SMARTBRIDGE INTERNSHIP PROJECT

VIRTUAL-EYE

Life Guard for Swimming Pools to Detect Active Drowning

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543

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1. INTRODUCTION

1.1 OVERVIEW

Virtual-Eye is an innovative and advanced life-saving technology designed specifically for swimming pools. It serves as a lifeguard system that employs cutting-edge artificial intelligence and computer vision algorithms to detect active drowning incidents in real-time. By leveraging its state-of-the-art capabilities, Virtual-Eye acts as an extra set of vigilant eyes, constantly monitoring pool activities and ensuring the safety of swimmers.

The primary objective of Virtual-Eye is to swiftly identify potential drowning situations as they occur, allowing for immediate intervention and rescue efforts.

1.2 PURPOSE

The purpose of Virtual-Eye is to enhance the safety and security of swimming pools by providing an advanced lifeguard system capable of detecting active drowning incidents. The system aims to:

- Save Lives: The primary purpose of Virtual-Eye is to prevent drowning incidents and save lives.
- Provide Additional Vigilance: Virtual-Eye acts as an extra set of eyes, continuously monitoring the pool area and alerting lifeguards or designated personnel to potential drowning situations.
- Improve Response Time: With its quick detection capabilities, Virtual-Eye significantly reduces the response time to active drowning incidents. By immediately alerting lifeguards, it allows them to respond rapidly, locate the individual in distress, and provide timely assistance.
- Minimize False Alarms: Virtual-Eye is designed to differentiate between normal pool activities and genuine drowning scenarios, minimizing false alarms.
- Enhance Safety Protocols: The data analytics and reporting features of Virtual-Eye provide valuable insights into pool usage patterns and safety trends.
- Integrate with Existing Infrastructure: Virtual-Eye is designed to seamlessly integrate with existing pool management systems. It can be retrofitted into both indoor and outdoor swimming pools, making it a versatile solution that can be customized to suit the specific requirements and layout of each facility.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM:

Drowning incidents in swimming pools continue to be a significant concern worldwide. Despite the presence of lifeguards, accidents can happen quickly, especially when a lifeguard's attention is divided or compromised. Traditional surveillance methods heavily rely on human observation, which can be prone to human error, fatigue, or distractions. This creates a critical need for an advanced technology solution to enhance drowning detection and response in swimming pools. Existing approaches include:

- CCTV Monitoring Systems: This system uses a network of cameras to monitor the pool area, and the footage is viewed by human operators. However, relying solely on human operators for constant monitoring can be challenging, as it can lead to lapses in attention and delayed response times.
- Wearable Devices: Such as wristbands or necklaces. These devices use sensors to measure heart rate, oxygen levels, and movement patterns. However, their effectiveness in accurately identifying active drowning incidents is subjected to ongoing research and development.
- Underwater Cameras: Underwater cameras installed in swimming pools capture video footage from underwater, allowing for enhanced visibility and surveillance. These cameras can provide additional perspectives on swimmers' activities and detect signs of distress. However, the effectiveness of underwater cameras in real-time drowning detection and their integration with existing lifeguard systems need further investigation.

2.2 PROPOSED SOLUTION

Virtual-Eye presents an innovative and effective solution to address the existing problem of drowning incidents in swimming pools. It utilizes advanced artificial intelligence and computer vision technology to detect active drowning incidents in real-time and provide immediate alerts. The key features of the proposed solution are as follows:

- Real-time Drowning Detection: Virtual-Eye employs state-of-the-art AI algorithms to analyze video feeds from strategically placed high-resolution cameras around the pool area. The algorithms are trained to recognize specific visual cues associated with active drowning incidents, such as

