A Rescue Pool Response Assistant Using Raspberry Pi for Distance Measurement and Object Identification

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Bachelor of Science in Computer Science

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An undergraduate thesis manuscript submitted to the faculty of the Department of Computer Studies, Cavite State University – Bacoor City Campus, City of Bacoor, Cavite in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science with Contribution No. _____. Prepared under the supervision of Mr. Alvin D. Catalo.

INTRODUCTION

Drowning continues to be a major global public health concern, leading to numerous unintentional injuries and fatalities each year. It ranks among the top causes of accidental deaths, especially among children and non-swimmers. Drowning accounts for an estimated 372,000 deaths annually worldwide (James P. Orlowski, MD, and David Szpilman, MD, 2017). Despite the known risks, countless individuals continue to enter swimming pools and natural bodies of water without having or learning swimming skills or supervision. This increases the probability of drowning, especially when an individual goes into deeper areas where they can no longer stand or maintain their body. The Traditional safety measures are lifeguards, warning signs, and physical barriers that are essential but not always sufficient, particularly in situations requiring immediate assistance.

The recent evolution of technology like artificial intelligence (AI), machine learning and robotic technologies offer promising new solutions for addressing these challenges. According to Jalalifar S., Belford A.(2024), the integration of AI and automation into safety systems presents a significant opportunity to enhance surveillance and emergency response

around pools and waterways. These technologies can support real-time monitoring, identify early warning signs of drowning behavior, and automate the deployment of rescue equipment ultimately saving lives more efficiently.

This study proposes the design and development of a smart drowning detection and response system aimed at enhancing pool safety. The system will utilize a surveillance camera to continuously monitor activity in the swimming pool. By leveraging computer vision and machine learning, the system will be trained to distinguish between normal swimming patterns and distress signals indicative of drowning. Once a drowning event is detected, the AI will also calculate the person's location and depth within the pool. This information will be used to guide a mechanical device powered by an Arduino that will automatically deploy a lifesaver as close as possible to the person drowning.

The goal of this system is to provide rapid, automated assistance in drowning situations, potentially closing the gap between the onset of an emergency and human intervention. By introducing an intelligent, responsive mechanism to aid in pool safety, the proposed solution aims to reduce the number of preventable drowning deaths and serve as a valuable complement to existing safety measures.

Statement of the Problem:

Drowning incidents remain a persistent issue due to delayed human response and lack of real time monitoring systems in many swimming facilities. The problem lies in the absence of immediate automated solutions that can assist a person in distress while human rescuers are distracted. *"How can this system alert the person in-charge for the safety of the people in the swimming pool areas?"*

Even though there are lifeguards or other people at swimming pools, accidents such as drowning are still unavoidable. And how can the lifeguards be sure if the person is drowning or just playing in the swimming pool. Sometimes people get distracted easily. What if the lifeguard is focused on something else. What if he focused on the person who wasn't drowning but just playing in the pool area and because of the splashes of water he's focused in that area and didn't immediately see the person who was really drowning. *"How can a system distinguish between normal swimming behavior and drowning using camera surveillance?"*

Another problem is the human's stress and fatigue. Due to humans having feelings it can be a hole for saving a person in a drowning incident. What if the lifesaver is not capable of saving people's lives both mentally and physically. It may affect the whole situation that can cause a fatal loss. *"How can the system accurately calculate the distance and depth of a person in distress to deploy a lifesaver effectively?"*

Theoretical Framework

The theoretical framework (shown in figure 1) describes how Rescue Pool Response Assistant Using Raspberry Pi for Distance Measurement and Object Identification detect and respond to possible drowning incidents. The system was divided into 4 modules: Computer Monitoring Module, Object Detection and Tracking Module, Distance Calculation Module, LifeSaver Module. The administrator can access and monitor all four modules and use some available functions and features.

