A. Cover Sheet

Project Title: The Fight Against Blue Catfish Invasion: Tell a Story Through Immersive Educational Games

Principal Investigator(s) (PI & Co-PI):

PI: Lizhou Cao, University of Maryland Eastern Shore (UMES) / Department of Computer Science and Engineering Technology

CO-PI: Cathy Liu, University of Maryland Extension (UME) / MD Sea Grant

Amount Requested: $17,028

Project Start & End Dates: 10/01/2025 - 09/31/2026

Contact Details:

Dr. Lizhou Cao - Email: lcao@umes.edu, Phone: 410-651-7270, Address: 30925 College Backbone Rd, Princess Anne, MD 21853

Dr. Cathy Liu - Email: cathyliu@umd.edu, Phone: 410-651-6636, Address: 30890 College Backbone Rd, Princess Anne, MD 21853

UNIVERSITY OF MARYLAND EASTERN SHORE

APPENDIX A

OFFICE OF RESEARCH

ROUTING AND APPROVAL FORM FOR APPLICATION/PROPOSAL

Have you completed and forwarded the Conflict of Interest Disclosure? ☑ Yes ☐ No

1. Title of Proposal: The Fight Against Blue Catfish Invasion: Tell a Story Through Immersive Educational Games

2. From: (Dept./Office): Computer Science and Engineering Technology

3. To (Sponsor/Funding Agency): Mid-Atlantic Panel on Aquatic Invasive Species

4. Principal Investigator(s): Lizhou Cao

   Email Address: lcao@umes.edu

   Phone: 410-651-7270

5. Total Years: From 10/01/2025 To 09/31/2026

Sponsored Support:

Total Direct Cost: $ 15480

Indirect Cost: $ 1548

Rate: 10 % (**If not** using the UMES Indirect cost rate of 60% please explain why and list what page on the proposal this is referenced Small Grant).

Total Cost: $ 17028

UMES Cost Sharing/Matching $_____

Matching Account # (If applicable, must be a state account number) _____

_____

Required Signatures:

_____ Administrative Affairs signature (required for match)

_____ (Chair or Dean Signature, if applicable)

Lizhou Cao PI Signature. Note: If application is awarded, the PI will work with the designated grant accountant and Administrative Affairs to ensure the matching funds are properly used and recorded.

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6. **Complete this section *ONLY* if applicable**

Release Time or Percent Effort for PI: By signing, **the PI affirms** that they have consulted with department chairs in all departments where Release time or Percent effort of faculty is included.

Please indicate which applies: ☐ Release Time ☐ Percent Effort

Percentage/Hours Per Week: _____

Principal Investigator Signature: _____

Department Chair Signature: _____

Release Time or Percent Effort for Co-PI: (If applicable)

Please indicate which applies: ☐ Release Time ☐ Percent Effort

Percentage/Hours Per Week: _____

Co-Principal Investigator Signature: _____

Department Chair Signature: _____

7. **SUBMISSION INSTRUCTIONS**:

Due Date: _____

Submission Portal: How will this need to be submitted: (example- Grants.gov, NSF Fastlane, EZFed Grants, email submission, ERA Commons etc.)

_____

Have you created an account for the designated submission website? ☐ Yes ☐ No

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8. Please indicate if you will be:

☑ Prime Awardee/Principal Investigator or

☐ Subawardee of another institution and the other institution will submit the grant

☐ Subawardee of another institution and UMES will submit the grant

The University cannot guarantee that it will be able to meet the sponsor's deadline for any proposal submitted to the Grants and Contracts Office later than ***10 business days prior to such deadline*. (Review #10 for IRB/IACUC/Biosafety approvals).** **Should you require assistance with grant development, please allow more time for review.**

9. Types of Project (check as appropriate):

☑ Research	☑ New	☑ Grant
☐ Demonstration/Training	☐ Renewal	☐ Contract
☐ Institutional Development	☐ Supplemental	☐ Formula
☐ Other _____	☐ Sub-Agreement	☐ Cooperative Agreement

10. Protection Assurances, This Project: (select as applicable)

If your proposal requires any of these approvals, you must submit your proposal to the Office of Research at least 10 days prior to grant submission to allow UMES committee review.

☐ Does ☑ Does not involve human subjects, laboratory animals, biohazards*

Proposal pages Ref._____

If it does, please attach IRB/IACUC/Biosafety approval.

e.g., Hazardous chemicals, pathogenic organisms, disease plants or animals, energy orradiation sources and materials such as microwave, laser, isotopes, recombinant DNA.* **(Consult Office of Research for assistance).

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11. Institutional Agreements:

A.	Patent/Copyright Issues	☐	Yes	☑	No	☐	N/A
B.	Cost Sharing or Matching	☐	Yes	☑	No	☐	N/A
C.	Campus Facility/Space Needs	☐	Yes	☑	No	☐	N/A
D.	Off-Campus Arrangements	☐	Yes	☑	No	☐	N/A

12. Will these grant funds be used to run a UMES Summer Camp?

☐ Yes ☑ No

If "Yes", on what page of the proposal is this mentioned? ____

If "Yes", approval from the Office of the Provost/Academic Affairs is required below.

