IBM Hack Challenge 2023

SafeZone: Real-time Video Analytics for Industrial Safety

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1. Introduction

In today's rapidly evolving industrial landscape, ensuring the safety of workers and maintaining a secure work environment is of paramount importance. The integration of cutting-edge technologies has paved the way for innovative solutions that can address these concerns effectively. This project aims to revolutionize industrial safety protocols by harnessing the power of real-time video analytics to identify, prevent, and respond to potential hazards in industrial settings.

1.1 Overview

This project merges the power of real-time video analysis with advanced machine learning techniques. Its primary objective is to create a safer working environment within industrial facilities, minimizing the risk of accidents, injuries, and potential loss of life. By harnessing the capabilities of AI-driven video analytics, this project can swiftly identify, assess, and respond to potential safety hazards as they unfold.

This project can be operated by deploying an array of strategically positioned cameras throughout the industrial space. These cameras act as vigilant sentinels, capturing every corner and aspect of the environment. The real magic, however, lies in the intelligent algorithms that process these live feeds. These algorithms have been trained to recognize patterns associated with dangerous situations, whether it's a breach of personal protective equipment (PPE) protocols, a fire caught, or a spill on the factory floor.

1.2 Purpose

Traditional safety measures often rely on retrospective analysis and manual intervention, which can lead to delays in addressing imminent dangers. This project aims to shift the paradigm by proactively identifying risks in real-time and enabling timely intervention.

By doing so, the system acts as a proactive safeguard, significantly reducing the likelihood of accidents and injuries. It not only protects the physical well-being of workers but also safeguards the infrastructure, minimizing the potential for costly downtime due to accidents. Moreover, the project contributes to cultivating a safety-first culture within the organization, emphasizing the value placed on employee welfare.

2. Literature Review

2.1 Existing Problem

Industrial safety has always been a critical concern, as the interplay of complex machinery, human workers, and dynamic environments creates a breeding ground for potential hazards. Traditional safety measures have relied heavily on manual inspection which inherently possess limitations in terms of speed, accuracy, and coverage. These methods often lead to delayed responses to emergent situations, increasing the risk of accidents, injuries, and operational disruptions. Additionally, the increasing scale and complexity of modern industrial facilities have highlighted the need for more proactive and comprehensive safety solutions.

The difficulties of dealing with industrial safety using traditional methods have led to the investigation of technological solutions. Early efforts included the use of surveillance cameras, but they often struggled to distinguish between regular and dangerous scenarios. Additionally, the lack of real-time analysis limited the ability to stop the accidents from becoming worse.

2.2 Proposed Solution

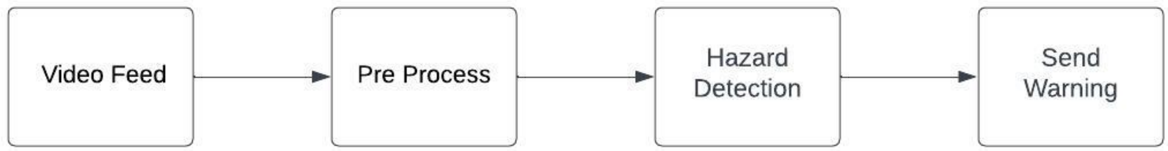
The proposed solution is a two-pronged approach: prevention and rapid response. We present a web application that detects hazards from live video feeds, which acts as a safeguard to reduce accidents and injuries. The system also sends alert messages via SMS and in the interface for rapid response to potential hazards.

This solution leverages advancements in computer vision, artificial intelligence, and real-time data analysis to transform industrial safety protocols. It involves incorporating intelligent algorithms to process live video feeds. These algorithms, which are meticulously trained using machine learning techniques, can identify hazardous patterns in real time, including breaches in personal protective equipment (PPE), fire detection, spill identification, and even the recognition of potential ignition sources such as cigarettes.

A distinguishing feature of this solution is its adaptability. Industry owners can select and fine-tune specific detection models to meet their specific needs. This flexibility ensures that the solution is relevant in a variety of industrial settings. Additionally, the project goes beyond real-time video analysis by incorporating static image analysis, demonstrating the system's real potential to enhance industrial safety.