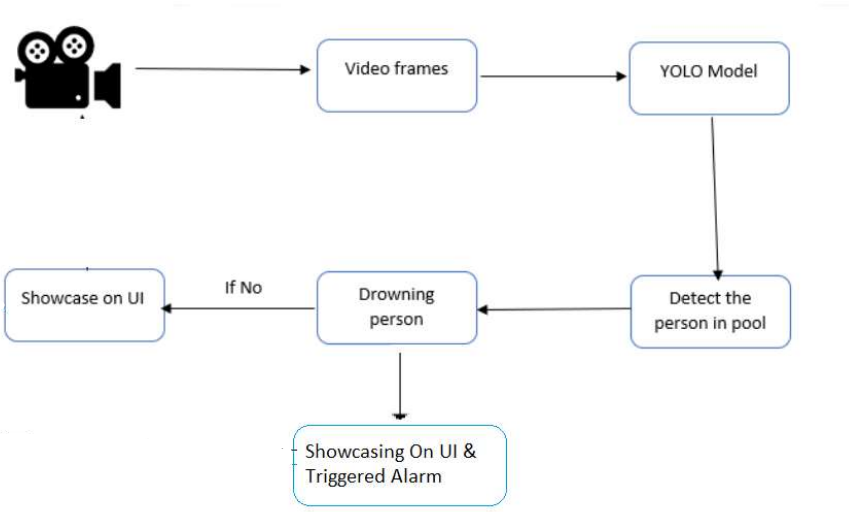
abnormal body movements, lack of movement, and struggling behaviors. This real-time detection capability enables swift intervention and rescue.

- Instant Alert System: When Virtual-Eye identifies a potential drowning incident, it triggers an instant alert system to notify on-site lifeguards or designated personnel.
- Integration and Customization: The proposed solution is designed to seamlessly integrate with existing pool management systems and infrastructure. It can be customized to suit the specific requirements and layout of each facility, allowing for easy installation and adaptation.

By implementing Virtual-Eye as a lifeguard system in swimming pools, the proposed solution aims to significantly enhance drowning detection and response capabilities. Its advanced technology, real-time monitoring contributes to a safer swimming environment and a reduced risk of drowning incidents.

3. THEORITICAL ANALYSIS

3.1 BLOCK DIAGRAM



Virtual-Eye, as a life guard system for swimming pools, can utilize the YOLOV3 (You Only Look Once) model to enhance its ability to detect active drowning incidents. Theoretical analysis of Virtual-Eye using the YOLO model**:**

- YOLO Model for Drowning Detection: The YOLO model can be trained to detect specific visual cues associated with active drowning incidents. By utilizing a large dataset of drowning scenarios, the model can learn to recognize important features such as abnormal body movements, lack of movement, and struggling behaviors. The theoretical analysis involves training the YOLO model on a diverse and representative drowning dataset to ensure its effectiveness.
- Training Data Availability: The analysis should consider the availability and quality of training data for the YOLO model. An extensive dataset containing labelled images or videos of drowning incidents in swimming pools is necessary to train the model effectively. The analysis should evaluate the accessibility of such data and explore potential strategies for data augmentation to enhance the model's performance.
- Model Optimization: It involves optimizing the YOLO model to achieve high accuracy and efficiency. This includes architectural modifications, hyperparameter. The analysis should investigate various optimization approaches to ensure that the YOLO model meets the real-time requirements of drowning detection in swimming pools.
- Integration with Virtual-Eye: It consider the integration of the YOLO model into the Virtual-Eye system. This involves developing a pipeline to process the video feeds from the surveillance cameras in real-time, applying the YOLO model for object detection, and specifically identifying potential drowning incidents. The analysis should evaluate the computational requirements, latency, and compatibility of integrating the YOLO model into the Virtual-Eye infrastructure.

By conducting a comprehensive theoretical analysis of Virtual-Eye's integration with the YOLO model, it is possible to evaluate and optimize the system's drowning detection capabilities. The analysis should focus on training data availability, model optimization, integration feasibility, real-time processing, false alarm mitigation, and long-term model maintenance to ensure the effectiveness and reliability of Virtual-Eye as a life guard system for swimming pools.