Signature: _____
Provost/VP Academic Affairs

13. Organizational Relationships: This Project (select as applicable):

☑ Does ☐ Does not involve other campuses, state or private organizations

No If awarded, this grant will require UMES to issue subawards

_____ If so, how many?

Total Amount allotted for all subawards to be issued. (For UMES to issue subawards from this award)

$ _____

Proposal Pages Ref. _____

IF YES, letter(s) of interest or support **must** be attached to proposal.

14. Are funds for this project requested for computer labs or infrastructure that requires UMES IT Department support, installation or procurement? If so, please list what page they are referenced on.
No

Signature of Chief Information Officer: _____

15. Will student workers be employed from this application (if awarded)? ☑ Yes ☐ No

UNIVERSITY OF MARYLAND EASTERN SHORE

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ROUTING AND APPROVAL FORM FOR APPLICATION/PROPOSAL

Administrative Approval: Please sign on the appropriate line and forward to the next approval authority.

By signing below, all parties certify that the contents of the proposal represent the work of the Principal Investigator and, if warranted, any and all collaborators.

Principal Investigator: Lizhou Cao Date: 02/24/2025

Department Chair: Asad Azemi Date: 02 / 25 / 2025

School Dean: Derrek B. Dunn Date: 02 / 25 / 2025

Director of Research: Joseph Pitula Date: 02 / 27 / 2025

Dean of Graduate Studies and Research: Date: 02 / 27 / 2025

Provost/VP Academic Affairs: Date: 02 / 28 / 2025

CC: jlshockley1@umes.edu (Josh Shockley)
jeguerrerodelacruz@umes.edu (Julia Guerrero De La Cruz)

B. Project Summary

Title: The Fight Against Blue Catfish Invasion: Tell A Story Through Immersive Educational Games

PI: Lizhou Cao, University of Maryland Eastern Shore (UMES) / Department of Computer Science and Engineering Technology

CO-PI: Cathy Liu, University of Maryland Extension (UME) / MD Sea Grant

Abstract:

The rapid expansion of blue catfish (*Ictalurus furcatus*) in Chesapeake Bay poses a significant ecological threat by disrupting native fish populations and local fisheries. While existing management strategies-including commercial harvesting, ecological research, and public education efforts-have made progress, continued action is needed to further mitigate their impacts. This project proposes to develop blue catfish invasion educational games using immersive technologies. The game will be designed for school students (mainly 4th-8th graders) and aims to engage them in boosting public awareness about the blue catfish invasion and understanding how everyone can play a role in fighting against the invasive fish species to help the Chesapeake Bay. The project consists of three key tasks:

- Task #1, Develop the educational content through close collaboration with experts recruited from the Invasive Catfish Workgroup to ensure scientific accuracy and alignment with conservation objectives.
- Task #2, Design and implement the game prototype using virtual reality and web-based technologies, allowing students to explore the Chesapeake Bay ecosystem, experience the impact of blue catfish, and engage in problem-solving scenarios.
- Task #3, Introduce the newly developed games into schools and community outreach programs through UMES extension, UME 4-H Youth Development programs, Caroline County Public Schools, and Virginia Seafood Agricultural Research and Extension Center at Virginia Tech. Evaluate the game's effectiveness through educator feedback.

This initiative directly supports MAPAIS's mission to promote sustainable fisheries and environmental stewardship. By combining immersive technology with conservation education, the project provides a scalable and interactive learning tool that can serve as a model for other invasive species and future environmental education efforts in the Chesapeake Bay region and beyond.

C. Project Narrative

1. Project Description

Background and Rationale: Blue catfish (*Ictalurus furcatus*) is an invasive species that disrupts the Chesapeake Bay ecosystem, outcompeting native species and threatening biodiversity [1, 2]. Several initiatives have been undertaken to manage blue catfish populations, including commercial fishing efforts, public education campaigns promoting blue catfish as a seafood option, and policy interventions encouraging increased harvest. The MD DNR has launched programs advocating for commercial fisheries to target blue catfish as a sustainable food source, with some success in local markets [3]. Additionally, the U.S. Geological Survey has developed ecological models to predict the spread and impact of blue catfish in estuarine systems [4].

Educating the next generation about invasive species management and conservation is essential for protecting the Chesapeake Bay. Traditional environmental education programs, such as those offered by the Chesapeake Bay Foundation (CBF) and the National Aquarium, provide workshops, informational campaigns, and field trips that engage students in conservation efforts [5,6]. The CBF offers outdoor education experiences and professional development for teachers, while the National Aquarium provides programs designed to foster a connection to aquatic ecosystems. Additionally, educational videos produced by the MD DNR and Chesapeake Bay Program serve as valuable tools for raising public awareness [7].

