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Infant Drowning Prevention and Alert System Using Video Vision Transformer

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ABSTRACT: Drowning deaths represent the third leading cause of accidental deaths worldwide. Drowning accidents in indoor swimming pools are growing in recent years, especially for children. This is because traditional techniques for the supervision and care of people, especially children, in large pools are inefficient or, in some cases, non-existent. Nowadays, this problem has become a topic of interest for several researchers who seek to propose different methods of drowning detection. This project seeks to propose the process to be followed to develop a drowning detection system in swimming pools using Video Vision Transformer. This project proposes a novel embedding scheme and a number of Transformer variants to model video clips. The output tokens of the pre-trained ViViT contain spatio-temporal information of drowning scenes. Then transform a query scene and candidate scenes into output token features using the pre-trained ViViT and calculate the similarity between the tokens with cosine similarity

KEYWORDS: Infant, Drowning, Prevention, Alert System, Video, Vision Transformer

I. INTRODUCTION

Drowning is a leading cause of death in children and teens. Among young children, most drownings happen in home pools or hot tubs. In teens, drowning is more likely to happen in oceans, lakes, and rivers. It happens fast and is usually silent. Drowning is a type of suffocation induced by the submersion of the mouth and nose in a liquid. Drowning is a respiratory impairment caused by being submerged or immersed in water.

Childhood drowning commonly occurs when a child is left unattended or during a brief lapse in attention (World Health Organization, 2023). Most instances of fatal drowning occur alone or in situations where others present are either unaware of the victim's situation or unable to offer assistance.Drowning is defined by the World Health Organization Opens a new window(WHO) and other medical groups as respiratory impairment (i.e. being unable to breathe) as a result of being underwater. of fifteen.

PROBLEM STATEMENT:

According to 2017-2023 Centers for Disease Control and Prevention (CDC) WISQARS data. Unintentional drowning was the leading cause of death among children ages 1-4. For children ages 5-14, drowning was the second leading cause of unintentional death (after motor vehicle crashes). Approximately 900 children and adolescents ages 0-19 died from unintentional drowning each year. That is an average of 3 drowning deaths per day. Indian/American/Alaska Native and Black children were significantly more likely to drown. Boys were more than twice as likely to drown compared to girls. Drowning occurs in less than 1 minute. Parents often underestimate how quickly danger can arise in the water. Even young children who know how to swim should be closely monitored the entire time they're in or near the water.

In movies and on TV, drowning is often accompanied by lots of splashing, yelling, and commotion. In reality, drowning is often swift and silent. That's why it's so essential to keep active eyes on the pool anytime children can get in the water.The highest risk locations for drowning vary by age. Among infants under 1-year-old, two thirds of all drownings occur in bathtubs.

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II.LITERATURE SURVEY

2.1. INFANT DROWNING PREVENTION: INSIGHTS FROM A NEW ECOLOGICAL PSYCHOLOGY APPROACH

AUTHOR: Carolina Burnay; Chris Button
YEAR:2022
PROBLEM:
The study addresses the significant mortality and morbidity caused by drowning globally, with a particular focus on infants (0–4 years of age) who are disproportionately affected. Despite existing drowning prevention efforts such as supervision and barriers, infant drowning remains a significant public health concern.

OBJECTIVE:
The objective of the study is to investigate the relationship between infants' perceptual-motor development and their behavior around bodies of water, with the aim of applying findings from ecological psychology to prevent pediatric drowning.

METHODOLOGY:
The methodology involves a review of recent research findings in the field of ecological psychology, specifically focusing on studies that explore infants' behavior around bodies of water. The review synthesizes existing literature to identify key insights into how infants perceive and interact with water environments based on their developmental stage and experiences..

FINDING:
The study findings suggest that infants' avoidance of water-related risks is influenced by their perceptual-motor development, particularly their crawling experience and the type of access way into water bodies. Infants with more crawling experience demonstrate more adaptive behaviors in avoiding water hazards.