3. Theoretical Analysis

3.1 Block Diagram



3.2 Software Designing

1. Architecture

- Web Application is build using Streamlit. Streamlit is hosted on Google Cloud Platform.

2. Modules

- Data Extraction
- Pre-processing
- Model training
- Prediction
- Visualization

3. Data

The datasets are downloaded from Roboflow. The following datasets were used to train the model.

Dataset	Train Images	Valid Images	Test Images
Fire	290	92	81
Cigarette	203	95	74
PPE	231	80	77
Spill	201	55	61

4. Experimental Investigation

We collected our dataset from Roboflow and divided it into two parts: training and testing. We allocated 80% of the data for training the model and reserved the remaining 20% for testing. To facilitate training, we converted the image annotations into CSV files, creating separate CSV files for both the training and testing datasets.

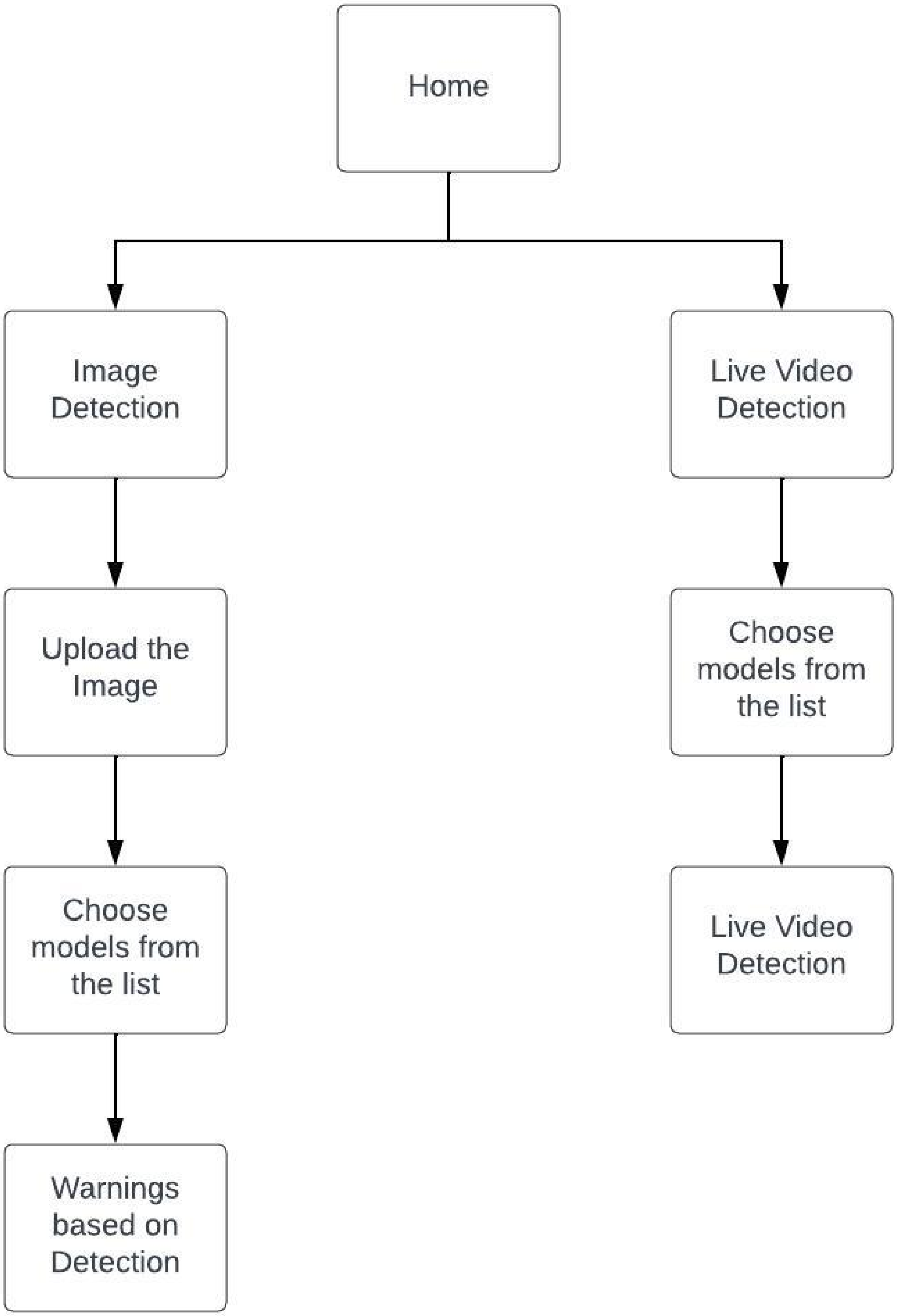
From these CSV files, we generated a label map file. This label map file plays a crucial role as it establishes a mapping between class IDs and their corresponding class names or labels.