While these approaches provide important knowledge, they primarily rely on passive learning methods, such as lectures and videos, which limit hands-on engagement. Meanwhile, field trips and workshops are often one-time experiences that may not be accessible to all students. Without interactive problem-solving opportunities, younger audiences may struggle to fully grasp complex ecological issues [8]. To address these limitations, a more engaging and scalable approach is needed to enhance student participation and extend learning beyond structured programs.

Goal and Objective: To address these limitations, we propose the development of an educational game that uses immersive entertainment technologies to teach 4th-8th grade students about invasive species management and conservation. The game will incorporate virtual reality (VR) to create an interactive learning experience, allowing students to explore the impact of invasive species in a simulated environment. Game-based learning with VR enhances engagement by providing hands-on exploration and problem-solving opportunities, making conservation education more accessible, engaging, and practical [9,10]. Beyond game development, this project includes active outreach efforts to integrate the game into classrooms and community programs. Through partnerships with experts across various disciplines, the game will be introduced at schools and community outreach programs. These outreach efforts will allow students to directly engage with conservation learning beyond the classroom.

Scope of Work: This project will be developed through a collaborative effort involving experts and educators from UMES, UME, NOAA Chesapeake Bay Office Invasive Catfish Workgroup, Maryland DNR, Caroline County Public Schools, Virginia Seafood Agricultural Research and Extension Center at Virginia Tech (Virginia Seafood AREC) , and other local organizations. The project consists of three key tasks:

Task #1: Establish a project advisory committee and develop educational content. An external advisory committee (EAC) will be established to provide guidance and feedback on the project's educational content. We plan to attend the pre-scheduled Invasive Catfish Workgroup (ICW) Meeting in October to connect with multiple disciplinary experts, introduce our project, and invite them to join the advisory committee. Our team will meet with the EAC members regularly to refine the educational content and storytelling elements. To ensure scientific accuracy, we will collect data from Maryland DNR reports, NOAA databases, and scientific studies on blue catfish population trends, ecological impact, and management strategies. Additionally, field visits to a fisheries research station and a local fish market will provide firsthand insights into conservation efforts and commercial fishing practices.

Task #2: Immersive educational game development and testing. The next step is to transform educational content into an interactive experience. The game design with two central characters, as shown in Figure 1.

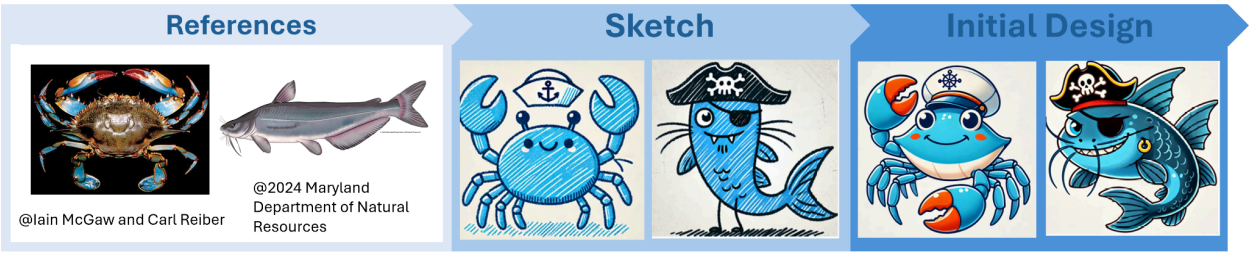

Figure 1. Character design process from references to sketches to initial designs.

As shown in Table 1, each game phase introduces new challenges and gameplay mechanics, reinforcing key conservation concepts in an interactive way. The game will be developed in Unity (C#) and designed for multiple platforms to maximize accessibility and engagement. The game will use VR to create an immersive learning experience, allowing students to explore the Chesapeake Bay ecosystem, interact with different species, and engage in activities on invasive species management. A browser-based version will extend learning beyond the classroom, enabling students to reinforce concepts at home. It will also encourage family engagement, fostering discussions on environmental conservation.

Table 1. Game design phases of the proposed immersive educational game.

Phase	**Gameplay Description**
Phase 1: Explore the Bay	Players navigate the Chesapeake Bay, meet native species, and learn about food webs.
Phase 2: Blue Catfish Invasion	Players experience how blue catfish spread and impact biodiversity. The ecosystem visibly degrades over time.
Phase 3: Conservation Action	Players switch roles to help manage the invasion through fishing mini-game while protecting native species.
Phase 4: Restoring Balance	Players see the Bay recover as conservation efforts succeed.

After developing the prototype, we will conduct internal game-play testing with the advisory committee. Dr. Joseph Love and his team at Maryland DNR who are aquatic biology experts on invasive fish species have agreed to help with brainstorming ideas, answering questions regarding the blue catfish, and verifying fishery information. Their feedback will be used to refine the prototype and ensure that it effectively conveys educational content.

Task #3: Outreach to schools and communities. The game will be integrated into schools and community outreach programs, including partnerships with UMES Extension, UME 4-H Youth Development programs, Caroline County Public Schools, Virginia Seafood AREC, and other community partners. Refer to Section 3: Outreach Plan for more details. We will assess the game's effectiveness by analyzing student engagement metrics and educator feedback. The insights gained will be used to refine the prototype, contribute to academic publications, and inform future expansion opportunities.

