International Journal of Innovative Research in Computer Science and Technology (IJIRCST)
ISSN (Online): 2347-5552, Volume 12, Issue 4, July 2024
https://doi.org/10.55524/ijircst.2024.12.4.8
Article ID IJIRD-1304, Pages 47-51
www.ijircst.org

Swimmer Safety Alert System for Encounters with Unidentified Marine Aquatic Animals

Dr. Zalak Thakrar[1], Krupal J. Buddhadev[2], Harsh D. Bhatt[3], Nakul H. Bhadrecha[4], and Mathan D. Bhogayata[5]

[1]Assistant Professor, Department of Computer Science, Shri V J Modha College of IT, Porbandar, India
[2,3,4,5] BCA Scholar, Department of Computer Science, Shri V.J. Modha College of I.T, Porbandar, India

Correspondence should be addressed to Dr. Zalak Thakrar: zalak.thakrar@gmail.com

Received: 5 June 2024 Revised: 20 June 2024 Accepted: 4 July 2024

Copyright © 2024 Made Dr. Zalak Thakrar et al. This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT- The perilous encounters between swimmers and marine animals pose a significant risk to both human safety and the well-being of aquatic creatures. Every year, a distressing number of swimmers succumb to attacks by marine animals, often with neither party at fault. In response to this ongoing threat, the Swimmer Alert System emerges as a groundbreaking technology aimed at safeguarding both humans and marine life, ensuring their mutual protection without harm to either party. By utilizing advanced sensors and real-time monitoring, this system detects the presence of potentially dangerous marine animals in swimmer-populated areas, alerting both swimmers and authorities to take necessary precautions. Through proactive intervention and awareness, the Swimmer Alert System endeavors to mitigate the frequency of unfortunate incidents, fostering harmonious coexistence between humans and the marine ecosystem. As a result, lives are spared, and ecosystems remain undisturbed, offering a promising solution to a longstanding challenge.

KEYWORDS Aquatic Safety, IoT Monitoring, Swimmer Alert System, Marine Encounter, Motion Tracking Technology, Algorithmic Analysis.

I. INTRODUCTION

Coastal waters beckon swimmers with their serene allure, offering a sanctuary from the summer heat and a playground for aquatic adventure. Yet, beneath the tranquil surface lies a hidden peril – the looming threat of encounters with marine animals, often resulting in tragic outcomes for both humans and creatures of the sea. Despite the absence of fault on either side, the distressing frequency of swimmers falling victim to marine animal attacks underscores a pressing need for innovative solutions to mitigate this risk[1]. In response to this urgent challenge, the Swimmer Alert System emerges as a beacon of hope, harnessing cutting-edge Internet of Things (IoT) technology to safeguard the lives of swimmers and the welfare of marine animals alike.

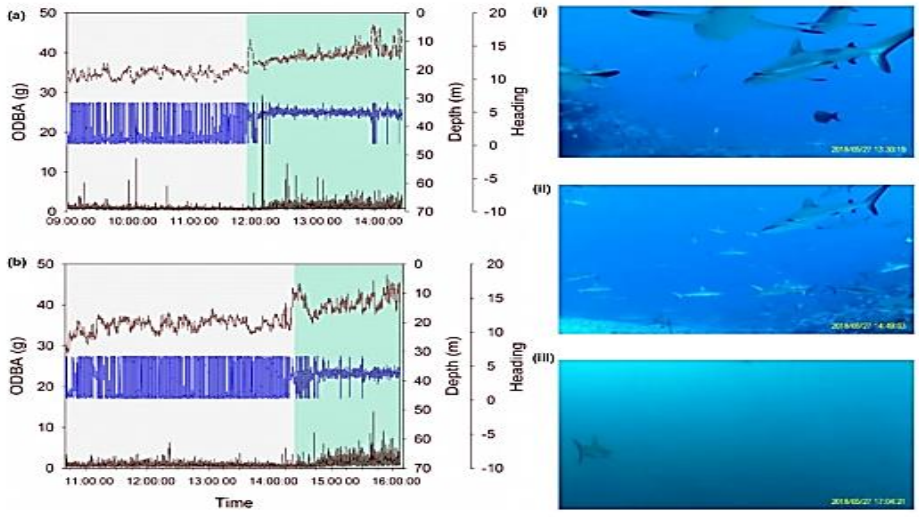

Figure 1: Fish Tracking Ultrasound

In the above figure 1 tracking ultrasound refers to the use of ultrasound technology to monitor and track various biological processes or movements within the body. This system offers real-time detection and proactive warning mechanisms, leveraging IoT sensors strategically placed along coastal areas to monitor water conditions and detect the presence of potentially dangerous marine animals. By analyzing data such as water temperature, salinity, and

animal behavior patterns, the system can predict and preemptively alert swimmers and authorities to potential risks, allowing for swift intervention and risk mitigation measures[2].

