Jung, G. Yun, D.-N. Kim, H.-Y. Kim  
Science Advances **4**, eaao7051 (2018)
- This paper studies the complex interplay between elasticity/plasticity and capillarity in flows in cellulose sponges. My contribution was to analyze Environmental Scanning Electron Microscopy images to obtain statistics of pore sizes, and develop a simple computational model to explain the merging of micro-pores in cellulose sponges. **This study has been introduced in Nature Research Highlight** (<https://www.nature.com/articles/d41586-018-04010-w>).



- 2016 Capillarity Ion Concentration Polarization as Spontaneous Desalting Mechanism  
S. Park\*, Yeonsu Jung\*, S. Y. Son, I. Cho, Y. Cho, H. Lee, H.-Y. Kim, S. J. Kim  
Nature Communications **7**, 11223 (2016)  
This paper studies capillarity flow with electrophoretic potentials and possible explanation for the spontaneous desalting mechanism in sea plants. As a co-first author, I developed a simple mathematical model to explain the interplay between electric charge and capillary flows. I also participated in the image analysis of experimental results.
- 2013 Three-Dimensional Point Spread Function of Surface Plasmon-Coupled Emission Microscopy  
Yeonsu Jung, Euiheon Chung  
Proceedings of SPIE, Nano-Bio Sensing, Imaging, and Spectroscopy, 88790D (2013)  
This conference proceeding numerically studies the three dimensional point spread function of super resolution microscopy based on surface plasmon phenomena.
- 2012 Overcoming the Resolution Limit Using Stripped Patterns: Structured Illumination Microscopy  
Y. Koh, E. Jung, Yeonsu Jung, E. Chung  
Physics and High Technology **21**, 21 (2012)  
This physical and technological review deals with the principles of super-resolution microscopy using structural illumination and its broad application in biomedical sciences.

## PRESENTATIONS

- 2024 Entanglement Transition in Random Roc Packings  
Network Science Institute, Northeastern University, MA, USA  
(<https://www.networkscienceinstitute.org/talks/yeonsu-jung>)  
Sep 11, 2024
- 2023 Entanglement Transitions in Rod Packings  
Physics Colloquium  
Department of Physics, Michigan Technological University, MI, USA  
Sep 28, 2023
- 2023 From Curiosity to Inventions:  
Exploring the Design Principles of Biological Soft Matter  
Physics Colloquium  
Department of Physics, Bard College, NY, USA  
Apr 14, 2023
- 2023 Entanglement in Filamentous Networks  
American Physical Society March Meeting 2023 (Mar 5-10, 2023)  
Las Vegas, Nevada, USA  
Mar 8, 2023
- 2019 Mathematical Model of Acinar Airway Design in Human Lungs

ASME-JSME-KSME Joint Fluids Engineering Conference 2019 (July 28-Aug 1, 2019)  
San Francisco, California, USA  
Aug 1, 2019

- 2018      Formation of Viscoelastic Liquid Bridges in the Soil  
by Drying of Root Mucilage  
The 71st Annual Meeting of the American Physical Society Division of Fluid Dynamics  
(Nov 18-20, 2018)  
Atlanta, Georgia, USA  
Nov 18, 2018
- 2018      Mathematical Optimization of Root Arrangement  
for Maximal Water Uptake From Soil  
The 12th European Fluid Mechanics Conference (Sep 9-13, 2018)  
Vienna, Austria  
Sep 1, 2018
- 2017      Optimal Design of Artificial and Real Roots for Water Uptake  
The 70th Annual Meeting of the American Physical Society Division of Fluid Dynamics  
(Nov 19-21, 2017)  
Denver, Colorado, USA  
Nov 20, 2017
- 2016      Visualization and Measurement of Laser-Induced  
Thermocapillary Flow in a Liquid Drop  
The 6th International Multidisciplinary Conference on Optofluidics (July 24-27, 2016)  
Beijing, China  
July 25, 2016
- 2016      Mathematical Model for Optimal Water Uptake by the Fibrous Root  
9th International Symposium on Nature-Inspired Technology (Jan 13-15, 2016)  
Daejeon, South Korea  
Jan 15, 2016
- 2015      Optimal Root Arrangement of Cereal Crops  
The 68th Annual Meeting of the American Physical Society Division of Fluid Dynamics  
(Nov 22-24, 2015)  
Boston, Massachusetts, USA  
Nov 22, 2015
- 2015      Theoretical Analysis for Capillary Ion Concentration Polarization  
ASME-JSME-KSME Joint Fluids Engineering Conference 2015 (July 27-31, 2015)  
Seoul, South Korea  
July 30, 2015
- 2015      Three-Dimensional Point Spread Function of Surface  
Plasmon-Coupled Emission Microscopy

Nano-Bio Sensing, Imaging, and Spectroscopy (Feb 20-23, 2013)  
Seoul, South Korea  
Feb 20, 2013

## HONORS, AWARDS, CERTIFICATION

- 2021-2022 Abroad Postdoctoral Fellowship (45,000,000 KRW)  
awarded by National Research Foundation of Korea
- 2014-2016 Superior Academic Performance Scholarship  
awarded by Seoul National University
- 2008-2010 National Scholarship  
awarded by National Research Foundation of Korea
- 2005 Bronze Medal, High School Physics Competition  
awarded by Gwangju Metropolitan Office of Education
- 2000 Craftsman Information Processing  
awarded by Ministry of Science and ICT (South Korea)

## TEACHING EXPERIENCE

- Spring 2024 I Wonder Why: Science as a Culture of Curiosity (Gene 1190)  
Harvard College Program in General Education, Harvard University
- Fall 2015 Flow in Life Systems (M2794.003900)  
Department of Mechanical and Aerospace Engineering, Seoul National University
- Spring 2010 Senior Tutor for Calculus (Math 110)  
Pohang University of Science and Technology
- Fall 2010 Senior Tutor for Thermofluid Engineering I (MECH 252)  
Pohang University of Science and Technology

## ACADEMIC MEMBERSHIP

- 2014- Member, American Physical Society (apS)
- 2018- Member, European Mechanics Society (Euromech)
- 2014- Member, Korean Society of Mechanical Engineers (Ksme)

## REFERENCES

**Lakshminarayanan Mahadevan, Ph. D.**

lmahadev@g.harvard.edu

Professor,

School of Engineering and Applied Sciences,  
Department of Organismic and Evolutionary Biology,  
Department of Physics, Harvard University, Cambridge, MA

**Ho-Young Kim, Ph. D.**

hyk@snu.ac.kr

Professor,

Department of Mechanical Engineering, Seoul National University, Seoul, South Korea

**Kaitlyn Becker, Ph. D.**

kait@mit.edu

Assistant Professor,

Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA

**Jeong-Yun Sun, Ph. D.**

jysun@snu.ac.kr

Professor,

Department of Materials Science and Engineering, Seoul National University, Seoul, South Korea

**Wonjung Kim, Ph. D.**

wonjungkim@sogang.ac.kr

Professor,

Department of Mechanical Engineering, Sogang University, Seoul, South Korea