2. Benefits or Results Expected

This project will result in the development of a functional educational game prototype that utilizes VR and web-based technologies to engage students in invasive species management and ecosystem conservation. Through interactive storytelling and problem-solving, the game will enhance student engagement, comprehension of ecological balance, and understanding of conservation strategies beyond traditional classroom instruction.

The project will also generate data on student learning and engagement, including in-game analytics and educator feedback, to assess its effectiveness and guide refinements. By raising awareness of the blue catfish invasion and its impact on native fisheries, the game will encourage discussions on harvesting and consumption as a sustainable management strategy. The insights gained will support scaling the project into broader conservation education efforts, addressing topics such as climate change, watershed management, and sustainable seafood practices.

More details on the project's deliverables are provided in Section F.

3. Outreach Plan

This project will be implemented in collaboration with UMES Extension and UME 4-H Youth Development Programs, Caroline County Public Schools, Virginia Seafood AREC (Virginia Tech), and other community partners to integrate the educational game into school curricula, STEM programs, and public outreach events. The outreach plan consists of two components in the format of workshops and installations:

School Integration: We will partner with Caroline County Public Schools, with the support of Ms. Beth Brewster, Supervisor of Food Services, to incorporate the game into science and environmental studies curricula. This integration will provide students with hands-on learning opportunities aligned with classroom instruction on invasive species and ecosystem management. Ms. Brewster has committed to assisting with game introduction and student engagement activities to enhance the learning experience. (Support letters from Ms. Brewster: [Link to Support Letter])

Community Outreach: We plan to showcase the game at the 4-H STEM Festival and Homecoming Week at UMES. Through partnerships with Caroline County

Public Schools, the game will be demoed in Maryland Home Grown Week, the Marshy Hope Blue Catfish Tournament, the Shore River Keepers Invasive Workshop for Youth, and the Annapolis Boat Show. With the support of Dr. Yiming Feng, Assistant Professor & Extension Specialist at Virginia Seafood AREC, Virginia Tech, we will expand outreach through university and STEM-focused events at Virginia Tech. Dr. Feng will introduce the game to school students, recruit volunteers for testing, and collect feedback. We will present the game at STEM Day and Open House at Virginia Tech. (Support letters from Dr. Feng: [Link to Support Letter])

4. Project Timeline

Activities	**Year 1**					
	B1	**B2**	**B3**	**B4**	**B5**	**B6**
Task 1: Establish a project advisory committee and develop educational content. **Deliverables**: 2 pages fact sheet on educational content (March 2026).	x	x 	 x			
Task 2: Immersive educational game development and testing. **Deliverables**: VR and web-based game prototypes, project repository with code and assets (June & July 2026).	x	x	x	x	x x	
Task 3: Outreach to schools and communities. **Deliverables**: flyers and posters, project website (March-September 2026).			x x	x x	x x	x x
Project Final Report and Post-Award Plan (September 2026).						x

After the one-year project period, we plan to conduct a post-award phase to evaluate collected data and user feedback, assessing the game's educational impact and engagement. Findings will be shared through conference presentations and research publications. Insights from this analysis will guide improvements and inform the development of similar interactive experiences for addressing other invasive species. Additionally, we will explore opportunities to expand the project's educational framework for broader environmental education efforts.

5. Previous MAPAIS funding

We have never received MAPAIS funding before.

References: Due to page limitations, please refer to the References for this proposal at the following link if needed: [Link to Reference]

D. Budget Table

Category	Estimated Cost ($)
Travels (Content Development and Storytelling, Outreach with Public Schools and Community)	1,960
Salary (Graduate Student Interns for Game Development)	10,800
Fringe Benefit Cost	864
Materials and Supplies	1,856
Indirect Cost	1,548
Total	17,028

E. Budget Justification

Travels ($1,960):
This budget supports outreach efforts for the PI, Co-PI, and graduate students with educators and community partners to facilitate the integration of the game into school curricula and community programs. Additionally, it covers travel to consult with aquatic biology experts and local stakeholders, ensuring the scientific accuracy of the educational content. Planned travel includes:
Visit to Virginia Seafood Agriculture Research and Education Center, Hampton, VA (2 trips):

- Estimated Average Round trip: 300 miles
- Mileage reimbursement: $0.70 per mile
- Total cost: 300 × 0.70 × 2 = $420

Visits to Caroline County Public Schools (4 trips):

- Estimated Average Round trip: 500 miles
- Mileage reimbursement: $0.70 per mile
- Total cost: 500 × 0.70 × 4 = $1,400

Visit the Bay and talk with aquatic biology experts and local stakeholders:

- Estimated Average Round trip: 200 miles
- Mileage reimbursement: $0.70 per mile
- Total cost: 200 × 0.70 = $140