2.2. AUTOMATIC REAL-TIME DETECTION OF INFANT DROWNING USING YOLOV5 AND FASTER R-CNN MODELS BASED ON VIDEO SURVEILLANCE

AUTHOR:Qianen He; Zhiqiang Mei;
YEAR:2023
PROBLEM:
Infant drowning incidents have been frequent in swimming pools in recent years, highlighting the need for improved detection methods. Traditional methods may not effectively detect infant drowning due to infants' small size and limited ability to signal distress.

OBJECTIVE:
The objective of this research is to develop an automatic real-time method for detecting infant drowning in swimming pools using video surveillance. The aim is to address the challenges posed by the small size and limited motion range of infants, as well as their inability to send distress signals during emergencies.

METHODOLOGY:
Collection and Labeling of Datasets: Diverse live-scene videos of infant swimming and drowning are collected from various natatoriums and labeled as datasets. A portion of the datasets is modified to enhance the generalization ability of the model.

FINDING:
In summary, the study proposes a novel automatic real-time method using YOLOv5 and Faster R-CNN for detecting infant drowning in swimming pools. The findings demonstrate the efficacy of YOLOv5s in achieving both high accuracy and real-time performance, thereby offering significant potential for reducing drowning accidents in swimming pools.

III.PROPOSED SYSTEM

The proposed system aims to leverage advanced technologies, including Video Vision Transformer and deep learning, to create a proactive and effective Infant Drowning Prevention and Alert System. It prioritizes real-time monitoring, rapid alerting, and caregiver intervention to enhance overall safety around water bodies.

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- **DrownNet Model: Build and Train:**

This module forms the core of the system, employing deep learning techniques to build an effective drowning detection model. It involves meticulous data collection, frame conversion, pre-processing, object detection using Region Proposal Network (RPN), feature extraction using a fully connected layer, and classification using Convolutional Neural Network (CNN).

- **Infant Drowning Detection:**

Utilizing real-time pool camera CCTV footage as input, the system integrates the Video Vision Transformer (VViT) and the DrownNet Model for prediction. VViT captures intricate visual patterns, while the DrownNet Model specializes in recognizing behaviors indicative of potential drowning risks. This combined approach enhances the accuracy of drowning predictions.

- **Alert Generation:**

A crucial aspect of the system, the alert generation process, involves comparing features extracted by VViT and the DrownNet Model. Predefined thresholds and anomaly detection mechanisms identify deviations from learned patterns, triggering alerts. These alerts, delivered through audible alarms, SMS, email, and in-app notifications, ensure rapid caregiver intervention.

3.1.1. Advantages

- Continuous surveillance of pool activities.
- Utilizes advanced technologies for precise predictions.
- Alerts through SMS, email, in-app, and audible alarms.
- Admin, pool manager, and caregiver functionalities.
- Anomaly detection for swift alert generation.
- Systematic handling of historical data.

IV.MODULES

Swimming Pool Surveillance Web App

The Swimming Pool Surveillance Web App, developed using Python, Flask, MySQL, and Bootstrap, encompasses various modules for comprehensive functionality.Users, including administrators and caregivers, access the system securely through the User Authentication Module. The centralized Dashboard Module provides a real-time overview of multiple pools, including live video feeds and alert statuses.

DrownNet Model: Build and Train

The Build and Train module of the DrownNet model is fundamental to the creation and optimization of the deep learning architecture for infant drowning prevention.

- **Data Collection**

In the initial phase of the Build and Train module, diverse video datasets are meticulously collected. These datasets encapsulate various scenarios depicting infants near water bodies, such as pools, bathtubs, or lakes. Annotating the datasets with labels for normal and potentially dangerous situations, including instances of potential drowning, ensures a comprehensive representation.