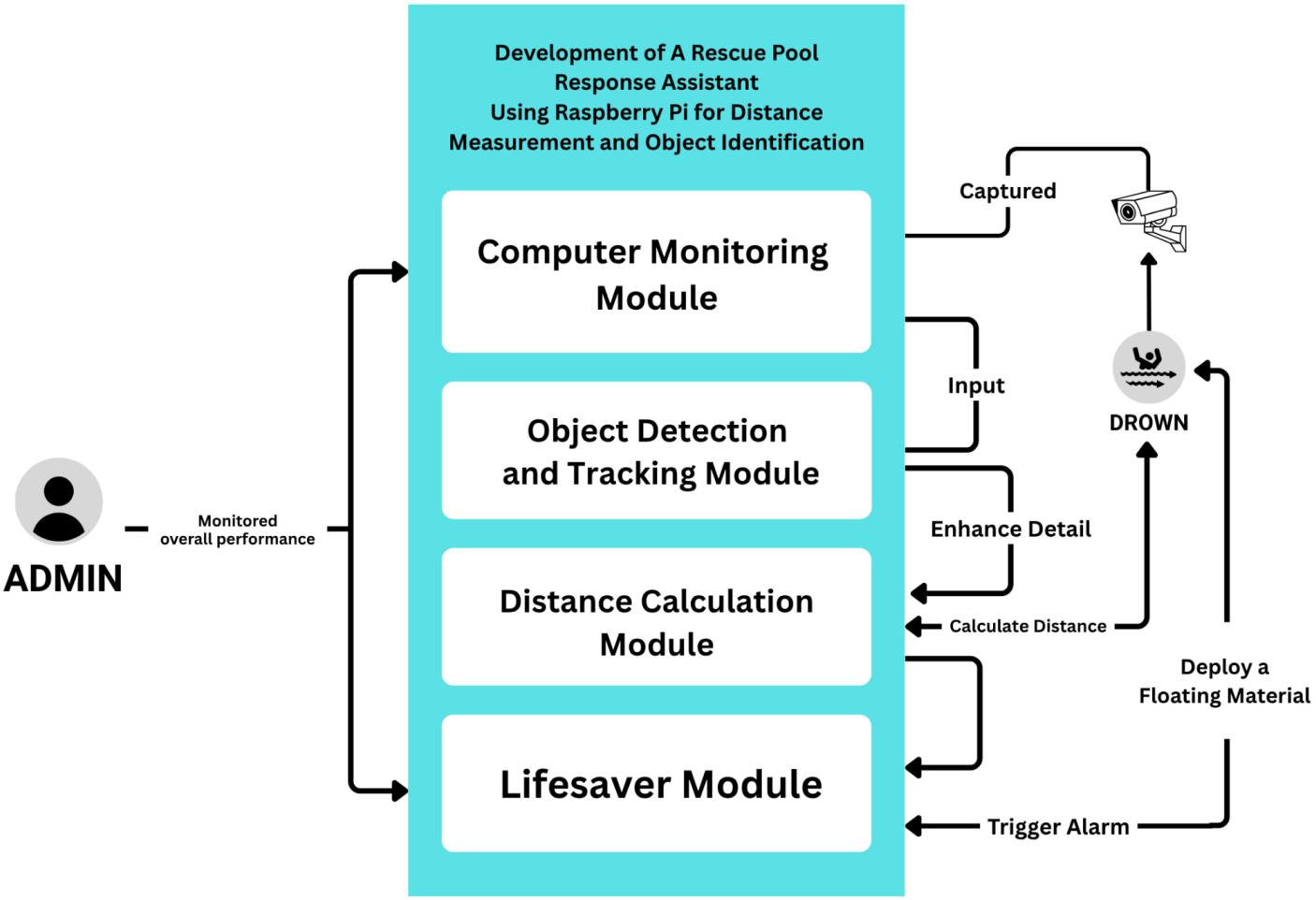


Figure 1. Development of A Rescue Pool Response Assistant Using Raspberry Pi for Distance Measurement and Object Identification

Monitoring Module. In this module, it monitors that area in the swimming pool using a surveillance camera.

Object Detection and Tracking Module. In this module, it will identify the object that is happening in the pool area.

Distance Calculation Module. In this module, it will calculate the distance of the person's location who's in distress using HC-SR04 Sensor.

Lifesaver Module. After the Detection and calculation, if the Ai detects that the person is in distress it will deploy the lifesaver near the position of the people in distress.