Total cost: 420 + 1400 + 140 = $1,960

Salary ($10,800):
Support for 1-2 graduate student interns recruited from UMES to develop the game, including programming, character design, and environmental assets. Hourly salary for 36 weeks (9 months), 20 hours per week at $15 per hour. The total cost is 36 × 20 × 15 = $10,800

Fringe Benefit Cost ($864)
The Fringe Benefit Cost for Graduate students at UMES is 8%. The total cost is 10,800 × 0.08 = $864

Materials and Supplies ($1,856)
This budget covers the purchase of essential materials to support both game development and outreach efforts:
Equipment for Game Development and Outreach($1,356):

- Supports the purchase of four Oculus Quest 3 ($299 each) and four Xbox controllers ($40 each) development, testing, and outreach at public schools and community events. Costs are based on institutional purchasing agreements and exclude sales tax due to the university's tax-exempt status. The total cost is 4 × 299 + 4 × 40 = $1,356

Art Assets for Game Development ($300):

- Funds will be used to purchase high-quality art assets to enhance the visual design of the game environment, ensuring an engaging and immersive experience for players.

Outreach Program Supplies ($200):

- Supports outreach activities at community events and schools to encourage student participation.
- Includes game rewards for children who play the game, such as stickers, small prizes, or certificates to reinforce learning and engagement.
- Covers printing and promotional materials (e.g., educational flyers, posters, and handouts) to raise awareness about invasive species and conservation efforts.

Total Cost: 1,356 + 300 + 200 = $1,856

Indirect Cost ($1,548)
10% Indirect Cost at UMES, with the base $15,480, the total cost is 15,480 × 0.1 = $1,548

Total Cost ($17,028)
The total cost is Travels ($1,960) + Salary ($10,800) + Fringe Benefit Cost ($864) + Materials and Supplies ($1,856) + Indirect Cost ($1,548) = $17,028

F. Deliverables

This project will produce key deliverables at each stage, ensuring structured progress and impact.

- **Two-Page Fact Sheet on Educational Concepts (March 2026)**
  A document summarizing key learning objectives, conservation principles, and gameplay integration strategies, developed with input from the advisory committee, scientific data from Maryland DNR and NOAA, and field visits.
- **VR and Web-Based Game Prototypes (June & July 2026)**
  Playable prototypes incorporating interactive educational content, allowing players to engage with real-world conservation challenges.
- **Project Repository with Code and Assets (June & July 2026)**
  A maintained repository containing source code, game assets, and documentation to support future development and expansion.
- **Flyers and Posters for Outreach (March-September 2026)**
  Promotional and educational materials designed to introduce the game and its environmental goals to schools and the community.
- **Project Website with Web-Based Game (July 2026)**
  A dedicated platform featuring information on blue catfish conservation, downloadable resources, and direct access to the web-based game.
- **Final Project Report and Post Award Plan (September 2026)**
  A comprehensive report documenting project development, testing outcomes, outreach impact, and evaluation findings. Analysis of player engagement and feedback to inform future improvements. Findings will be shared through conference presentations and research publication. Additionally, we will explore opportunities to extend the project's impact to broader conservation topics and seek additional funding to expand the game's reach and integrate new educational initiatives.

Lizhou Cao

Assistant Professor · Department of Computer Science & Engineering Technology

University of Maryland Eastern Shore, Princess Anne, MD, 21853

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Education

Rochester Institute of Technology — *Rochester, New York, USA*

Ph.D. in Computing and Information Sciences — *May 2024*

- Dissertation: Hierarchical Spherical Parameterization and Feature Alignment for Morphologically Varied Character Generation
- School of Interactive Games and Media

The University of Alabama in Huntsville — *Huntsville, Alabama, USA*

M.S in Computer Science — *May 2019*

Beijing Institute of Technology — *Beijing, China*

M.E in Software Engineering — *June, 2015*

Beijing Institute of Technology — *Beijing, China*

B.E in Software Engineering (Digital Media) — *June, 2013*

Professional Experience

2024-present	**Assistant Professor**, Department of Computer Science & Engineering Technology, University of Maryland Eastern Shore
2022-2024	**Adjunct Instructor**, School of Interactive Games and Media, Rochester Institute of Technology
2019-2022	**Graduate Research Assistant**, Golisano College of Computing and Information Sciences, Rochester Institute of Technology
Summer 2022	**Game/Media Developer (Research CO-OP)**, MAGIC Spell Studios, Rochester Institute of Technology
2016-2019	**Graduate Research Assistant**, Computer Science Department, The University of Alabama in Huntsville
2014-2015	**Adjunct Instructor**, Beijing Film Academy
2013-2015	**Graduate Research Assistant**, Beijing Institute of Technology

Publications

Selected Peer-Reviewed Journal Articles

[J8] **Lizhou Cao** and Chao Peng , "Hierarchical Spherical Cross-Parameterization for Deforming Characters", Computer Graphics Forum, p. e15197. 2024. (link)

[J7] Huadong Zhang, **Lizhou Cao**, Gel Howell, David Schwartz, and Chao Peng , "An Educational Virtual Reality Game for Learning Historical Events", Virtual Reality, 1-15, Springer, 2023. (link)