- **Classification using Convolutional Neural Network (CNN)**

The core classification task is carried out using a Convolutional Neural Network (CNN). This component of the model is trained to distinguish between normal and dangerous behaviours exhibited by infants near water, ensuring a robust capability for behaviour recognition.

- **Build and Train Model**

The assembly of the DrownNet model architecture occurs in this stage, incorporating the RPN, fully connected layer, and CNN components. The model is trained using the pre-processed and annotated dataset, iteratively adjusting weights and biases through backpropagation to optimize its performance.

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Infant Drowning Detection

Input

The Infant Drowning Detection system relies on real-time pool camera video footage as its primary input source. The camera continuously captures activities in the pool area, focusing on scenarios involving infants. This dynamic video feed serves as the foundation for the detection system's analysis.

Alert Generation

The alert generation process in the Infant Drowning Detection system is a crucial aspect that ensures swift response to potential risks. Analyzing infant behaviors near water, the system compares features extracted by the Video Vision Transformer (VViT) and the DrownNet Model. Predefined thresholds and anomaly detection mechanisms are employed to identify deviations from learned patterns, triggering alerts when potentially dangerous situations are detected. These alerts, delivered through various means such as audible alarms or notifications to caregivers, enable rapid intervention.

Notification

The Notification Module employs a versatile approach, delivering alerts through multiple channels to ensure timely communication. Caregivers receive notifications via SMS, providing a direct and immediate alert on their mobile devices. Email notifications offer an additional layer of communication, delivering alerts to caregivers' email inboxes for easy access and documentation..

User Interface

- **Web Admin:** The Web Admin interface provides administrative functionalities for system management.
- **Pool Manager:** The Pool Manager interface caters to the needs of pool management and safety oversight.