Objectives of the Study

The objective of this research is to create, enhance, and evaluate an AI-based intelligent system for drowning detection and rescue assistance. This system utilizes computer vision and machine learning to recognize signs of distress in real time and to automatically send a lifesaver to the individual's location. By decreasing the time it takes for a person to react and raising the probability of survival in drowning events, the system aims to improve current pool safety measures. Specifically, it aims to:

- **Create and develop Ai based model** trained through machine learning to detect abnormal swimming patterns and identify potential drowning behavior with high accuracy.
- **Calculate the distance using the sensor** of the distressed swimmer using object detection and distance estimation techniques to determine the optimal deployment point for the lifesaver.
- **Construct an Arduino based mechanical system** capable of launching or deploying a lifesaver with precision toward the individual detected in distress.
- **Develop an application** for the user or the people that facilitate the swimming pools to alert them early if the situation happens.

The research aims to aid in the creation of intelligent and automated life-saving technologies for water environments by achieving these objectives. Its goal is to act as a

model for improving pool safety, cutting down response times in crises, and possibly saving lives by integrating artificial intelligence and machine learning.

Significance of the Study

This study addresses the critical issue of drowning and pool related accidents by leveraging artificial intelligence and visual monitoring systems to enhance safety in swimming pools. Through real-time surveillance and object detection, the system can identify signs of distress and unusual behavior in the water, enabling prompt intervention. By integrating intelligent monitoring with automated alerts, this system offers a proactive and reliable solution to ensure a safer swimming environment.

Swimmers and Pool Users.

The system significantly enhances safety for all pool users, particularly vulnerable individuals such as children, elderly swimmers, and non-swimmers. It provides real time monitoring that can detect sudden changes in behavior, inactivity, or distress factors often associated with drowning incidents. For regular swimmers, the system also promotes confidence in knowing that assistance is instantly available if needed, encouraging a safer and more secure swimming experience.

Lifeguards and Pool Staff.

The AI-powered surveillance acts as a supportive tool for lifeguards, helping monitor multiple zones of the pool simultaneously. It reduces human error due to fatigue or distraction by providing constant, automated observation and alert systems. Lifeguards can respond more quickly to emergencies. This enhances the efficiency and effectiveness of staff.

Pool Owners, Administrators, and Facility Managers.

The system improves the safety standards of swimming facilities such as public pools and

resorts. It helps meet reduces potential risk, and enhances the reputation of the establishment by demonstrating a commitment to safety.

Parents and Guardians.

For parents with children swimming, the system offers peace of mind by serving as an extra layer of protection. It ensures that even when adults are momentarily distracted, the system remains vigilant, ready to alert staff in case of any emergency.

Future Researchers and Developers.

This study contributes to the growing body of research on AI in public safety applications. It provides a technical foundation for future enhancements, such as wearable integration, predictive drowning behavior models, or even multi-environment detection systems (e.g., beaches, lakes). Future developers may build upon this system to innovate further in the field of aquatic safety.

Time and Place of the Study

This study was conducted over a four-month period from April 2025 to June 2025 including the interviews. The development to testing phases and Integration will take place in Las Pinas and Cavite (Bacoor) after the title's approval. It may start development in September 2025 if this title has been approved.

- Design and Material Preparation: September 2025

- Machine Assembly: October 2025 - December 2025

- App Development: February – March 2026

- Testing: - April 2026

- Deployment: May - June 2026

Scope and Limitation of the Study

This study focuses on the development of a smart drowning detection and rescue assistance system utilizing a camera, artificial intelligence (AI), and machine learning. The primary function of the system is to monitor the swimming pool area and distinguish between normal swimming behavior and drowning incidents. Through machine learning algorithms, the system is trained to identify signs of distress and detect when a person is drowning.

Once a potential drowning event is identified, the AI will calculate the distance between the drowning individual and the launching device. This allows the system to accurately determine the appropriate position to deploy the lifesaver. The deployment mechanism, which is powered by an Arduino, will release the lifesaver near the detected individual to provide immediate assistance.

Definition of Terms

Distress - People can’t help themselves in the pool that can cause drowning.

