Woen-Sug Choi (최원석)

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Naval Postgraduate School
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PROFILE

- Highly self-motivated with research expertise with shipbuilding and ocean engineering background. Strong interpersonal skills, research proposals, and project management. Various experiences on projects with government entities (i.e., ROK Navy, ADD) and private corporations (i.e., DSME, HHI).
- Rich experience in AUV/ASV simulator developments for implementation of dynamics/kinematics model of ROVs and underwater gliders at ROS-Gazebo platform to support autonomous robotics developments. Development experience in various sensor supports, including real-time multi-beam sonar simulation using GPU accelerations.
- Rich experience in modeling and simulation of hydrodynamics for ship resistance/maneuvering using OpenFOAM and developments of acoustics and vibrations analysis tools for underwater structures.
- Strong adaptation to different programming languages and platforms. (First learned programming at the age of 9)
- Language: Fluent in Korean (Native), English (Graduated middle school in San Antonio, Texas, USA), and Japanese.
- US residency experience: 9th grade at Rogers high school, Newport, RI (3 years grade skipping at the age of 13)
- Member of a military family
  - Father: former submarine captain and naval attaché to the USA retired as a rear admiral at the ROK Navy.
  - Brother: Served ROK Marine Corps
  - Myself: Served as Technical Research Personnel for ROK Army

EDUCATION

July. 2020 ~ Present — **Naval Postgraduate School** (Postdoctoral Researcher; NRC Fellowship) — Monterey, CA, USA
CRUSER (Consortium for Robotics and Unmanned Systems Education and Research)
NRC Research Associateship Award (Research Associate Program)
(Developments of virtual underwater acoustic environments and test and evaluation platforms for autonomous robotic systems, PI: Prof. Brian Bingham)

Mar. 2020 ~ June. 2020 — **Center for Naval Ship Engineering** (Postdoctoral Senior Researcher) — Seoul, Korea
Institute of Engineering Research, Seoul National University

Mar. 2013 ~ Feb. 2020 — **Seoul National University** (Integrated Ph.D. Program) — Seoul, Korea
Department of Naval Architecture and Ocean Engineering, Ship Noise and Vibration Laboratory
Thesis: Development of numerical analysis methods for flow-induced noise due to turbulent flows around underwater structures
Advisor: Prof. Suk-Yoon Hong

Mar. 2009 ~ Feb. 2013 — **Yokohama National University** (Korea-Japan Joint Government Scholarship Program) — Yokohama, Japan
Department of Mechanical Engineering and Materials Science, Digital Engineering Laboratory
Thesis: Constrained B-spline surface fitting by iterative geometric approximation algorithm
Advisor: Prof. Takashi Maekawa
Bachelor of Science in Mechanical Engineering and Materials Science (Machine processing course)

RESEARCH INTEREST

- **UUV/AUV dynamics and controls simulation**
  - ✓ Kinematics and dynamics of underwater vehicles, including hydrodynamics and controls for mission planning optimizations
  - ✓ Simulation of real-time multi-beam sonar using GPU accelerations, including target scattering

- **Computational aeroacoustics/hydroacoustics and vibroacoustics**
  - ✓ Modeling and simulation of flow-induced noise and vibration
  - ✓ Turbulence models of computational fluid dynamics and application of computational acoustics
- **Fluid-structure interaction analysis**
  - ✓ Predictions of vibration and noise excited by turbulent boundary layers and turbulent flows
  - ✓ Simulation of flow-induced resonance behavior such as frequency lock-in phenomenon and safety boundaries.

AWARDS

- **NRC Research Associateship Award** – *Research Associateship Programs* July. 2020 ~ Present
  The National Research Council of the National Academies, USA
  'Developments of virtual underwater acoustic environments and test and evaluation platforms for autonomous robotic systems' at Naval Postgraduate School in Monterey, California, USA

RESEARCH EXPERIENCES (PM; PROJECT MANAGER)

