



**COLLEGE OF ENGINEERING  
AND COMPUTER SCIENCE**  
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

## **Casey Den Ouden**

for the degree of Doctor of Philosophy (Ph.D.)

### **“Novel Kirigami-Inspired Flexible Robotic Extension for Mobile Platforms”**

**October 23, 2023, 3:00 p.m.  
Engineering West, Room #187  
777 Glades Road  
Boca Raton, FL**

**DEPARTMENT:**

Ocean and Mechanical Engineering

**CO-ADVISORS:**

Tsung-Chow Su, Eng.Sc. D.

Bing Ouyang, Ph.D.

**PH.D. SUPERVISORY COMMITTEE:**

Tsung-Chow Su, Eng.Sc. D., Co-Chair

Bing Ouyang, Ph.D., Co-Chair

Paul Wills, Ph.D.

Cuiling Gong, Ph.D.

**ABSTRACT OF DISSERTATION**

**Novel Kirigami-Inspired Flexible Robotic Extension for Mobile Platforms**

Since 2010, aquaculture practices have produced 70% of global seafood consumption. However, this fast-growing sector of agriculture has yet to see the adoption of advanced technologies to improve farm operations. The Hybrid Aerial Underwater robotiCs System (HAUCS) is an IoT framework that aims to bring transformative changes to pond aquaculture. This project focuses on the latest developments in the HAUCS mobile sensing platform and field deployment. A novel rigid Kirigami-based robotic extension subsystem was created to expand the functionality of the HAUCS platform. The primary objective of this design was to limit the surface area of the extender arm on the drone during the flight and minimize the in-flight drag. By utilizing a novel combination of shape memory polymer (SMP) and nitinol to extend and retrieve the sensing arm, the structure was able to conserve energy while operating under varying environmental conditions. The Kirigami fold patterns can be altered to satisfy other project constraints, primarily those posed by surface area and flight drag. By alternating the extender’s end effectors, we can expand the capabilities of the platform to include additional sample collection and imaging above and below the air-sea interface. The platform also has the potential to act as an intermediary link between a command vessel and an AUV to extend operations.

**BIOGRAPHICAL SKETCH**

Born in Asheville, NC

B.S., Bemidji State University, Bemidji, MN, 2019

M.S., Florida Atlantic University, Boca Raton, FL, 2022

Ph.D., Florida Atlantic University, Boca Raton, Florida, 2023

**CONCERNING PERIOD OF PREPARATION  
& QUALIFYING EXAMINATION**

**Time in Preparation: 2021 - 2023**

**Qualifying Examination Passed: Spring 2021**

**Published Papers:**

**Den Ouden, C.**, Wills, P. S., Lopes, L., Sanderson, J., Ouyang, B., "Evolution of the Hybrid Aerial Underwater Robotic System (HAUCS) for Aquaculture: Sensor Payload and Extension Development," MDPI Vehicles, (accepted: April 15, 2022)

**Den Ouden, C.**, Estrada, D., Dalgleish, F. R., and Ouyang, B., "Evaluation of a technique to simulate LiDAR image datasets for training a machine learning-based image enhancement algorithm," Proc. SPIE 11730, April 2021.

Estrada, D., Dalgleish, F. R., **Den Ouden, C.**, and Ouyang, B., "Multi-Frame GAN-based Machine Learning Image Restoration for Degraded Visual Environments," Proc. SPIE 11730, April 2021.

Schaff, C. A., Li, Y., Ouyang, B., **Den Ouden, C.**, Zhou, T., and Ahmed, F., "Development of a lowcost subsea datalogger for passive phased sonar arrays," Proc. SPIE 11730, April 2021.

Estrada, D., Lee, S., Dalgleish, F. R., **Den Ouden, C.**, Young, M., Smith, C., Desjardins, J., and Ouyang, B., "DeblurGAN-C: Image Restoration Using GAN and a Correntropy Based Loss Function in Degraded Visual Environments," Proc. SPIE 11395, April 2020.

Ouyang, B., Wills, P. S., Li, Y., and **Den Ouden, C.**, "Hybrid Aerial Underwater Robotic System (HAUCS): the Initial Instruments Development and Deployment" 2020 IEEE 92nd Vehicular Technology Conference (VTC2020-Fall), 2020, pp. 1-6.