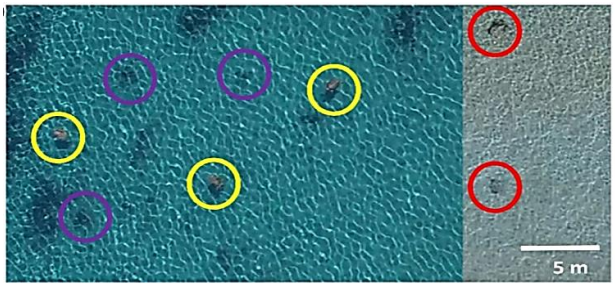

Figure 2: Fish Tracking Drone Cam

As the toll of casualties continues to mount, the imperative to implement such solutions grows ever more urgent. Each year, countless lives are lost to marine animal encounters, leaving families devastated and ecosystems disrupted. Yet, amidst these challenges, the Swimmer Alert System offers a ray of hope, promising a future where both swimmers and marine life can coexist harmoniously without fear or harm[3].

In figure 2, Fish tracking using drone cameras is an innovative approach that leverages aerial technology to monitor and study fish populations and their behaviors in various aquatic environments. Fish tracking drone cameras combine the mobility and high-resolution imaging capabilities of drones with the ability to track and monitor fish in real-time. This technology is used in both marine and freshwater environments for ecological research, conservation efforts, and commercial applications. Fish tracking drone cams represent a significant advancement in our ability to monitor and understand aquatic environments, offering new opportunities for research, conservation, and sustainable management of fish populations.

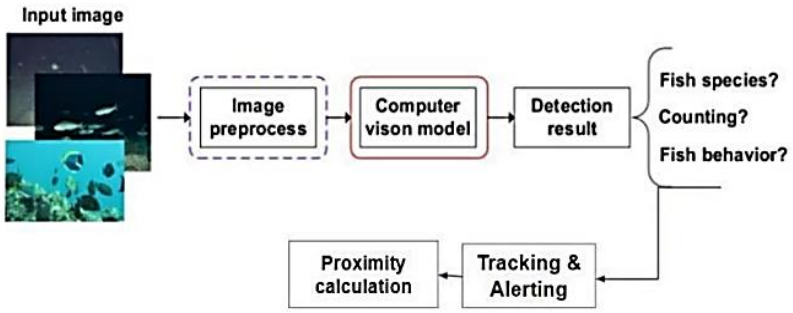

Figure 3: Process of fish tracking

In a world where coastal recreation is a cherished pastime, ensuring the safety of swimmers is paramount. In the figure 3, the Swimmer Alert System represents a significant step towards achieving this goal, providing a crucial layer of protection against unforeseen dangers. By leveraging IoT technology to anticipate and mitigate risks, it fosters a culture of responsible enjoyment of our natural environments. As communities come together to embrace such innovations, the vision of a safer, more sustainable future for all becomes increasingly attainable[4].

II. LITERATURE REVIEW

R. Perumalraja, M. Saraswathi, S. S. Priya, and R. Sweatha, (2022) [5] propose a pattern recognition system named "RetinaNet" for identifying predators in coastal regions using high-resolution cameras and drones. This study focuses on enhancing safety measures by alerting swimmers to the presence of predators in common locations along the coast. By employing advanced technology and algorithmic models, the research offers a promising approach to mitigate risks and safeguard swimmers in vulnerable coastal environments.

K. R. Bairos-novak, M. C. O. Ferrari, and D. P. Chivers, (2019) [6] Chivers conducted a survey focusing on prey animals' responses to predator sounds, examining the chemicals they produce when sensing these sounds. Their study aimed to better understand predator-prey interactions and the role of chemical cues in detecting potential threats. Chivers' research highlighted the necessity for further integrative studies spanning various disciplines to elucidate the function of disturbance cues, particularly whether they serve as alarm signals. This underscores the complexity of predator-prey dynamics and the importance of interdisciplinary approaches in unraveling the mechanisms underlying animal communication and behaviour.