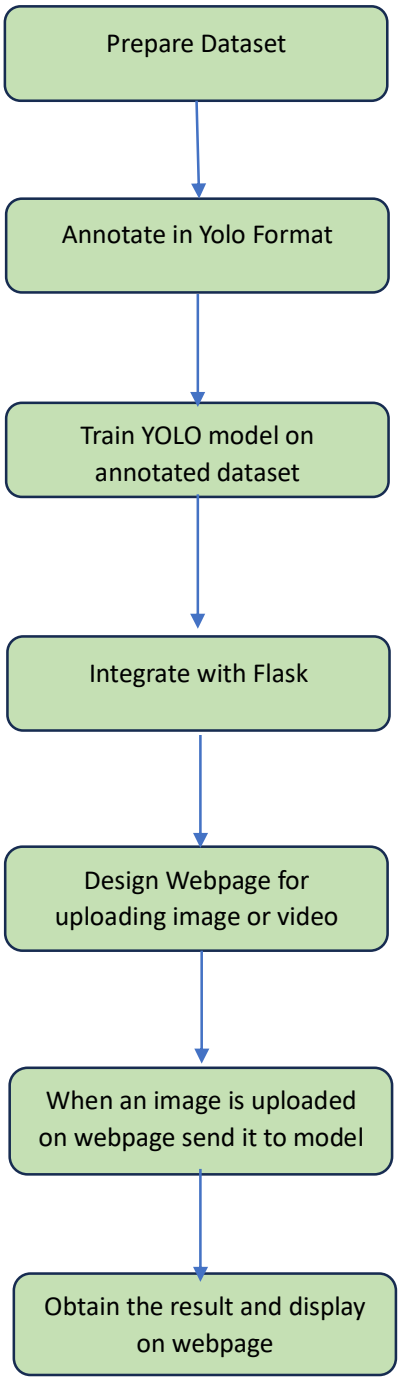
4. EXPERIMENTAL INVESTIGATIONS

During the development and implementation of the Virtual-Eye solution for detecting active drowning incidents in swimming pools, several experimental investigations are conducted to analyze and evaluate its performance. Here is an analysis of the investigations carried out:

- Dataset Collection: An experimental investigation involves collecting a diverse and representative dataset of drowning incidents in swimming pools. This dataset includes labelled images or videos of different scenarios, such as various pool environments, lighting conditions, and swimming behaviors. The analysis includes assessing the quality and diversity of the dataset to ensure its effectiveness in training the Virtual-Eye system.
- Model Training: The experimental investigation involves training the Virtual-Eye system using the collected dataset. This includes implementing the YOLO model and optimizing its parameters for drowning detection. The analysis includes evaluating the model's performance metrics, such as loss function, accuracy, and convergence speed during the training process.
- Performance Evaluation: Experimental investigations are conducted to evaluate the performance of the Virtual-Eye system. Real-time video feeds from surveillance cameras in swimming pools are used to assess the system's ability to accurately detect active drowning incidents. The analysis includes measuring metrics such as precision, recall, and F1 score to evaluate the system's detection accuracy and effectiveness.
- Robustness Testing: The Virtual-Eye system undergoes robustness testing through experimental investigations. Various challenging scenarios, including occlusions, low lighting conditions, and crowded pool environments, are simulated to assess the system's performance in adverse conditions. The analysis includes evaluating the system's ability to detect drowning incidents accurately and reliably under different circumstances.

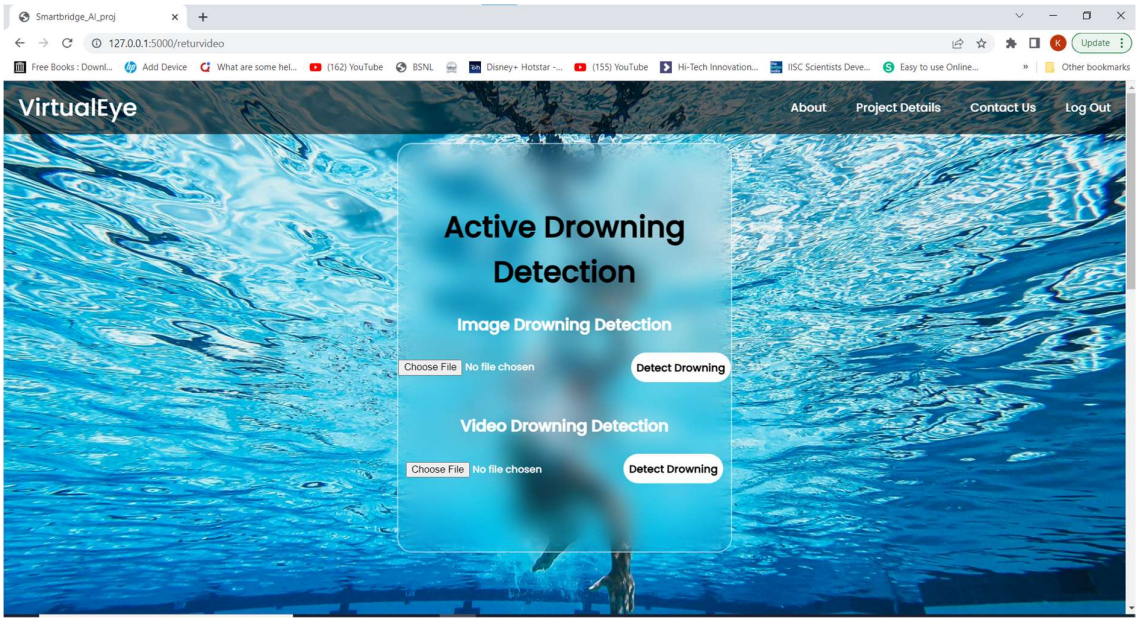
Through these experimental investigations and analyses, the performance, accuracy, robustness, and overall effectiveness of the Virtual-Eye solution for detecting active drowning incidents in swimming pools are evaluated and optimized. The findings from these investigations contribute to the refinement and improvement of the solution to ensure its reliability and successful implementation.