Raspberry PI - Use for the main brain of the system.

Artificial Intelligence - Use to calculate the distance to throw a life saving material.

Machine Learning - Use to distinguish people drowning or just doing simple swimming.

REFERENCES

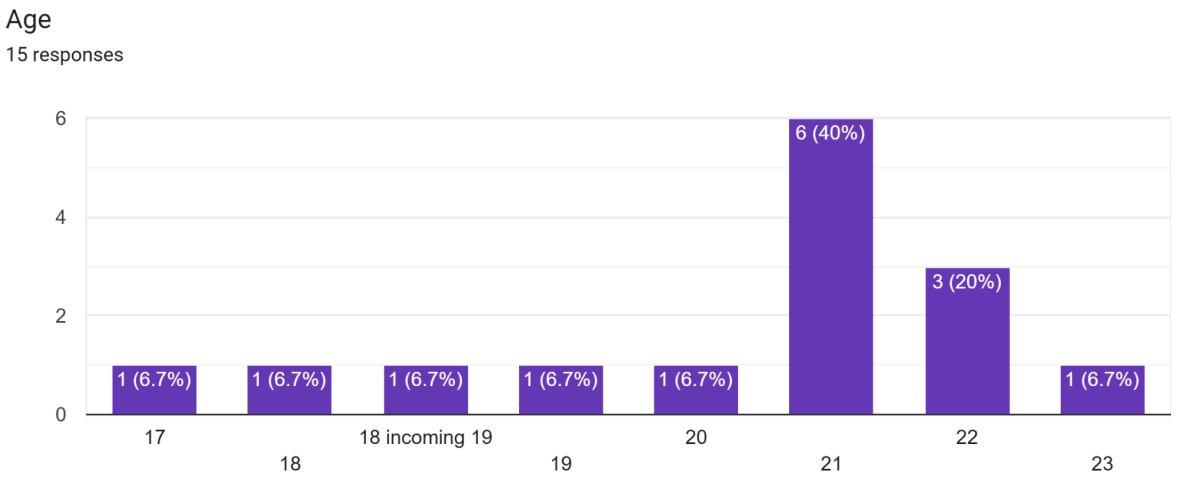
Jalalifar S., Belford A., (2024). Enhancing Water Safety: Exploring Recent Technological Approaches for Drowning Detection.https://www.mdpi.com/1424-8220/24/2/331

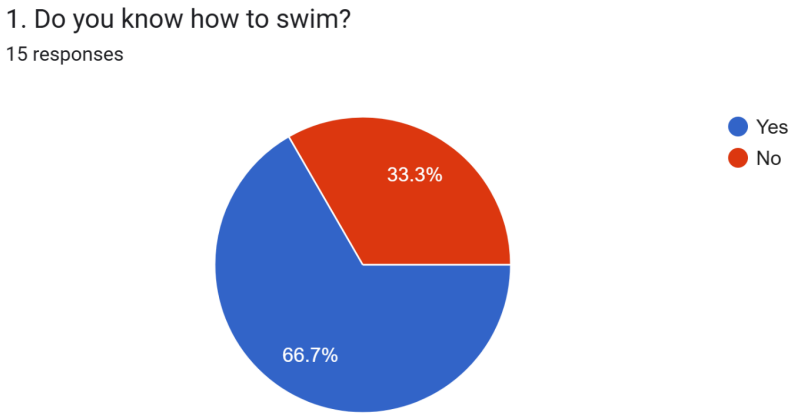
David S., James P. O., (2017).
https://www.researchgate.net/publication/316588342_Drowning

APPENDICES

Appendices 1. Survey Report

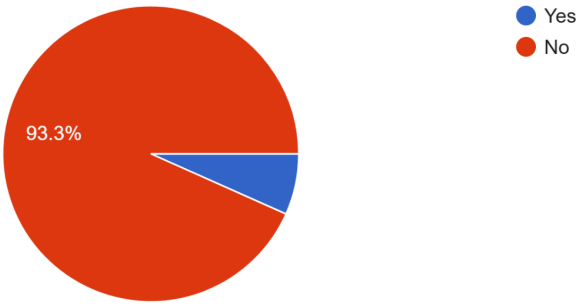
The researchers conducted an online survey using Google Forms. The survey aimed to support the development and evaluation of a proposed title Rescue Pool Response Assistant. The insights collected were used to better understand user needs and inform the design and features of the proposed system.