[J6] **Lizhou Cao**, Huadong Zhang, Chao Peng, and Jeffery Hansberger, "Real-time Multimodal Interaction in Virtual Reality - a Case Study with a Large Virtual Interface", Multimedia Tools and Applications, Springer, 2023. (link)

[J5] Mingming Fan, Vinita Tibdewal, Qiwen Zhao, **Lizhou Cao**, Chao Peng, Runxuan Shu, and Yujia Shan, "Older Adults' Concurrent and Retrospective Think-Aloud Verbalizations for Identifying User Experience Problems of VR Games", Interacting with Computers, iwac039, Oxford University Press, January 2023. (link)

[J4] **Lizhou Cao**, Chao Peng, and Yangzi Dong, "Ellic's Exercise Class: Promoting Physical Activities During Exergaming with Immersive Virtual Reality", Virtual Reality, Vol. 25, 597-612, Springer, 2021. (link)

[J3] Vaidyanath Areyur Shanthakumar, Chao Peng, Jeffrey Hansberger, **Lizhou Cao**, Sarah Meacham, and Victoria Blakley, "Design and Evaluation of a Hand Gesture Recognition Approach for Real-Time Interactions", Multimedia Tools and Applications, Springer, Vol. 79, pp. 17707–17730, July 2020. (link)

[J2] **Lizhou Cao**, Chao Peng, and Jeffrey T. Hansberger, "Usability and Engagement Study for A Serious Virtual Reality Game of Lunar Exploration Missions", Journal of Informatics (A Special Issue: Gamification and Advanced Technology to Enhance Motivation in Education), MDPI, ISSN 22279709, Vol. 6, Issue 4, Article 44, 16 pages, October 2019. (link)

[J1] Chao Peng, **Lizhou Cao**, and Sabin Timalsena, "Gamification of Apollo Lunar Exploration Missions for Learning Engagement", Entertainment Computing, Elsevier, Vol. 19, pp. 53-64, March 2017. (link)

Selected Peer-Reviewed Conference Papers

[C7] **Lizhou Cao**, Cielo Serna, Huadong Zhang, and Chao Peng, "Ellic's Exercise Camp: Engaging Children in Physical Activity Through Virtual Reality Gaming", ACM SIGGRAPH 2024 Immersive Pavilion , July 28 - August 2, 2024. (link)

[C6] Chao Peng, **Lizhou Cao**, David Schwartz, and Huadong Zhang, "Incorporating Distributed Collaboration in a Game Programming Assignment", ACM SIGGRAPH 2024 Educator's Forum, July 28 - August 2, 2024. (link)

[C5] Huadong Zhang, **Lizhou Cao**, and Chao Peng, "Spherical Parametric Measurement for Continuous and Balanced Mesh Segmentation", High-Performance Graphics - Symposium Papers, 2023. (link)

[C4] **Lizhou Cao**, Jackson Shuminski, Huadong Zhang, Pruthviraj Solanki, David Long, David Schwartz, Ihab Mardini, Chao Peng, "Multi-User VR Experience for Creating and Trading Non-Fungible Tokens", HCI International, 2023. (link)

[C3] Chao Peng, Yangzi Dong, **Lizhou Cao**, "Real-Time Bimanual Interaction Across Virtual Workspaces", The International Conference on Human-Computer Interaction, pp. 338-356, 2022. (Best Paper Award) (link)

[C2] Huadong Zhang, **Lizhou Cao**, Gel Howell, Chao Peng, "VR Education on Historic Lunar Roving Missions", 2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW), pp. 612-613, Christchurch, New Zealand, March 12-16, 2022. (link)

[C1] **Lizhou Cao**, Chao Peng, and Jeffrey T. Hansberger, "A Large Curved Display System in Virtual Reality for Immersive Data Interaction", IEEE Games, Entertainment, Media Conference (GEM), pp. 1-4, New Haven, CT, June 18-21, 2019. (link)

Exhibitions

[E9] "Ellic's Exercise Camp: Engaging Children in Physical Activity Through Virtual Reality Gaming", ACM SIGGRAPH Immersive Pavilion, Denver, Colorado, July 28 to August 2, 2024.

[E8] "Multi-User VR Experience for Creating and Trading Non-Fungible Tokens", The 8th Annual Frameless Symposium 2023, Demo Showcase, Magic Spell Studios, Rochester, New York, November 16-17, 2023.

[E7] "Ellic's Exercise Camp", The 8th Annual Frameless Symposium 2023, Demo Showcase, Magic Spell Studios, Rochester, New York, November 16-17, 2023.

[E6] "Ellic's Exercise Camp", Rochester Game Festival, Magic Spell Studios, Rochester, September 9, 2023. (Attracted 200+ visitors)

[E5] "Ellic's Exercise Class", ImagineRIT, Rochester Institute of Technology, April 27, 2023. (Attracted 200+ visitors.)

[E4] "Ellic's Exercise Class", ImagineRIT, Field House, Rochester Institute of Technology, April 23, 2022. (Attracted 200+ visitors.)

