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IoT Based Drowning Detection in Swimming Pools

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Abstract: *Drowning incidents pose a significant threat to water safety, necessitating advanced technologies for timely and accurate detection. The proposed system integrates multiple sensors, including heart rate monitoring, temperature sensing, SpO2 (oxygen saturation) measurement, and a Wi-Fi module, to capture comprehensive physiological and environmental data. The heart rate, temperature, and SpO2 sensors provide vital signs crucial for identifying distress, while the Wi-Fi module enables real-time communication and data transmission. The proposed system aims to address limitations in existing drowning detection methods by providing a comprehensive, multi-sensor approach coupled with advanced deep learning techniques. The integration of IoT devices ensures scalability, accessibility, and the ability to deploy the system in various aquatic settings. Additionally, the deep learning verification mechanism enhances the system's accuracy, reducing false positives and negatives. Preliminary experiments and simulations demonstrate promising results, indicating the system's potential to significantly improve the efficiency and reliability of drowning detection in real-world scenarios. The proposed approach contributes to the ongoing efforts to enhance water safety measures through the synergy of IoT and deep learning technologies.*

Keywords: Drowning

I. INTRODUCTION

This project introduces an innovative approach to drowning detection, leveraging the capabilities of the Internet of Things (IoT) and a sophisticated array of sensors. Drowning, often swift and silent, necessitates a proactive and technologically advanced system that can swiftly identify distress signals and initiate timely responses. Our proposed solution incorporates real-time monitoring of key physiological indicators – heart rate, temperature, and blood oxygen saturation (SpO2) – alongside a Wi-Fi module for immediate communication. The system mainly consists of three modules: a visionmodule, an event-inference module and an event-driven module. The vision module is responsible for monitoring and detecting the position of the person who is drowning. The event-inference module is responsible for determining a swimmer's position, velocity, and path of the movement. The event-driven module is responsible for initiating the rescue by sending an alarm alerting the lifeguard. This project is a modified version of our project submitted to the Think Science competition, where swimmers' positions, velocities, movement paths and time under water were collected and used to determine through inference the eminent danger.

II. PROBLEM STATEMENT

Current drowning detection systems often rely on singular indicators or lack the integration of real-time physiological andenvironmental data, leading to potential delays or inaccuracies in identifying distress situations. Additionally, the reliance on manual monitoring or simplistic sensors may result in a higher rate of false positives or negatives. The need for a comprehensive and efficient drowning detection system that combines multi-sensor data with advanced computational techniques is evident

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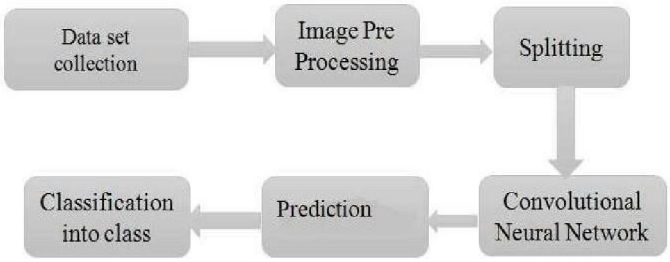
III. PROPOSED SYSTEM

The Arduino Nano board will be used in controlling the entire system. The individuals entering the pool territory should wear a passive yellow vest. Two Pixy cameras will continuously monitor the swimming pool. The captured 2-D images will be processed by the internal hardware attached to the cameras. The analyzed data will be sent to the Arduino board where a python script is running. The script will calculate swimmers' positions, velocities, paths of movement, and time under water. Based on these calculations, the occurrence of any abnormal events will be detected. If such events occur, Arduino will send an order to the linear stage. The linear stage will directly move to the victim's location with a hook attached to it. The hook will help in pull the swimmer upwards out of the pool. Meanwhile, a warning signal will alert the lifeguard of an imminent danger.



IV. OBJECTIVES

Some objectives of this project could include:

- Develop an integrated IoT-based system incorporating heart rate monitoring, temperature sensing, SpO2 measurement, and a Wi-Fi module to capture comprehensive data in aquatic environments.
- Implement a deep learning model for image processing using video footage to classify drowning incidents and non-drowning activities.
- Enhance real-time communication and data transmission capabilities through the IoT system for swift response inemergency situations.
- Evaluate the system's performance in terms of accuracy, sensitivity, and specificity under various environmentalconditions and scenarios.
- Investigate the scalability and adaptability of the proposed system for deployment in diverse aquatic settings, such aspools, beaches, and open water bodies.