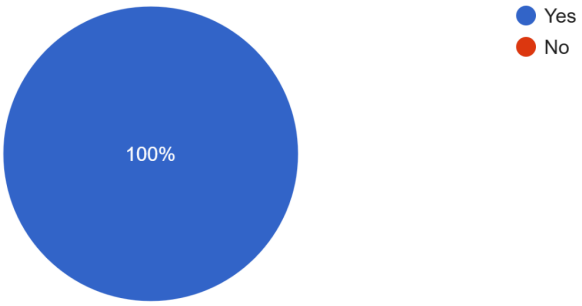
2. Do you regularly visit or work around swimming pools?

15 responses



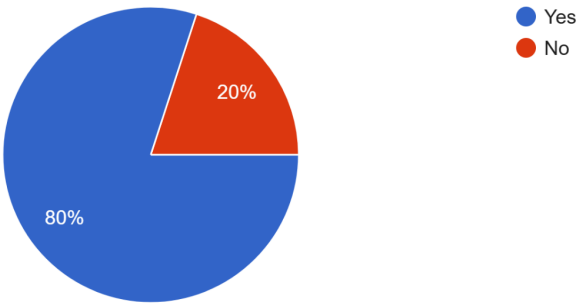
3. Do you think people go to swimming pools even though they do not know how to swim?

15 responses



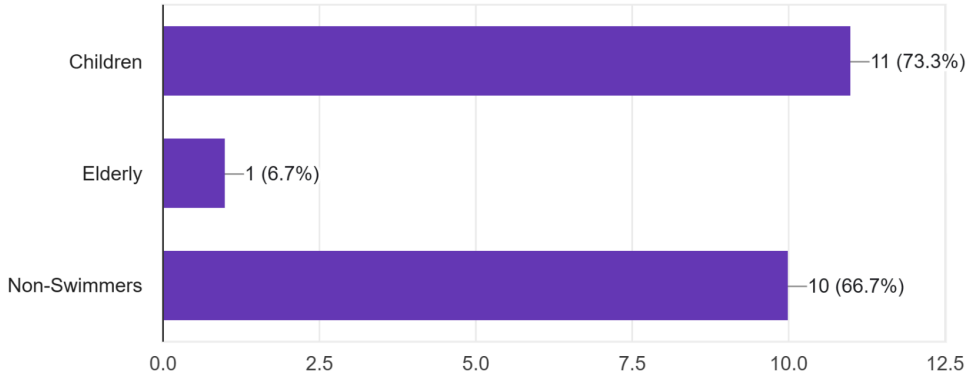
4. Have you ever witnessed/experience a near-drowning or drowning incident at a pool?

15 responses



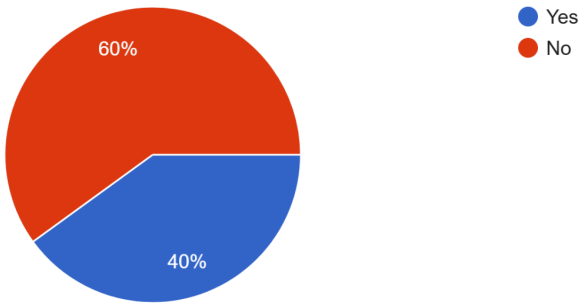
5. Who do you think is most at risk in pools?

15 responses



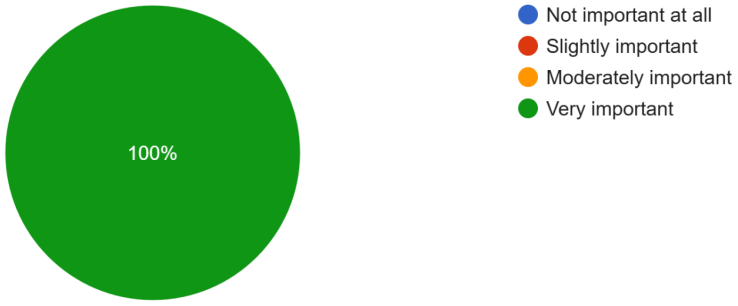
6. Are you aware of existing automatic or smart rescue systems in pools?