[E3] "Lunar Exploration: Past", The Finalist Game Showcase at The Serious Games Showcase & Challenge (SGS&C), Orlando, Florida, Nov. 28-Dec 2, 2021. (Attracted 100+ visitors.)

[E2] "Ellic's Exercise Class: an Active VR Game for Fitness", The 4th Annual Frameless Symposium 2019, Abstract and Demo, Magic Spell Studios, Rochester, New York, November 21-22, 2019.

[E1] "Lunar Roving Adventure: A Serious VR Game of Lunar Exploration Missions", The 4th Annual Frameless Symposium 2019, Abstract and Demo, Magic Spell Studios, Rochester, New York, November 21-22, 2019.

Professional Services

Reviewer for Computer Animation and Virtual Worlds	*Januray 2023 - Present*
Reviewer for Springer Journal on Multimedia Tools and Interaction	*September 2022 - Present*
Reviewer for Journal of Virtual Reality	*June 2023*
Reviewer for the IEEE Virtual Reality conference	*November 2022*

Chengchu "Cathy" Liu, PhD.
Seafood Technology Specialist/Extension Professor (Tenured)
University of Maryland Sea Grant Extension Program
Phone: 410-651-6636; Email: cathyliu@umd.edu

EDUCATION

- PhD, Food Science, Ehime University, Ehime, Japan. 2000.
- MS, Food Science, Southwest Agricultural University, China. 1992.
- BS, Soil Science and Agrochemistry, Southwest Agricultural University, China. 1986.

PROFESSIONAL TRAININGS AND CERTIFICATIONS

- Certificate of Lead Instructor Training for Food Safety Preventive Control Alliance (FSPCA) Foreign Suppliers Verification Program (FSVP). Issued by the FSPCA. 2017.
  Certificate for Completion of Lead Instructor Training for FSPCA Preventive Controls for Human Food Issued by the FSPCA. 2016.
- Certificate for Seafood Hazard Analysis and Critical Control Point (HACCP) Qualified Trainer (2011 Trainer Re-Qualification) Issued by the National Seafood HACCP Alliance for Training and Education (SHA) in cooperation with the Association of Food and Drug Officials (AFDO). 2011.
- Certificate for Completion of Train-the-Trainer Workshop for Controlling *Listeria monocytogenes* on Ready-To-Eat (RTE) Meat and Poultry Products. Issued by Lake Buena Vista. 2007.

PRESENT AND PAST POSITIONS (in the USA and China)

- Seafood Technology Specialist/Extension Professor (2/2014-Present): University of Maryland College Park and Maryland Sea Grant Extension Program, Princess Anne, MD 21853, USA (2014-Present)
- Visiting Professor in Seafood Microbiology and Safety (3/2013-1/2014): US Food and Drug Administration (FDA) Gulf Coast Seafood Laboratory (Dauphin Island, AL 36528, USA) and Oregon State University Seafood Research and Education Center (Astoria, OR 97103, USA).
- Professor and Director (9/2004-2/2013): Marine Bio-resources Utilization Division, Shanghai Ocean University (SOU) Food Science College, Shanghai 201306, China
- Associate Professor and Director (3/2000-8/2004), and Lecturer (7/1992-9/1996): Food Hygiene and Nutrition Division, Shanghai Ocean University Food Science College, Shanghai 200093, China
- Agri. Extension Agent (7/1986-9/1989): Agriculture Bureau of Rongxian County, Sichuan 643100, China

AWARDS, HONORS AND RECOGNITION

- Fellow, Institute of Food Technologists (IFT) (2024)
- Fellow, International Academy of Food Science and Technology (2022)
- Outstanding Service Award, IFT Aquatic Food Product Division (2022)
- Northeast Regional Extension Career Award, (US) National Epsilon Sigma Phi (2018)
- Professional Achievement Award, Chinese American Food Society (CAFS) (2018)
- Special Recognition Award, the International Association of Fish Inspectors (IAFI) (2017)
- Outstanding Volunteer Award, IFT Aquatic Food Product Division (2017)

ACADEMIC AND PROFESSIONAL SERVICES

National and International Organizations

- Steering Committee Member: US National Seafood HACCP Alliance (2014-present)
- Steering Committee Member: The United Nations Educational, Scientific and Cultural Organization (UNESCO)/Intergovernmental Oceanographic Commission (IOC) Western Pacific Sub-Commission (WESTPAC) Project on Toxic Marine Animals and Their Toxins (2010-2017)
- Invited Academic Member: The Joint Food and Agriculture Organization (FAO) /World Health Organization (WHO) Electronic Expert Group on Assessment of the Public Health Risk due to the presence of *Salmonella* in bivalve molluscs (2011-2013)
- Invited Expert: Joint FAO/WHO Expert Meeting on the Risk Assessment Tools for *Vibrio parahaemolyticus* and *Vibrio vulnificus* Associated with Seafoods (2010)