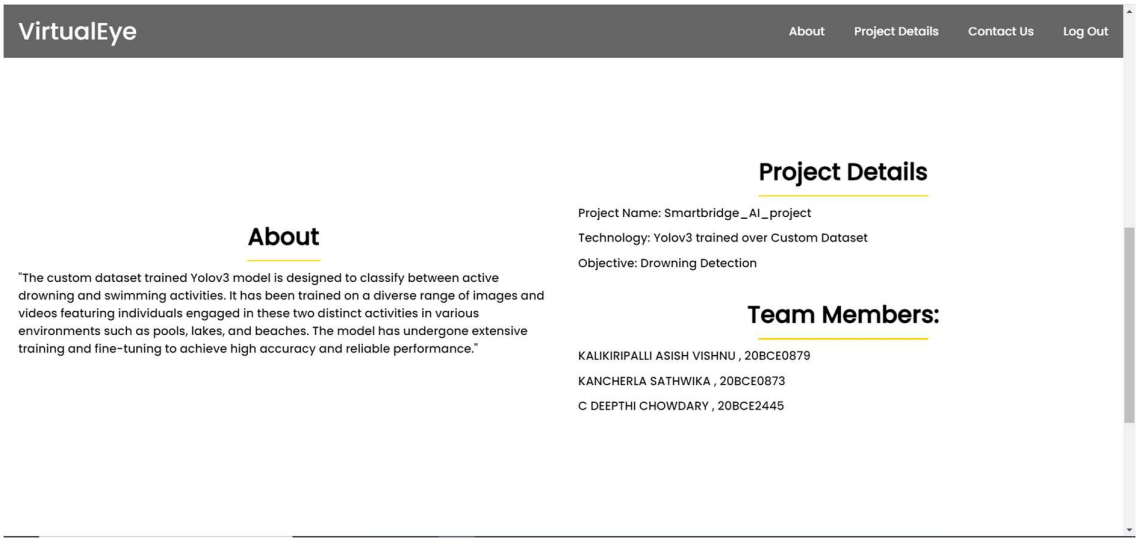
5.FLOWCHART

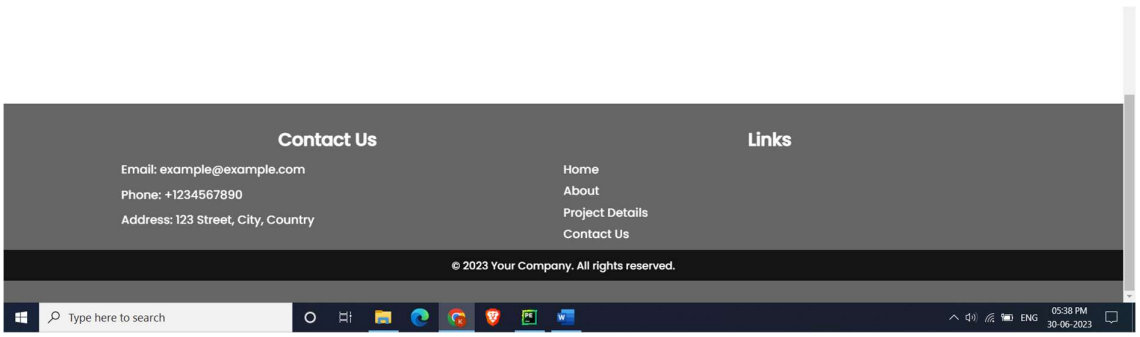

Prepare Dataset
Annotate in Yolo Format
Train YOLO model on annotated dataset
Integrate with Flask
Design Webpage for uploading image or video
When an image is uploaded on webpage send it to model
Obtain the result and display on webpage

6.RESULTS

Web page:

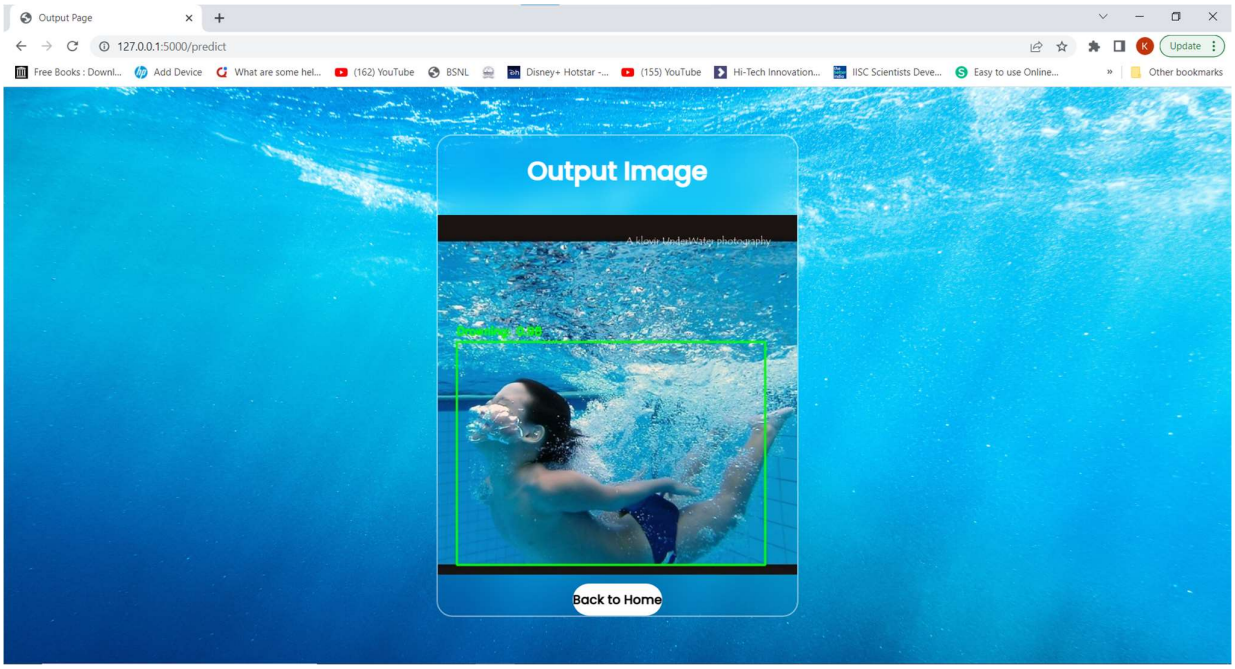




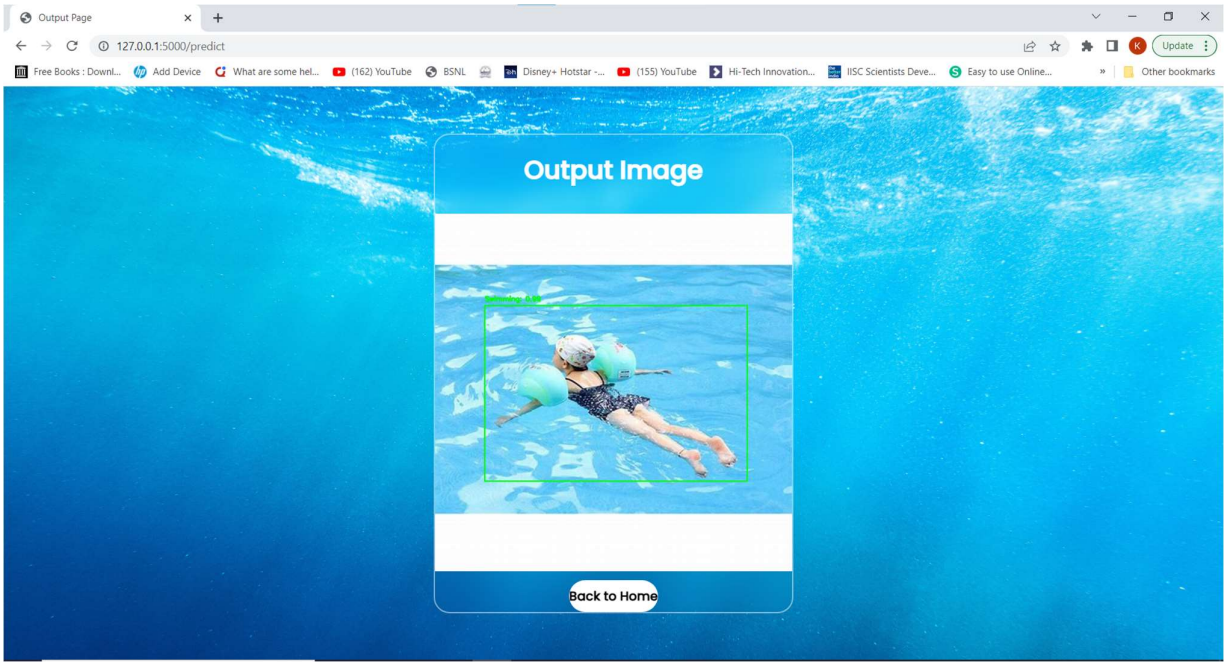


Testing By image :