V. EXPERIMENT AND RESULTS

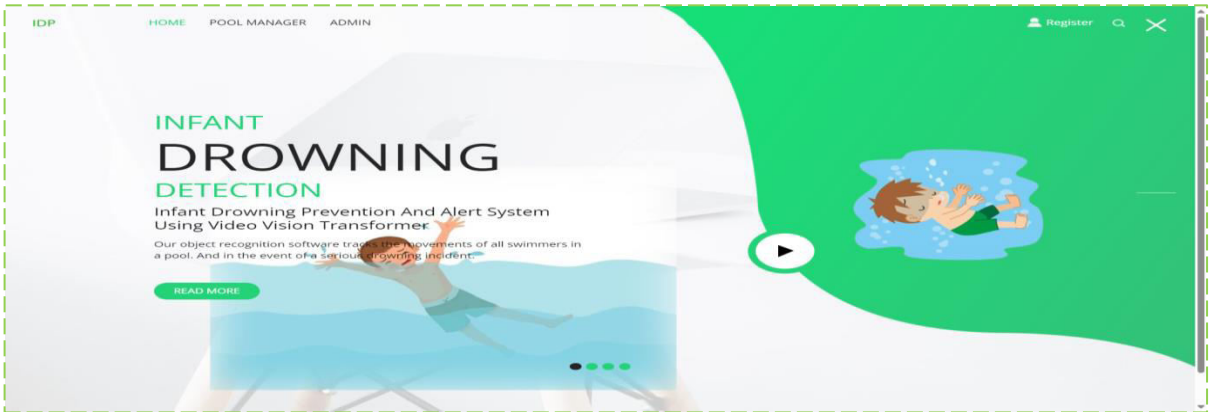

Fig.1. Infant Drowning Home Page

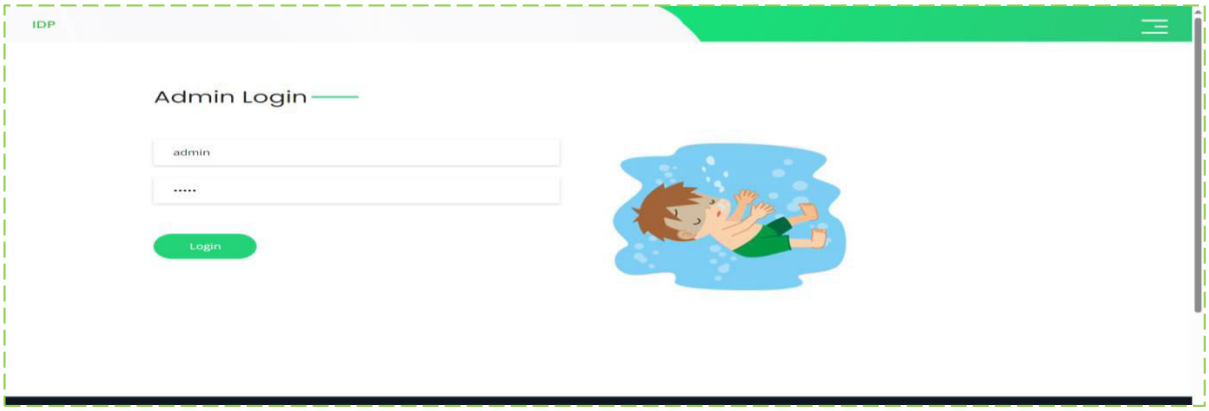

Fig.2.Admin Login

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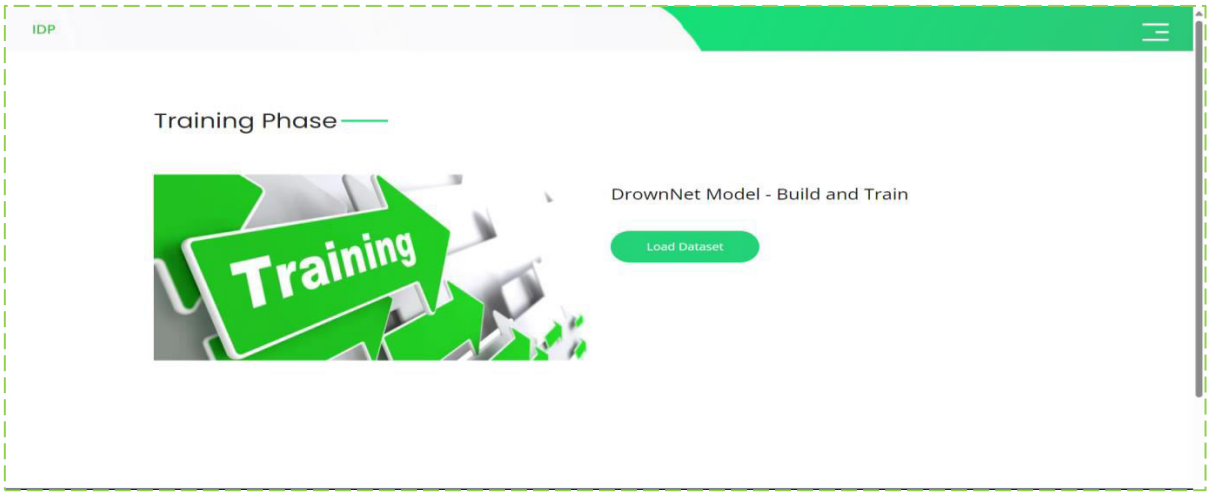