Our dataset has images, which we transformed into TensorFlow TFRecord files to make them compatible with the training pipeline.

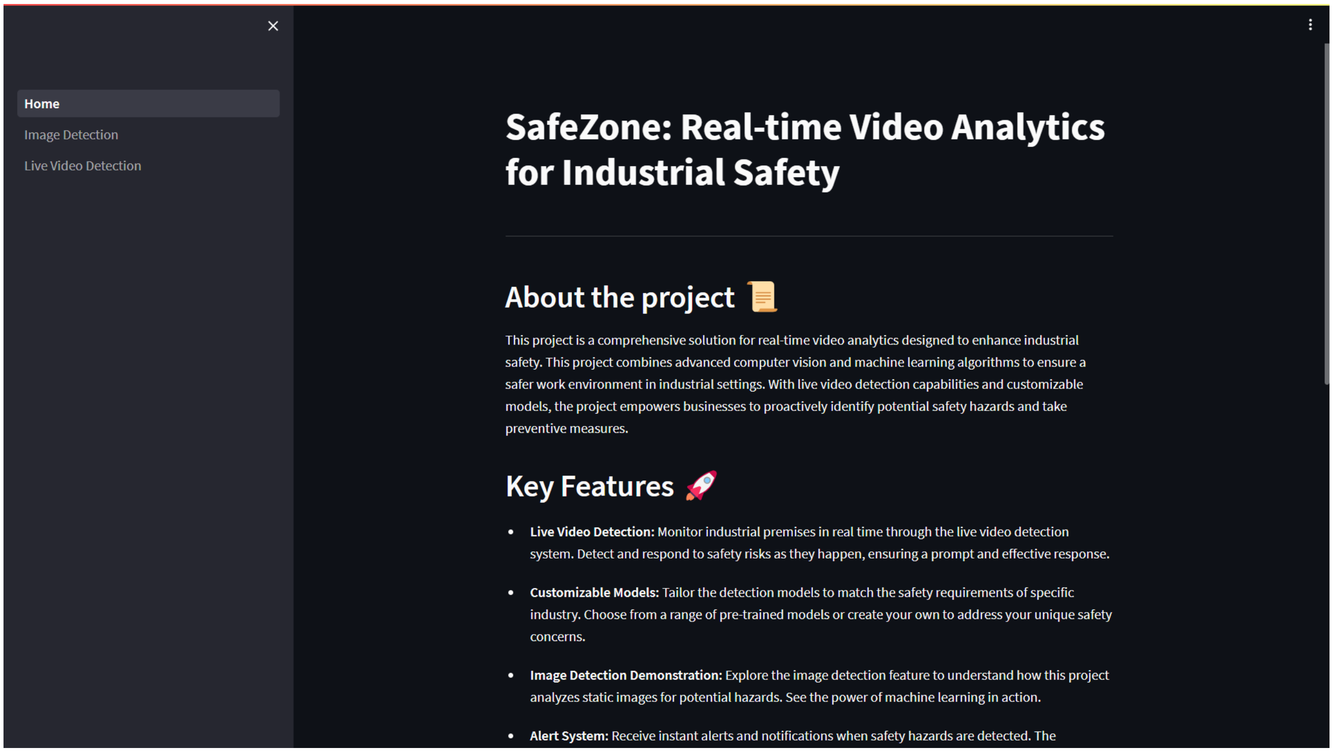
For training our model, we chose the SSD Mobilenet v2 architecture and configured its parameters according to the characteristics of our dataset. We then proceeded to train the model using this setup.