V. SYSTEM REQUIREMENTS

Hardware Requirements

Arduino Uno

The word "Uno" means "One" in Italian and was chosen to mark a major redesign of the Arduino Software and Hardware. The Uno board was the successor of the Duemilanove released

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Pulse Oximetry Sensor

Pulse Oximetry is a non-invasive method for monitoring a person's blood oxygen saturation. Peripheral Oxygen Saturation (SPo2) readings are typically within 2 percent accuracy of the more accurate reading of Arterial Oxygen Saturation (SAo2) from arterial blood gas analysis.

Temperature Sensor

Temperature sensors are devices that detect and measure coldness and heat and convert it into an electrical signal. Temperature sensors are utilized in our daily lives, be it in the form of domestic water heaters, thermometers, refrigerators,or microwaves.

Heartbeat Sensor

An optical heart rate sensor measures pulse waves, which are changes in the volume of a blood vessel that occur when theheart pumps blood. Pulse waves are detected by measuring the change in volume using an optical sensor and green LED.

Power Supply

All Arduino boards need electric power to function. A power supply is what is used to provide electric power to theboards and typically can be a battery, USB cable, AC adapter or a regulated power source device

Wi Fi Module

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The Arduino Uno Wi-Fi is an Arduino Uno with an integrated Wi-Fi module. The board is based on the ATmega328P with an ESP8266WiFi Module integrated. The ESP8266WiFi Module is a self-contained SoC with integrated TCP/IP protocol stack that can give access to your Wi-Fi network.

Software Requirements

OpenCV

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly for real-time computer vision. It is written in the programming language C++, as is its primary interface, but it still retains a less comprehensive though extensive older C interface.

Embedded C

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to addresscommonality issues that exist between C extensions for different embedded systems.

Python

Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability withthe use of significant indentation.

Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Microsoft Windows, macOS, and Linux) that is written in the Java programming language.

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VI. BLOCK DIAGRAM

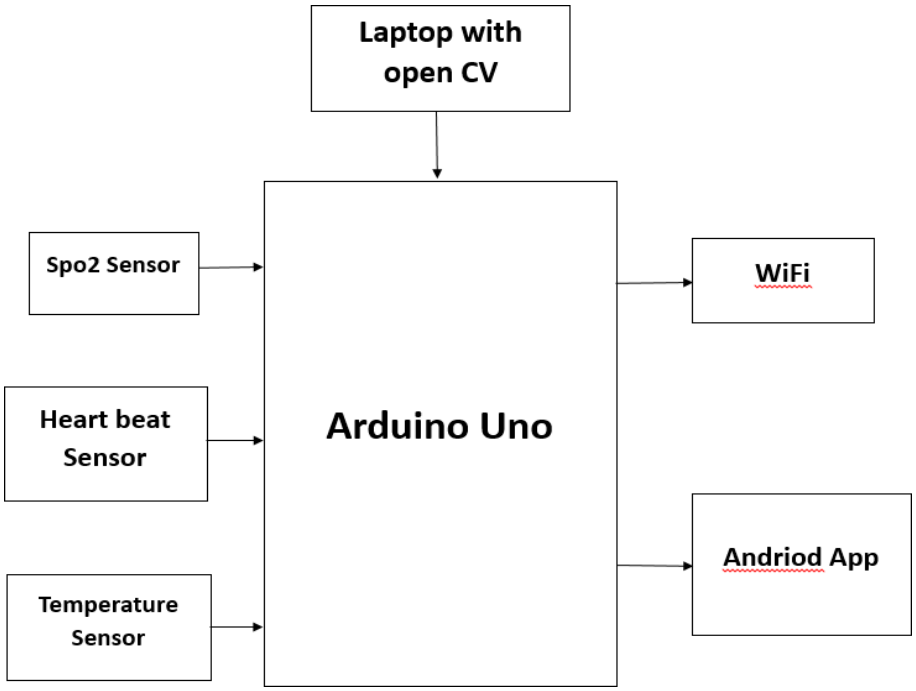

Figure: Block Diagram

VII. ADVANTAGES

- Rapid response
- Enhanced safety
- Accurate detection
- Data analysis
- Remote monitoring

VIII. DISADVANTAGES

- Cost
- Privacy concerns
- Technical challenges
- Maintenance requirements

IX. CONCLUSION

This presents an automated vision-based surveillance system to detect drowning incidents in swimming pools. The swimmers in the pool are detected and tracked using the Pixy camera. As soon as the swimmer remains under a certain level for more than a determined period of time, Arduino Uno will calculate that swimmers' position, velocity, path of movement and send an order to the linear stage. The linear stage will directly move to the victim location with a hook attached to it. The hook will help with flotation by pulling the swimmer upwards. Meanwhile, a warning message will signal the lifeguard of an imminent danger. With such a system, the number of drownings would be reduced. For future development, the system is currently being improved by attaching an infrared LED to the swimmer's vest.

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