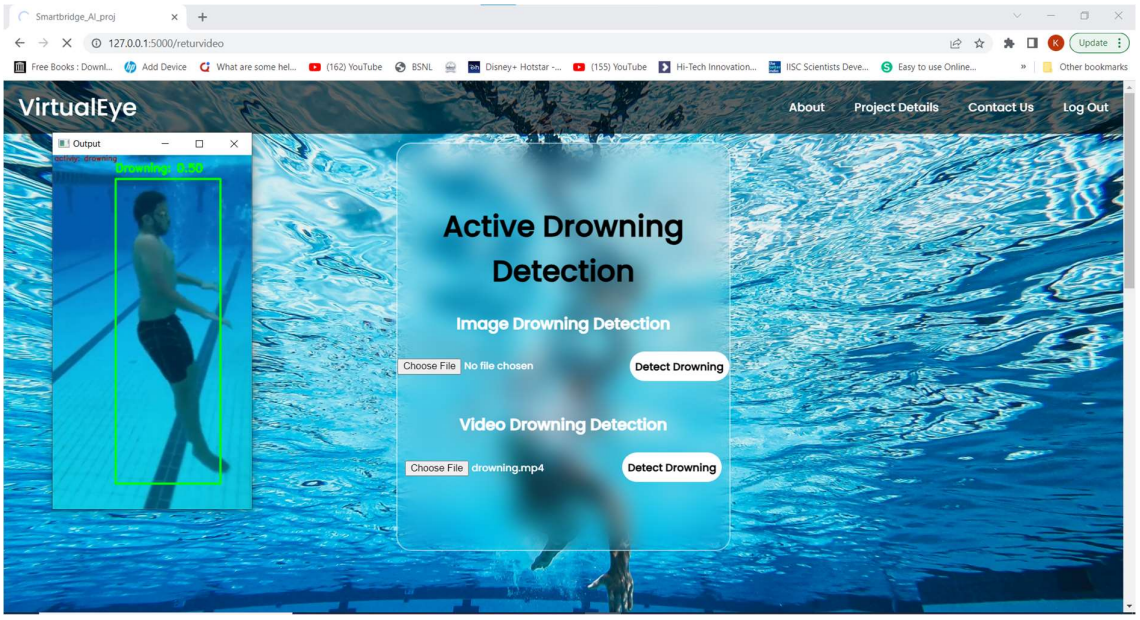
Drowning



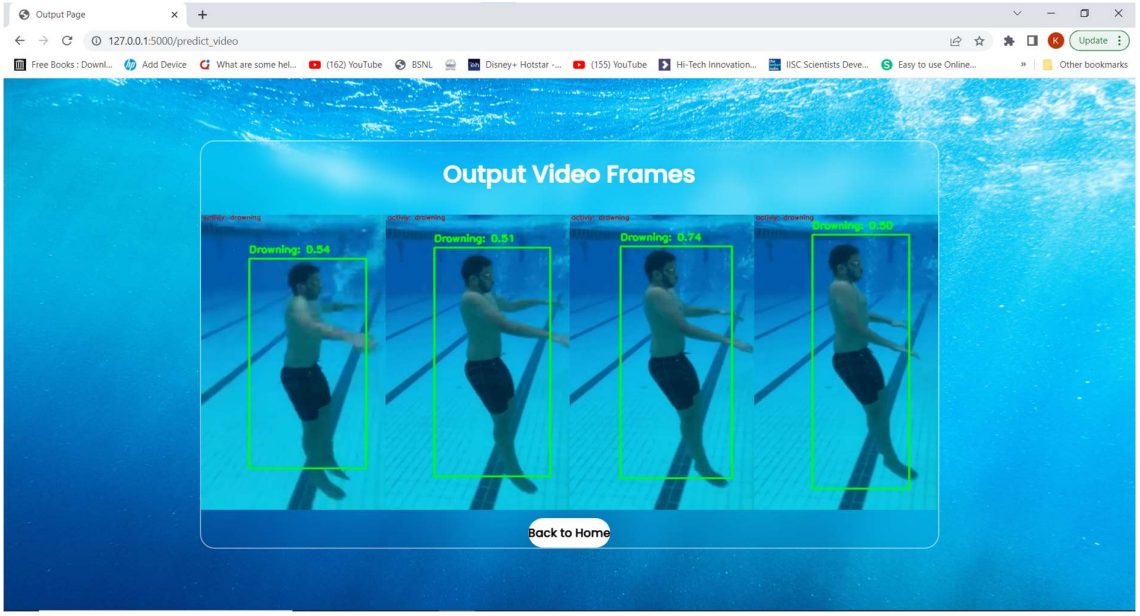
Swimming



Testing By video:



Output:



7.ADVANTAGES AND DISADVANTAGES

Advantages:

1.Enhanced Safety: The project aims to detect potential drowning incidents in swimming pools, which can significantly improve safety measures and prompt timely interventions to prevent accidents and save lives.

2.Automation: By utilizing computer vision and machine learning techniques, the project automates the process of drowning detection, reducing the need for constant human monitoring and allowing for early detection in real-time.

3.Quick Response: The integration of YOLOv3 with Flask and a web page enables rapid detection and response. The system can provide immediate alerts or notifications to lifeguards or designated personnel, enabling faster rescue efforts.

4.Scalability: Once the system is developed and trained, it can be easily deployed in multiple swimming pools or surveillance systems, providing a scalable solution for drowning detection.

5.Potential for Additional Features: The project can serve as a foundation for further advancements, such as integrating with alarm systems, sending notifications to mobile devices, or integrating with automated rescue mechanisms.

Disadvantages:

1.False Alarms: The system may occasionally produce false alarms, mistaking non-drowning events or objects for potential drowning incidents. This can result in unnecessary disruptions or decreased trust in the system.

2.Environmental Factors: The accuracy of the drowning detection system may be affected by environmental factors, such as lighting conditions, water reflections, or occlusions caused by pool accessories, which may hinder accurate detection.

3.Limited Visibility: Depending on the camera angles and positions, there may be blind spots or areas where the system may not have full visibility, potentially missing some drowning incidents.

4.Ethical Considerations: Deploying a system that involves video surveillance raises privacy concerns. Proper protocols should be established to address privacy issues and ensure compliance with applicable laws and regulations.