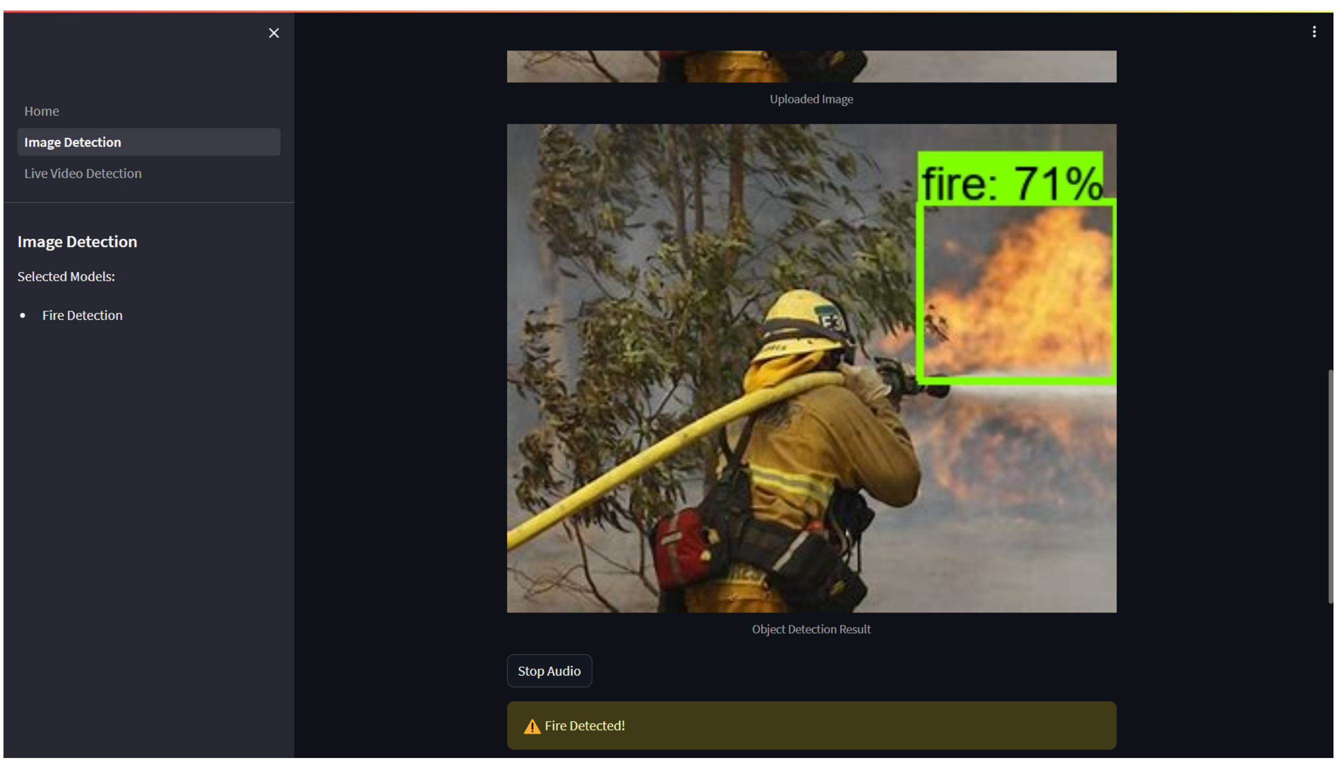
After training, we evaluated and tested the model's performance, making necessary optimizations as needed to achieve the desired results.