Professional Membership and Leadership Service

- Chinese American Food Society: Past President/President/President-Elect (2024-2025/2023-2024/2022-2023), Executive Board of Directors (2020-2022), and Lifetime Member (2004-present)
- Epsilon Sigma Phi: Member and Maryland Chapter Leadership Team (2015-present)
- International Association of Food Protection (IAFP): Seafood Safety and Quality Professional Development Group Steering Committee Member (2007-present)
- Institute of Food Technologists (IFT): Aquatic Food Product Division Past Chair/Chair/Chair Designed (2020-2021/2019-2020/2018-2019).
- Phi Tau Sigma: Bylaws Committee (2020-present); Lifetime Member (2013-present)

Editorial Board and Reviewing Services for Professional Journals

- Receiving Editor: Journal of Aquatic Food Product Technology (2007-present)
- Editorial Boards: Food Science and Human Wellness (2024-present), Journal of Food Protection (2019-present); Food Science and Nutrition (2017-present)

Selected Peer-reviewed Journal Articles (*Asterisk indicates corresponding author):

- Liu, Z., Zhou, Y., Wang, H., Liu, C., Wang*, L. 2024. Recent advances in understanding the fitness and survival mechanisms of *Vibrio parahaemolyticus*. *International Journal of Food Microbiology* 417: 110691. https://doi.org/10.1016/j.ijfoodmicro.2024.110691
- Gilstrap, O., Liu, C*., Nindo, C., and Parveen, S. 2023. Pilot Scale Assessment of High-Pressure Processing (HPP) to Enhance Microbiological Quality and Shelf Life of Fresh Ready-To-Eat (RTE) Blue Crab Meat. *Microorganisms* 2023, 11, 2909.
- Cheng, W.P., Patar, A., Wong, Y.F., Zulfigar, S.B., Mohd Rozalli, N.H., Liu, C., and Zulkurnain*, M. 2023. Effects of Superheated Steam Pretreatment on Muscle Release and Meat Quality of Shucked Tropical Oyster (*Crassostrea iredalei*). *Food and Bioprocess Technology.*
- Mu, R., Liu, C*., Parveen, S., Webster, D., and Pang*, J. 2022. Controlled Recirculating Wet Storage Purging *V. parahaemolyticus* in Oysters. *Pathogens* 11: 553.
- Shen X., Hou Y., Su Y-C., Liu* C, Oscar T., and DePaola A. 2019. Efficacy of *Vibrio parahaemolyticus* Depuration in Oysters (*Crassostrea gigas*). *Food Microbiology* 79: 35-40.
- Liu C, Mou J, Su* Y-C. 2016. Behavior of *Salmonella* and *Listeria monocytogenes* in Raw Yellowfin Tuna during Cold Storage. *Foods* 5: 16.
- Gao, H. and Liu, C*. 2014. Biochemical and Morphological Alteration of *Listeria monocytogenes* Under Environmental Stress Caused by Chlorine-T and Sodium Chlorite. *Food Control* 46: 455–461.
- Li, Y., Li, J., Chen, S., Yang, D., Liu*, C. and Fan*, G. 2014. Optimization and Validation of a MEKC Method Assisted by Box–Behnken Design for Fast and Simultaneous Determination of Nitrendipine and Atenolol in New Antihypertensive Combination Tablets. *Analytical Methods* 2013, 5, 3353-3364
- Yang, D., Zhao, X., Sun, F., Qi, T., Liu*, C. and Fan*, G. 2014. The Study on the Fluorescence Spectrometry for a Novel Photosensitizer of Chlorinee6-C15-Monomethyl Ester and Its Application in Biosamples Analysis. *Spectroscopy and Spectral Analysis* 34: l007-1011.
- Chen*, S. and Liu, C. 2013. Ether Glycerophospholipids and Their Potential as Therapeutic Agents. *Current Organic Chemistry* 17: 802-811.
- Xi, D., Liu, C. and Su*, Y-C. 2013. Impacts of Probiotics in Post-harvest Treatments for Reducing *Vibrio parahaemolyticu*s in Pacific Oysters (*Crassostrea gigas*). *J. Aquatic Food Product Technology* 23: 165-.
- Zheng, T., Liu*, C., Yang, J., Liu, Q. and Li, J. 2013. Hijiki Seaweed (*Hizikia Fusiformis*): Nutritional Value and Safety Concern. *Advanced Materials Research* 634-638: 1247-1252.
- Xi, D., Liu, C. and Su*, Y-C. 2012. Effects of Green Tea Extract on Reducing Vibrio parahaemolyticus and Increasing Shelf Life of Oyster Meats. *Food Control* 25: 363-373.
- Gao, X., Sun, Y., Sun, X., Zhao, Y. and Liu*, C. 2012. Response and Biochemical Alteration of Vibrio parahaemolyticus to Chlorine-containing Disinfectants. *Advanced Materials Research* 586: 92-98.
- Li, Y., Liu*, C., Xie, J., Li, Y., Li, J., and Chen, S. 2011. Research Advance in Extraction and Separation of Phosphatidylserine. China Oils and Fats 36(3):56-61.