Fig.3. Training Phase

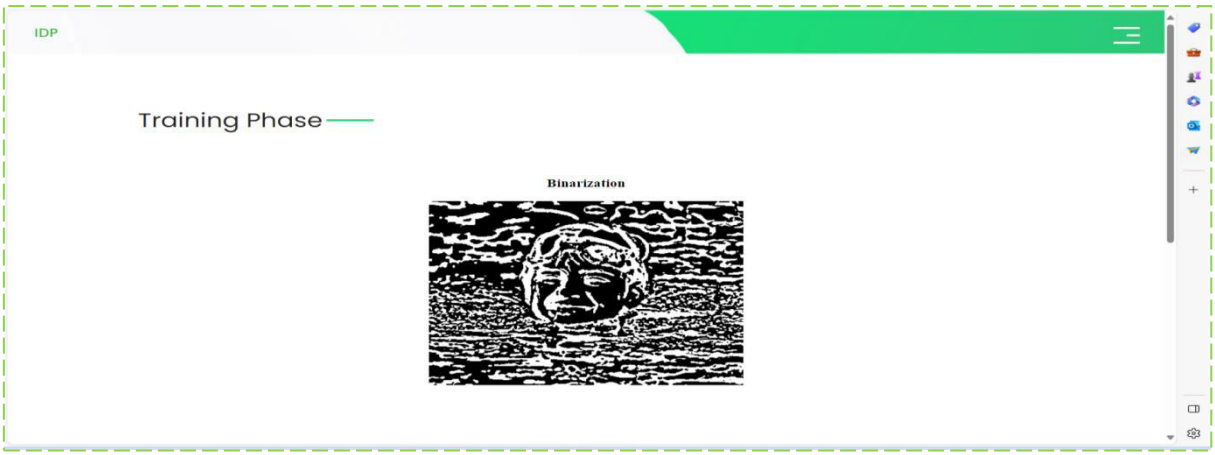

Fig.4. Binarization

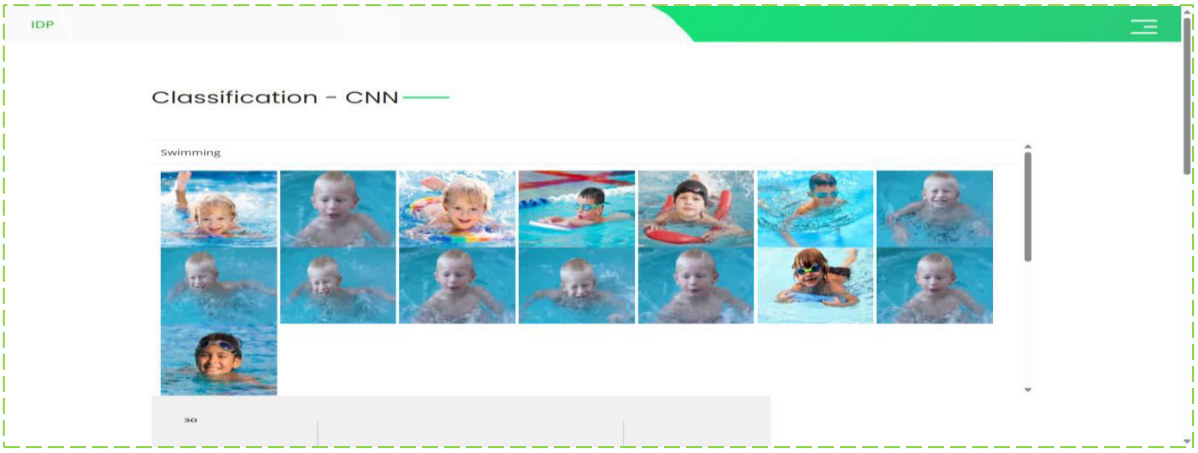

Fig.5. Classification-CNN-Swimming

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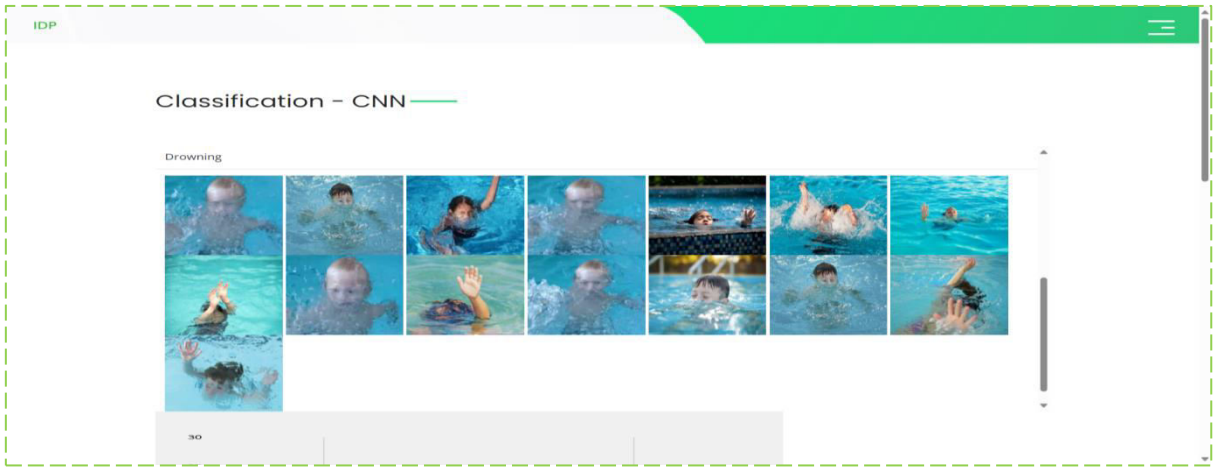