J. Luo, Y. Yang, Z. Wang, and Y. Chen, (2021) [7] conducted a comprehensive study on underwater wireless sensor networks (UWSN) and wireless sensor networks (WSN) aimed at surveying the underwater localization of marine animals and facilitating communication in aquatic environments. Their research explored various aspects of underwater communication and localization, drawing on cited data to gain insights into different facets of the topic. By focusing on both UWSN and WSN technologies, the study addressed the challenges of underwater communication and the unique requirements for monitoring marine animal behavior. This literature review underscores the significance of Yang et al.'s work in advancing our understanding of underwater communication systems and their applications in marine ecology and conservation efforts.

A. M. Dujon *et al* (2021) [8] conducted a notable study focusing on the application of machine learning algorithms for tracking three focal organisms: Australian fur seals, loggerhead sea turtles, and Australasian gannets. Through this research, Arnould aimed to enhance the understanding of the movements and behaviors of these species. The study concluded with the recognition that while machine

learning algorithms offer valuable tools for tracking, no single algorithm can capture all tracking data comprehensively. As a result, the importance of manual detection methods in finding efficient ways to complement algorithmic tracking was emphasized. This literature review highlights the significance of Arnould's work in advancing tracking methodologies for marine and avian species, emphasizing the need for a balanced approach that integrates both automated and manual techniques for optimal data collection and analysis.

Z. Yang *et al* (2022) [9] conducted a thorough analysis of over 1100 research articles on UAV remote sensing in marine monitoring. Their study highlights the growing importance of UAV technology due to its flexibility and ability to produce systematic data. By promoting the extensive application of UAV remote sensing, the researchers aim to advance marine monitoring practices, paving the way for improved understanding and management of marine ecosystems.

Z. Gao, Y. Zhuang, C. Chen, and Q. Wang (2023) [10] delved into optimizing the Marine Predator Algorithm (MPA) for enhanced performance in predator detection. Their approach involved integrating MPA with Teaching-Learning Based Optimization (TLBO), aiming to boost both efficiency and speed in detecting predators. Their findings indicate that this fusion, termed MMPA-TLBO, demonstrates superior performance compared to alternative trackers. Notably, it excels particularly in tracking abrupt motion, showcasing a significant advantage over other tracking methods.

N. Sharma, M. Saqib, P. Scully-Power, and M. Blumenstein (2022) [11] shed light on the threat posed by unprovoked shark attacks and the shortcomings of current prevention methods such as shark nets, which can harm ecosystems. They advocate for an alternative approach: the development of an artificial intelligence-based shark spotting device named SharkSpotter. This innovative solution utilizes AI to detect sharks and promptly alerts users through audible alerts and messages. The authors emphasize the importance of fostering a harmonious relationship between humans and ecosystems.

D. P. McPhee, C. Blount, M. P. Lincoln Smith, and V. M. Peddemors (2021) [12] delve into shark bites annually and non-lethal methods for establishing safe swimming areas. Their research suggests that no single universally applicable approach exists for mitigating unprovoked shark bites at ocean beaches. However, they argue that well-considered and locally appropriate mitigation measures can effectively reduce the risk. This highlights the importance of tailoring strategies to specific beach environments and circumstances to enhance swimmer safety while acknowledging the inherent variability of shark behavior and beach conditions.

X. Li, H. Huang, and A. V Savkin [13] conducted a study focusing on the impact of shark attacks and the resultant fear experienced by tourists. They introduced the innovative concept of a 'drone shark shield system,' which employs autonomous communication between drones to safeguard swimmers and surfers. This system features an algorithm designed to direct drones to anticipated locations where sharks may be present, effectively deterring potential encounters. By leveraging advanced technology, this approach offers a proactive solution to mitigate the threat posed by sharks and alleviate the anxiety associated with beach activities, thereby enhancing overall safety and enjoyment for tourists.

C.- Nd. (2020) [14] introduce the Marine Predator Algorithm (MPA) in their paper, showcasing its real-life application in engineering. MPA is inspired by the optimal foraging strategy and encounter rate policy observed in marine ecosystems between predators and prey. Through comparative testing against other systems, MPA achieved second place, demonstrating highly competitive results. This study highlights the effectiveness of MPA in engineering applications and underscores its potential as a promising optimization technique, offering insights into nature-inspired algorithms for solving complex real-world problems.