- **Researcher (PM)** – *Developments of kinematics/dynamics motion control model for hybrid-driven underwater gliders* (Funded by NRC, NPS, WHOI) July. 2020 ~ Present
  - ✓ Development of kinematics/dynamics motion simulation and control systems for hybrid-driven underwater gliders in ROS-Gazebo platform (https://github.com/Field-Robotics-Lab/glider_hybrid_whoi).
- **Researcher (PM)** – *Developments of virtual underwater acoustic environments and test and evaluation platforms for autonomous robotic systems* (Funded by NRC and NPS) July. 2020 ~ Present
  - ✓ Development of multi-beam sonar for underwater applications using GPU accelerations to support real-time simulation of autonomous vehicles. Kinematics/dynamics plugins for underwater vehicles in ROS-Gazebo platform. (https://github.com/Field-Robotics-Lab/DAVE)
- **Researcher (PM)** – *Development of vibrational response prediction methods for underwater structures excited by wake considering fluid-structure interactions* Mar. 2019 ~ June. 2020
  (Funded by Hyundai Heavy Industries)
  - ✓ Development of prediction methods for vibrational response of self-excited lifting bodies with hybrid coupling FSI analysis to simulate frequency lock-in and effect of trailing edge designs to its characteristics.
- **Researcher (PM)** – *Future Submarine Low Noise Propeller Specialized Laboratory* Oct. 2018 ~ June. 2020
  (With Korea Research Institute of Ships & Ocean Engineering funded by Agency for Defense Development)
  - ✓ Broadband noise predictions of marine propellers induced by turbulent boundary layer using wall pressure spectrum models with available RANS CFD results.
- **Researcher (PM)** – *Research on engineering requirements of next generation advanced navy ships and acquisition considerations for core equipment* April. 2018 ~ Dec. 2018
  (With Daewoo Shipbuilding and Marine Engineering funded by Republic of Korea Navy)
  - ✓ Conceptual design calculation methods development and literature research for future advanced navy ship equipment requirements including acquisition consideration and planning.
- **Researcher (PM)** – *Research on technical counterplans for future propulsion systems* Aug. 2017 ~ Dec. 2017
  (Funded by Republic of Korea Navy)
  - ✓ Conceptual design calculation methods development and literature research for future propulsion systems including pump-jet propulsions and noise attenuations at sea.
- **Researcher** – *Development of performance assessment methods for perforated noise absorption structures in high flow environments* (Funded by Hyundai Electronics) Aug. 2017 ~ Dec. 2017
  - ✓ Estimation of noise produced by perforated structures in flow environments
- **Researcher (PM, Representative)** – *Advanced Naval Vessels Research Laboratory* June. 2013 ~ Dec. 2017
  (Funded by Agency for Defense Development and Daewoo Shipbuilding and Marine Engineering)

- ✓ Turbulence-induced noise analysis of ship appendages using acoustic analogy and turbulent boundary layer excited vibro-acoustic response analysis for ship hull designs using empirical wall pressure spectrum models and Energy flow analysis methods.

- **Researcher** – *Underwater self-noise analysis modeling and measurements* June. 2014 ~ June. 2015
  (Funded by Agency for Defense Development)
  - ✓ Calculation of flow-induced noise generated at the head of torpedoes