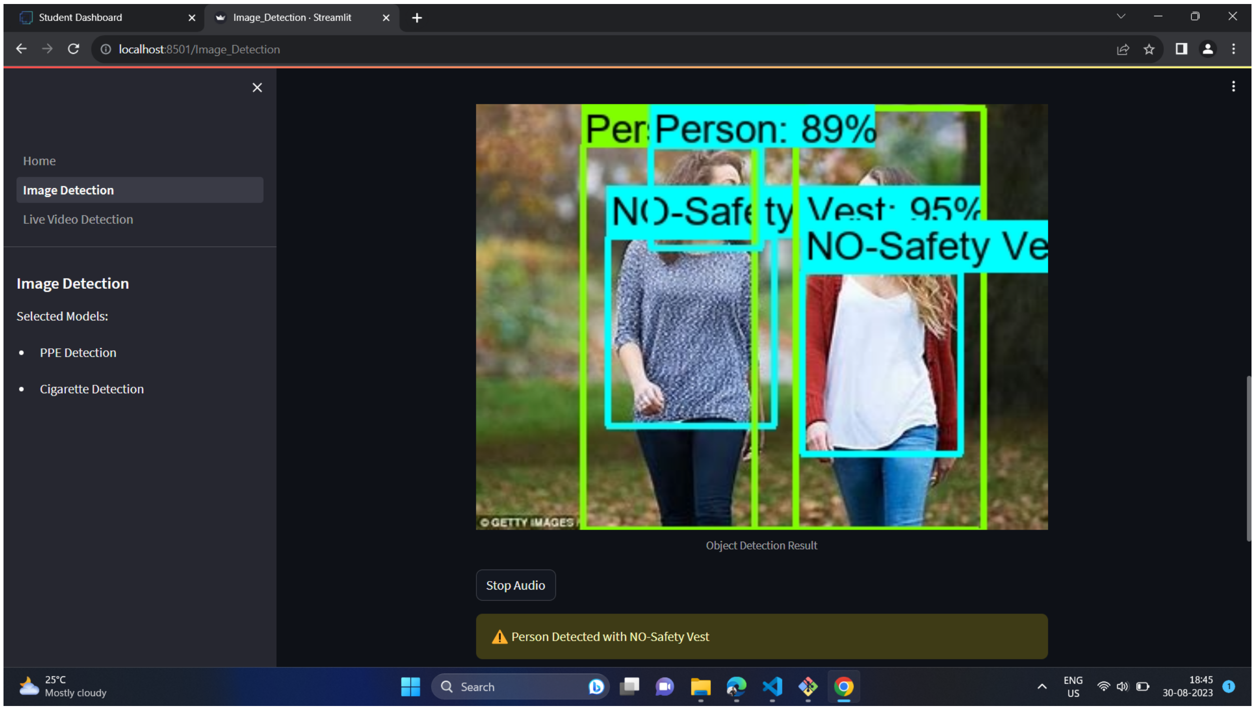
5. FlowChart


Home
Image Detection
Live Video Detection
Upload the Image
Choose models from the list
Choose models from the list
Live Video Detection
Warnings based on Detection