15 responses



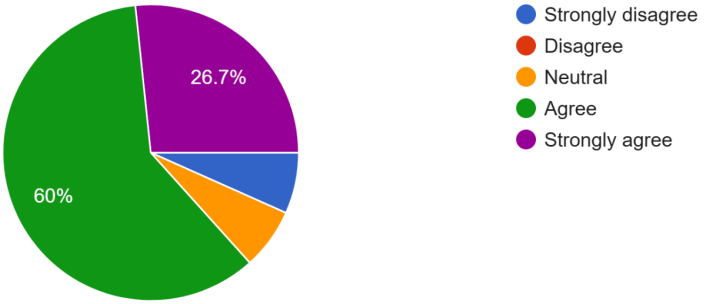
7. How important is it to have a fast-response system in pool emergencies?

15 responses



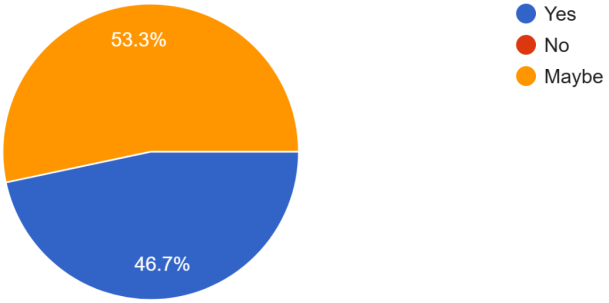
8. Do you think a device that automatically deploys a lifebuoy (Salbabida) in emergencies can reduce risk?

15 responses



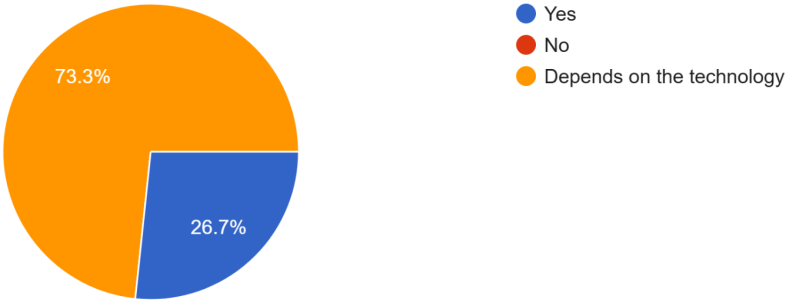
9. Would you feel safer in a pool that uses smart rescue technology?

15 responses



10. Do you trust automated systems (e.g., machines or devices) to assist in life-saving situations?

15 responses



Appendices 2. Interview Question

The researchers also conducted an interview with a lifeguard to gain practical insights into real-world pool accident response scenarios. These insights played a key role in shaping the design, objectives, and features of the proposed system.

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DEPARTMENT OF COMPUTER STUDIES

From:
MATTHEW ISAAC L. BIDES
Thesis Group Leader

To:

Good day!

We are third-year Bachelor of Science in Computer Science students from Cavite State University - Bacoor City Campus, currently enrolled in DCIT 60: Methods of Research. As part of our course requirement, we are conducting a research study entitled:

"A Rescue Pool Response Assistant Using Raspberry Pi for Distance Measurement and Object Identification"

In line with this, we would like to respectfully request your participation in a research interview. Your expertise and professional insights will be invaluable in helping us understand the practical applications, technical considerations, and challenges. Your input will greatly contribute to the relevance and credibility of our study.

Please be assured that the interview will be recorded strictly for academic purposes only, and all information gathered will be kept confidential in compliance with Republic Act No. 10173, or the Data Privacy Act of 2012.

For your reference, we have attached a list of guide questions. These are general questions, and we may ask follow-up questions depending on the flow of the conversation.

We hope you will consider granting us an interview at a time most convenient for you. We are more than willing to adjust our schedule based on your availability.

Thank you very much for your time and consideration. We look forward to your positive response.