Fig.6. Classification-CNN-Drowning

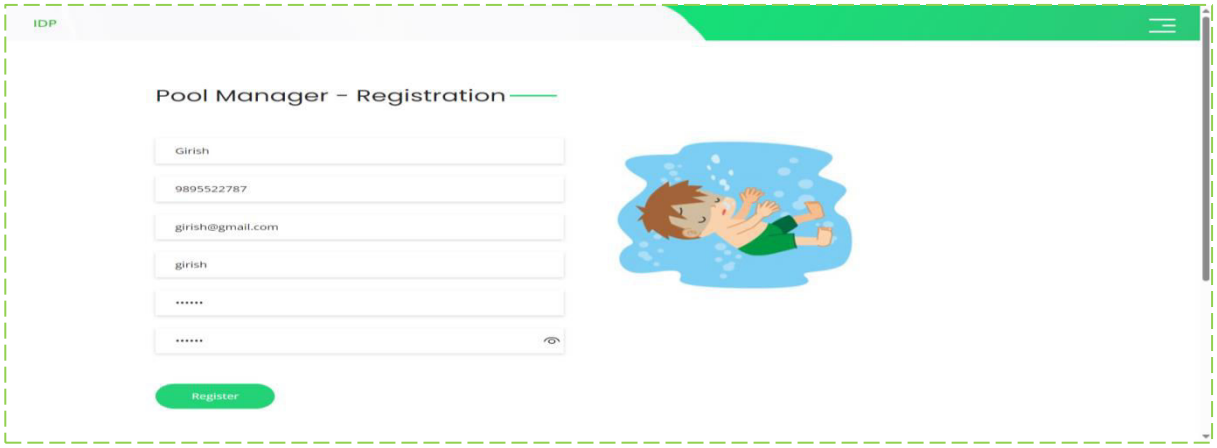

Fig.7.Pool Manager Registration

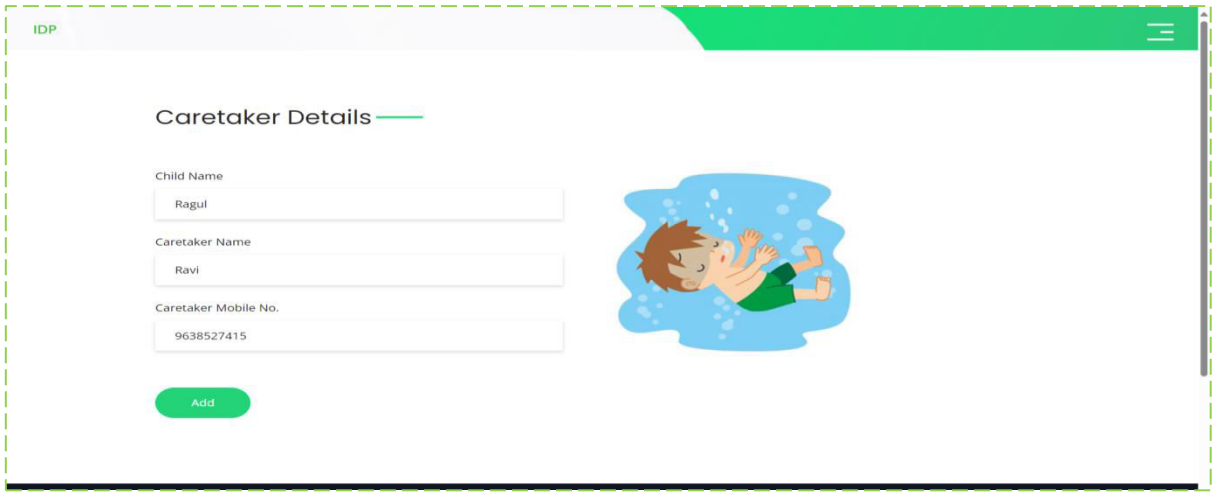

Fig.8.Caretaker Details

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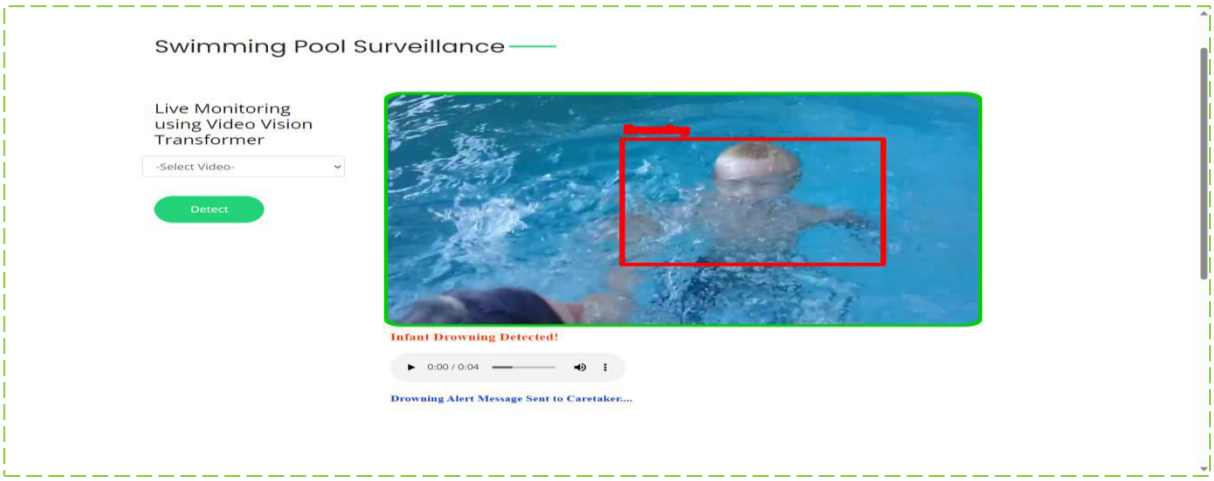

Fig.9.Infant Drowning Detected

VI. CONCLUSION

In conclusion, this project stands at the forefront of technological innovation in ensuring the safety of infants around water bodies. By harnessing the capabilities of the Video Vision Transformer (VVT) and the trained DrownNet Model, the system demonstrates remarkable accuracy in the real-time detection of potential drowning risks. Its proactive alerting mechanism serves as a crucial lifeline, delivering immediate notifications to caregivers and facilitating prompt intervention in critical situations. The user interfaces, including the Web Admin, Pool Manager, Pool Camera, and DrownNet Model interfaces, collectively contribute to a comprehensive and user-friendly system. Administrators benefit from secure access and flexible configuration options, while pool managers gain oversight and control over camera setups and emergency contacts.

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