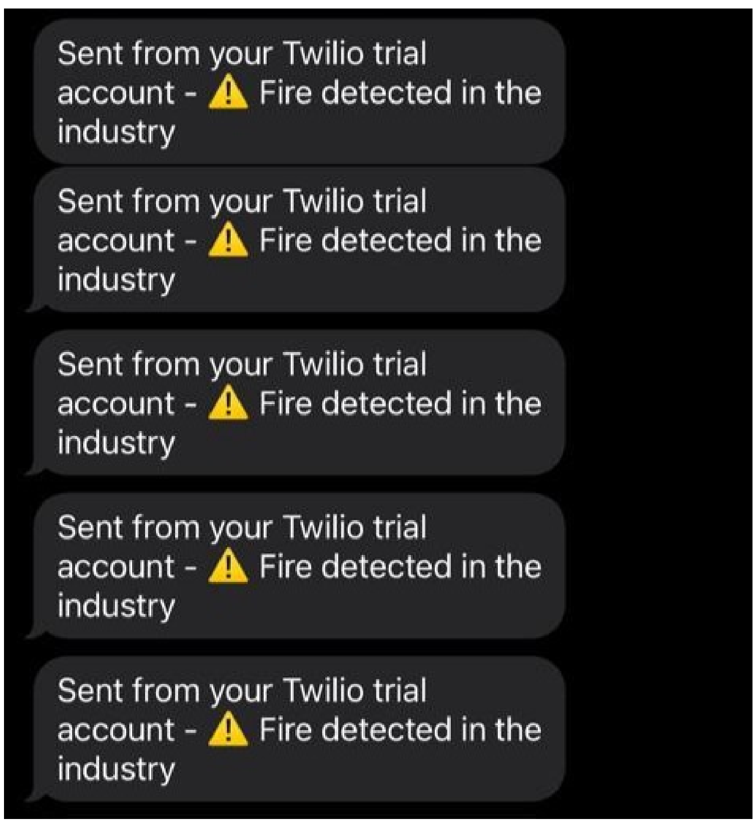
6. Result


Home
Image Detection
Live Video Detection
SafeZone: Real-time Video Analytics for Industrial Safety
About the project
This project is a comprehensive solution for real-time video analytics designed to enhance industrial safety. This project combines advanced computer vision and machine learning algorithms to ensure a safer work environment in industrial settings. With live video detection capabilities and customizable models, the project empowers businesses to proactively identify potential safety hazards and take preventive measures.
Key Features
Live Video Detection: Monitor industrial premises in real time through the live video detection system. Detect and respond to safety risks as they happen, ensuring a prompt and effective response.
Customizable Models: Tailor the detection models to match the safety requirements of specific industry. Choose from a range of pre-trained models or create your own to address your unique safety concerns.
Image Detection Demonstration: Explore the image detection feature to understand how this project analyzes static images for potential hazards. See the power of machine learning in action.
Alert System: Receive instant alerts and notifications when safety hazards are detected. The


Home
Image Detection
Live Video Detection
Image Detection
Selected Models:
Fire Detection
Uploaded Image
fire: 71%
Object Detection Result
Stop Audio
Fire Detected!



Alert Message received via sms



7. Advantages

- It can help detect safety breaches and potential hazards promptly.
- It can send immediate alerts or notifications when it detects unsafe conditions or unauthorized access. This allows for rapid response to incidents.
- It reduces the reliance on human operators to monitor video feeds continuously, which can be prone to fatigue and oversight.
- This project can scale to cover large industrial facilities, making it suitable for a variety of industries and acations.

8. Disadvantages

- There are chances to generate false alarms due to changes in lighting conditions, moving objects, or other factors. Tuning the system to reduce false positives can be challenging.
- It can raise privacy concerns among employees and visitors.
- They require regular maintenance to ensure whether they continue to function correctly. This includes cleaning cameras, updating software, and addressing hardware failures.

9. Conclusion

This project marks a substantial advancement in industrial safety protocols, blending real-time video analysis with advanced machine learning. Traditional safety methods often struggle to cope with the intricacies of modern industrial settings. By actively spotting potential risks as they arise, our solution not only lowers the chances of accidents and injuries but also nurtures a safety-oriented workplace culture. Our thorough data collection, model training, and rigorous testing have showcased the system's effectiveness and potential.

10. Future Scope

The potential for further advancement in this project is promising. Firstly, we can expand its applicability to a wider range of industrial sectors, tailoring the detection models to specific hazards prevalent in those environments. Additionally, integrating more advanced sensors and IoT devices could enhance real-time data collection and provide a more comprehensive safety overview. Fine-tuning the machine learning models and optimizing computational efficiency can lead to faster and more accurate hazard identification.

Furthermore, the project can be extended to offer predictive analytics, allowing it to anticipate potential hazards based on historical data and patterns. It can also be adapted to monitor worker behavior and assess fatigue levels to prevent accidents related to human factors. Collaboration with wearable technology could be explored for real-time monitoring of personal protective equipment (PPE) compliance.