PUBLICATIONS

1. B. Bingham, C. Aguero, M. McCarrin, J. Klamo, J Malia, **W.-S. Choi**, K. Allen, T. Lum, M. Rawson, and R. Waqar, "Mobile Robot simulation for Unmanned Surface Vehicles in Ocean Environments", *Frontiers, in preparation*
2. B. Bingham, J. Klamo, K. Young, and **W.-S. Choi**, "On the Effects that Wave-Induced Loads have on the Development of Autonomy for an Unmanned Underwater Vehicle", *IEEE Journal of Oceanic Engineering, in preparation*
3. **W. –S. Choi**, B. Bingham, R. Camilli, "Faster-than-real-time Hybrid Automotive Underwater Glider Simulation for Ocean Mapping", *Journal of the Korean Society of Maritime Environment & Safety, under review*
4. **W.-S. Choi**, S.-J. Yeo, S.-Y. Hong, J.-H. Song, H.-S. Seol, "Estimation of marine propeller broadband noise from steady-state CFD solutions for early design stage", *Ocean Engineering, under review*
5. **W.-S. Choi**, O. Derek, D. Davis, M. Zhang, A. Racson, B. Bingham, M. McCarrin, C. Vogt, and J. Herman. "Physics-based modelling and simulation of Multibeam Echosounder perception for Autonomous Underwater Manipulation", *Frontiers Robotics and AI*, **8**, 279-290, (2021). **ESCI**
6. **W. –S. Choi**, W.-S. Jang, B.-J. Joe, S. -Y. Hong, J.-H. Song, H.-W. Kwon, J.-H, "Methods for assessing the ship rudder stability under lock-in phenomena considering fluid-structure interactions", *Proc. Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment,* **236**, 1, 113-124, (2021). **SCI**
7. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, J.-H Choi, S.-G. Lee, I.-R. Park, H.-S. Seol, and M.-J. Kim, "Time domain broadband noise predictions for non-cavitating marine propellers with wall pressure spectrum models", *International Journal of Naval Architecture and Ocean Engineering*, **13**, 75-85, (2021). **SCI**
8. W. -S. Jang, S. -Y. Hong, H.-W. Kwon, J.-H. Song, and **W.-S. Choi**, "Study on Vortex-Induced Vibration Predictions for Ship Rudders", *Journal of Ocean Engineering and Technology*, **34**, 5, 325-333, (2020). KCI, In Korean
9. **W. –S. Choi**, S. -Y. Hong, H.-W. Kwon, J.-W. Seo, S.-H. Rhee, and J.-H. Song, "Estimation of turbulent boundary layer induced noise using energy flow analysis for ship hull designs", *Proc. Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, **234**, 1, 196-208, (2020). **SCI**
10. **W. –S. Choi**, S. -J. Jeong, S.-Y. Hong, J.-H. Song, H.-W. Kwon, and M.-J. Kim, "Predictions of Broadband Noise for non-cavitation hydrofoils using wall pressure spectrum models", *Journal of the Korean Society of Maritime Environment & Safety*, **25**, 6, 765-771, (2019). KCI, In Korean.
11. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, J.-W. Seo, and S.-H. Rhee, "Analysis of hull-induced flow noise characteristics for wave-piercing hull forms", *Journal of the Korean Society of Maritime Environment & Safety*, **24**, 5, 619-627, (2018). KCI, In Korean
12. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Prediction of turbulent boundary layer noise on plate using energy flow analysis", *Transactions of the Korean Society for Noise and Vibration Engineering*, **27**, 5, 608-615, (2017). KCI, In Korean
13. Y.-S. Choi, **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, H.-S. Seol, and C.-M. Jung, "Development of formulation Q1As method for quadrupole noise prediction around a submerged cylinder", *International Journal of Naval Architecture and Ocean Engineering*, **9**, 5, 484-491, (2017). **SCI**
14. **W. –S. Choi**, Y.-S. Choi, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and H.-S. Seol, "Experimental investigation of noise generated by submerged circular cylinder", *Noise Control Engineering Journal*, **65**, 4, 288-294, (2017). **SCI**
15. **W. –S. Choi**, Y.-S. Choi, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Turbulent-induced noise of a

submerged cylinder using a permeable FW-H method", *International Journal of Naval Architecture and Ocean Engineering*, **8**, 3, 235-242, (2016). **SCI**

16. J.-Y. Kim, **W. –S. Choi**, S. -Y. Hong, H.-G. Chung, J.-H. Song, W.-S. Im, and H.-W. Kwon, "A Study on Efficient Test & Evaluation Methods in Naval Ship Acquisitions", *Journal of the Korea Institute of Military Science and Technology*, **19**, 6, 703-711, (2016). KCI, In Korean
17. Y.-S. Choi, S. -Y. Hong, J.-H. Song, H.-W. Kwon, **W. –S. Choi**, and C.-M. Jung, "Turbulent-induced noise of 2-dimensional sonar dome shaped structure", *Transactions of the Korean Society for Noise and Vibration Engineering*, **26**, 1, 39-48, (2016). KCI, In Korean
18. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Turbulent-induced noise around a circular cylinder using permeable FW-H methods", *Journal of the Korean Society of Marine Environment & Safety*, **20**, 6, 752-759, (2014). KCI, In Korean

INTERNATIONAL CONFERENCES (FIRST AUTHOR LIST ONLY)