C. A. Gallagher, M. Chimienti, J. Nabe-, and C. A. Gallagher. (2021) [15] conducted research on the effects of climate change on the behavioral dynamics of prey and predators. Their study focused on utilizing an existing agent-based model parameterized specifically for harbor porpoises (Phocoena phocoena). This model was designed to represent the detailed energetics and movement patterns of these animals. By incorporating climate change scenarios into the model, the researchers aimed to investigate how changing environmental conditions might influence the behaviors of both prey and predators. This approach provides valuable insights into the potential ecological impacts of climate change on marine ecosystems, particularly regarding the interactions between species such as harbor porpoises and their prey.

Y. P. Papastamatiou *et al*. (2021) [16] found that these sharks strategically utilize areas with predicted updrafts to optimize their energy expenditure. They observed that the sharks adjust their core areas of space use based on tidal states, presumably to take advantage of updrafts and conserve energy. The researchers suggest that incorporating updrafts into dynamic energy landscapes could provide valuable insights into the distribution, behavior, and potentially the abundance of marine predators. This study highlights the importance of considering environmental factors, such as updrafts, in understanding the ecological dynamics of marine ecosystems and the behaviors of apex predators like grey reef sharks.

A. M. Helmi, M. A. A. Al-qaness, A. Dahou, and M. Abd Elaziz, (2023) [17] present a noteworthy contribution to the evolving technological landscape by investigating the integration of deep learning (DL) and swarm intelligence (SI) methodologies in the development of a robust Human Activity Recognition (HAR) system. Their study introduces the Marine Predator Algorithm (MPA) in both basic and binary versions as a novel approach to optimization within this context. By leveraging DL, SI, and MPA, the research aims to enhance the efficacy and reliability of HAR systems, showcasing the potential of interdisciplinary approaches in addressing complex real-world challenges while paving the way for further exploration and refinement in activity recognition systems.

III. RESEARCH GAP

A. Algorithm Performance

Evaluating the performance of the algorithms in accurately identifying and classifying different types of marine

creatures, considering factors such as species variability, environmental conditions, and sensor accuracy. This could involve testing the system with a diverse range of marine animals commonly found in various marine environments to assess its sensitivity and specificity.

B. False Positive and False Negative Rates

Analyzing the system's false positive and false negative rates in detecting potential encounters with marine creatures. Understanding the factors contributing to false alarms and missed detections can inform improvements to the algorithm and sensor technology, enhancing the system's reliability and reducing the likelihood of unnecessary alerts or missed hazards.

C. User Feedback and Validation

Soliciting feedback from users, such as beachgoers, swimmers, and marine safety experts, to validate the accuracy and effectiveness of the alerts generated by the system. User input can provide valuable insights into the system's practical utility, usability, and areas for improvement, guiding iterative refinement and optimization efforts[18].

Addressing these research gaps can enhance the Swimmer Safety Alert System's capability to accurately identify and alert swimmers to potential encounters with marine creatures, thereby improving overall swimmer safety in marine environments.

IV. CONCLUSION

The development and implementation of the Swimmer Alert System signify a pivotal step towards addressing the persistent threat posed by marine animal encounters to swimmers. By leveraging technological innovation and proactive measures, this system offers a viable means to enhance the safety of swimmers while simultaneously safeguarding marine life. Through its deployment, communities can mitigate the risk of tragic incidents, fostering a more harmonious relationship between humans and the marine environment [19]. As efforts continue to refine and expand such technologies, the potential for coexistence and mutual protection between humans and marine animals becomes increasingly achievable, promising a safer and more sustainable future for all.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

[1] J. K. Salet and B. Parekh, "Implementation of E-Governance Framework for Rural Areas of India," in *Advances in Information Communication Technology and Computing: Proceedings of AICTC 2022*, Springer, 2023, pp. 341–352. Available from: https://doi.org/10.1007/978-981-19-9888-1_26

[2] V. Pandya, "Role of E-Learning based higher education in sustainable development," *E-Commerce Futur. Trends*, vol. 7, no. 2, pp. 20–23, 2023. Available from: http://dx.doi.org/10.1016/j.jclepro.2014.11.056

[3] J. K. Salet and P. K. Gokani, "E-governance: Enhanced Learning Technology in Education Policy". Available from: https://www.ijrte.org/wp-content/uploads/papers/v8i1C2/A11650581C219.pdf

[4] N. Mehta and H. Thaker, "Data Collection for a Machine Learning Model to Suggest Gujarati Recipes to Cardiac Patients Using Gujarati Food and Fruit with Nutritive Values," in *International Conference on Information and Communication Technology for Intelligent Systems*, Springer, 2023, pp. 271–281. Available from: https://doi.org/10.1007/978-981-99-3982-4_24