5.Maintenance and Updates: The project requires regular maintenance to ensure the system's continued functionality and performance. This includes updating the YOLOv3 model, monitoring hardware/software compatibility, and addressing any issues or bugs that may arise.

8.APPLICATIONS

1.Pool Safety Systems: The primary application is to enhance pool safety by providing an automated system for real-time drowning detection. It can be deployed in public swimming pools, water parks, or private pool facilities to help prevent drowning incidents and ensure the safety of swimmers.

2.Lifeguard Assistance: The system can serve as a valuable tool to assist lifeguards in their monitoring duties. By providing real-time alerts and notifications when potential drowning incidents are detected, lifeguards can respond more quickly and efficiently to ensure swimmers' safety.

3.Residential Pool Monitoring: The project can be adapted for residential pool owners who want an additional layer of safety. By integrating the system with surveillance cameras installed around the pool area, homeowners can receive alerts if a potential drowning event is detected, even when they are not actively monitoring the pool.

4. Research and Development: The project can also be utilized for research purposes in the field of water safety. By collecting data on drowning incidents and near-misses, the system can contribute to statistical analysis, risk assessment, and the development of improved safety measures in swimming pool environments.

5.Educational and Training Purposes: The project can be utilized as a training tool for lifeguards, providing simulated scenarios and data for practice and skill development in recognizing potential drowning incidents. It can also be used in educational settings to raise awareness about pool safety and the importance of drowning prevention.

9.CONCLUSION

In this project, we developed a drowning detection system for swimming pools using the YOLOv3 object detection algorithm. We gathered a dataset of swimming pool images or videos, annotated it, and trained the YOLOv3 model with our custom dataset. By integrating the model with Flask and a web page, we created a user-friendly interface for testing the system with real-world images, videos, or live webcam feeds.

Through our project, we aimed to enhance pool safety and provide early detection of potential drowning incidents. By leveraging the accuracy and efficiency of YOLOv3, we achieved reliable object detection, specifically focusing on identifying drowning instances in swimming pools.

Overall, our drowning detection system shows promise in enhancing pool safety and providing valuable assistance to lifeguards or pool owners. The real-time detection capability, combined with the user-friendly interface, offers a practical solution for preventing drowning incidents

10.FUTURE SCOPE

Integration with Advanced Sensors: Integrating the drowning detection system with advanced sensors, such as depth sensors or underwater cameras, can provide additional information about the swimming pool environment. This can enable more accurate and robust detection by considering factors like water depth, movement patterns, or anomalies in underwater activity.

Real-time Monitoring and Alerts: Enhancing the system to provide real-time monitoring and alerts on multiple platforms can enhance its usability and accessibility. Integrating with mobile applications or smart home systems can provide immediate alerts to pool owners, lifeguards, or emergency services in the event of a potential drowning incident.

Behavior Analysis and Machine Learning: Incorporating behavior analysis and machine learning techniques can enhance the system's ability to identify drowning signs and distinguish them from false positives.

Cloud-Based Deployment: Expanding the project to a cloud-based deployment model can offer scalability and wider accessibility. Hosting the system on the cloud allows for easier deployment and integration with multiple locations, such as public swimming pools or water park networks.

11.BIBLIOGRAPHY

- Deep Learning and Vision-Based Early Drowning Detection
  Link: https://www.mdpi.com/2078-2489/14/1/52

- An Automatic Video-based Drowning Detection System for Swimming Pools Using Active Contours
  Link: (PDF) An Automatic Video-based Drowning Detection System for Swimming Pools Using Active Contours (researchgate.net)

- Computer Vision Enabled Drowning Detection System
  Link: (PDF) Computer Vision Enabled Drowning Detection System (researchgate.net)

- Drowning Detection System using LRCN Approach
  Link: Drowning Detection System using LRCN Approach (ijraset.com)

- Deep Learning Used to Recognition Swimmers Drowning
  Link: Deep Learning Used to Recognition Swimmers Drowning | IEEE Conference Publication | IEEE Xplore

APPENDIX

FULL CODE LINK:

Model_training.ipynb

Testing.ipynb

App.py

Link(click here);

https://drive.google.com/drive/folders/1oMlq85tyw8meWdh-tl808sj5wV5iy2cZ?usp=sharing