1. **W. -S. Choi**, B. Bingham, G. Burgess, P. Ventola, R. Camilli, M. Jakuba, "An Open-Source Faster-than-real-time, Interactive Autonomous Underwater Glider Simulator", OSM2022, Hawaii, USA, (2022) – oral.
2. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, and H.-W. Kwon, "Turbulent boundary layer noise analysis using energy flow analysis", NOVEM2018, Ibiza, Spain, (2018) – oral.
3. **W. –S. Choi**, S. -Y. Hong, T.-G. Kim, Y. Choi, J.-H. Song, and H.-W Kwon, "Turbulent-induced noise of underwater submerged bodies for hydrodynamic design", IMDC2015, Tokyo, Japan, (2015) – oral.
4. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Turbulent-induced noise around a circular cylinder using permeable FW-H methods", NAA2015, Shanghai, China, (2015) – oral.

DOMESTIC CONFERENCES (FIRST AUTHOR LIST ONLY)

1. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, J.-H Choi, S.-G. Lee, I.-R. Park, H.-S. Seol, and M.-J. Kim, "Predictions of non-cavitation broadband noise for underwater propellers", KSNVE2019, Jeju, Korea (2019) – oral.
2. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, M.-J. Kim, and K.-C. Lee, "Numerical study on non-cavitation broadband noise for hydrofoil", KIMST2018, Daejeon, Korea (2018) – oral.
3. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Turbulent-induced noise prediction methods for high-speed future naval ships", KIMST2017, Daejeon, Korea (2017) – oral.
4. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "A study on characteristics of turbulent boundary layer noise using fluid-structure interaction analysis", KSNVE2017, Kwangju, Korea (2017) – oral.
5. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and C.-M. Jung, "Characteristics of turbulent-induced noise for naval ship appendages", KSOE2014, Busan, Korea (2014) – oral.
6. **W. –S. Choi**, S. -Y. Hong, J.-H. Song, H.-W. Kwon, and Y.-L. Jung, "Turbulent-induced noise for underwater submerged bodies", KSOE2014, Busan, Korea (2014) – oral.

INVITED TALKS

1. ROS Gazebo Community Meeting, "Physics-based GPU Parallelized Multibeam Forward Looking Sonar in Gazebo Classic", 2022.3.31. – Online, oral.
2. ROS Maritime Robotics Working Group Meeting #2, "Open-Source Physics-based GPU Parallelized Multibeam Forward Looking Sonar in Gazebo Classic", 2022.4.6. – Online, oral.
3. Center for Coastal and Ocean Mapping, Universy of New Hampshire, "Open-Source Physics-based GPU Parallelized Multibeam Forward Looking Sonar in Gazebo Classic", 2022.4.7. – Online, oral.

MAJOR COURSES

- Engineering Acoustics
- Ship Noise and Vibration Measurements and Analysis
- Fundamentals of Underwater Acoustics
- Noise Control Engineering

- Turbulent Flows
- Advanced Computational Fluid Dynamics (Discretization of Compressible Euler and Navier-Stokes Eqn.)
- Advanced Computational Fluid Dynamics (Basic Elements and Scalar Conservation Laws)
- Numerical Analysis in Mechanical Engineering
- Computational Fluid Dynamics for Turbulent Ship Flows

PROFESSIONAL REFERENCES (PLEASE INFORM ME PRIOR TO CONTACT)

- Brian Bingham, Naval Postgraduate School, USA, Professor, *bbingham@nps.edu* (Current PI)
- Suk-Yoon Hong, Seoul National University, KOREA, Professor, *syh@snu.ac.kr* (Ph.D Advisor)
- Shin-Hyung Rhee, Seoul National University, KOREA, Professor, *syr@snu.ac.kr* (Ph.D Co-advisor)
- Jee-Hun Song, Chonnam National University, KOREA, Professor, *jhs@jnu.ac.kr* (Ph.D Co-advisor)
- Hyun-Wung, Kwon, Koje Colleage, KOREA, Professor, *khw1@snu.ac.jp* (Ph.D Co-advisor)
- Takashi Maekawa, Waseda University, JAPAN, Professor, *maekawa@ynu.ac.jp* (Bechelor's advisor)