[5] R. Perumalraja, M. Saraswathi, S. S. Priya, and R. Sweatha, "Real-Time Dangerous Marine Animals Monitoring to Alert Scuba Divers Using Computer Vision," vol. 91, no. 4, pp. 1460–1470, 2022 Available from:. https://doi.org/10.37896/pd91.4/91495

[6] K. R. Bairos-novak, M. C. O. Ferrari, and D. P. Chivers, "RESEARCH ARTICLE A novel alarm signal in aquatic prey : Familiar minnows coordinate group defences against predators through chemical disturbance cues," no. January 2018, pp. 1281–1290, 2019, Available from: https://doi.org/10.1111/1365-2656.12986

[7] J. Luo, Y. Yang, Z. Wang, and Y. Chen, "Localization Algorithm for Underwater Sensor Network : A Review," no. August, 2021, Available from: https://doi.org/10.1109/JIOT.2021.3081918.

[8] A. M. Dujon *et al.*, "Machine learning to detect marine animals in UAV imagery : effect of morphology , spacing , behaviour and habitat," 2021, Available from: https://doi.org/10.1002/rse2.205.

[9] Z. Yang *et al.*, "UAV remote sensing applications in marine monitoring: Knowledge visualization and review," *Sci. Total Environ.*, vol. 838, p. 155939, 2022, Available from: https://doi.org/10.1016/J.SCITOTENV.2022.155939.

[10] Z. Gao, Y. Zhuang, C. Chen, and Q. Wang, "Hybrid modified marine predators algorithm with teaching-learning-based optimization for global optimization and abrupt motion tracking," *Multimed. Tools Appl.*, vol. 82, no. 13, pp. 19793–19828, 2023, Available from: https://doi.org/10.1007/S11042-022-13819-7/METRICS.

[11] N. Sharma, M. Saqib, P. Scully-Power, and M. Blumenstein, "SharkSpotter: Shark Detection with Drones for Human Safety and Environmental Protection," *Humanit. Driven AI*, pp. 223–237, 2022, Available from: https://doi.org/10.1007/978-3-030-72188-6_11.

[12] D. P. McPhee, C. Blount, M. P. Lincoln Smith, and V. M. Peddemors, "A comparison of alternative systems to catch and kill for mitigating unprovoked shark bite on bathers or surfers at ocean beaches," *Ocean Coast. Manag.*, vol. 201, p. 105492, 2021, Available from: https://doi.org/10.1016/j.ocecoaman.2020.105492

[13] X. Li, H. Huang, and A. V Savkin, "A Novel Method for Protecting Swimmers and Surfers from Shark Attacks using Communicating Autonomous Drones," pp. 1–11. Available from: https://doi.org/10.1109/JIOT.2020.2987997

[14] C.- Nd, "Marine Predators Algorithm : A Nature-inspired Metaheuristic," pp. 0–43, 2020. Available from: https://doi.org/10.1016/j.eswa.2020.113377

[15] C. A. Gallagher, M. Chimienti, J. Nabe-, and C. A. Gallagher, "mediated responses to changing prey size and distribution in marine top predator movements and population dynamics," no. October 2021, pp. 241–254, 2022, Available from: https://doi.org/10.1111/1365-2656.13627.

[16] Y. P. Papastamatiou *et al.*, "Sharks surf the slope : Current updrafts reduce energy expenditure for aggregating marine predators," no. January, pp. 2302–2314, 2021, Available from: https://doi.org/10.1111/1365-2656.13536

[17] A. M. Helmi, M. A. A. Al-qaness, A. Dahou, and M. Abd Elaziz, "Human activity recognition using marine predators algorithm with deep learning," *Futur. Gener. Comput. Syst.*, vol. 142, pp. 340–350, 2023, Available from: https://doi.org/10.1016/j.future.2023.01.006

[18] S. J. Kanjibhai and D. P. K. Gokani, "Effective Role of E-governance in Higher Education," *NOLEGEIN-Journal Corp. Bus. Laws*, vol. 3, no. 1, pp. 1–6, Jul. 2020,

Accessed: Mar. 14, 2024. Available from: https://doi.org/10.9790/7388-04215762

[19] N. Mehta, "Fuzzy Logic Driven Nutrition-based Recommendation System for Gujarati Cardiac Patients: Integrating Cultural Preferences and Patient Feedback," *J. Comput. Technol. Appl.*, vol. 15, no. 1, pp. 59-83p, 2024. Available from: https://doi.org/10.37591/JOCTA.v15i01.0