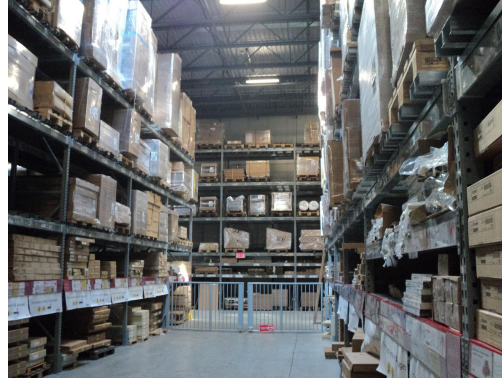


Safecheck AI – Using Convolutional Neural Networks to Improve Safety at Warehouses

By: Alfredo Hernandez, September 2024
Mentor: David Lara Arango Ph.D.

Background

- Warehouse dangers & hazards
 - 16 fatalities
 - 5% of workers report injury (higher than national average for other industries)
- OSHA (Occupational Safety and Health Administration)
 - **PPE**
 - Training
 - Cleanliness
 - Free of hazards
 - Inspect and maintain



Audit - 13/17 76.47%

Question	Response	Details
PPE Inspection Score (13/17) 76.47%		
Is ear protection provided to crew when around noisy equipment or machinery?	No	There are no ear protection available on site.
Are safety vests accessible and PPE provided and used when clearing up spillage or on hazardous materials and equipment?	Yes	
Are appropriate safety work procedures in place for the lifting of and decommissioning PPE after hazardous equipment?	Yes	
Recommendations		
List recommendations here: 1. Conduct regular inspection to maintain safety vest 2. Notify if any of employees wear appropriate PPE before commencing work 3. Respirator and ear protection should be available on site.		
Completion		
Full name and signature of Inspector	James Atkinson	13 Dec 2018 10:33 AM

Problem statement

- Develop a computer vision system to detect compliance with PPE using real time video feed.
 - At least 90% accuracy
 - 2s alert
 - 📉 PPE violations by 90%



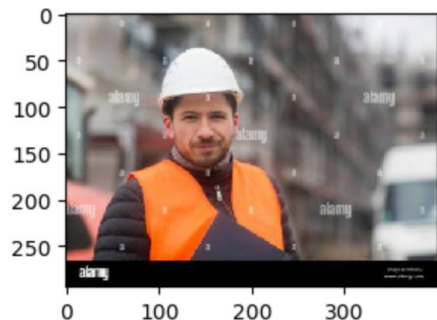
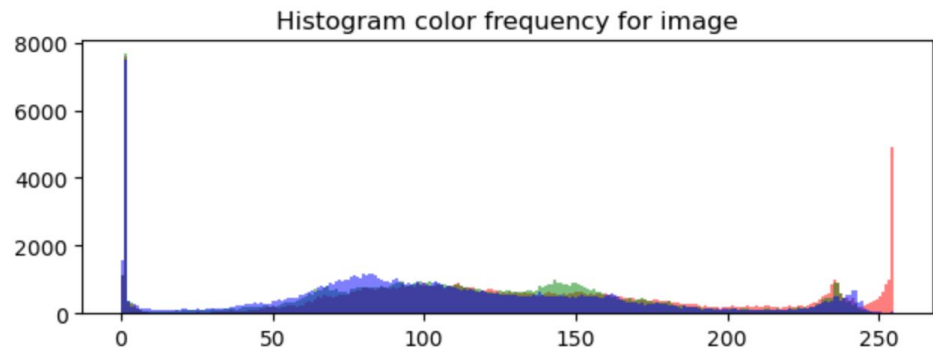
- Safety Officers
- Warehouse Managers
- Compliance officers

Data Sources

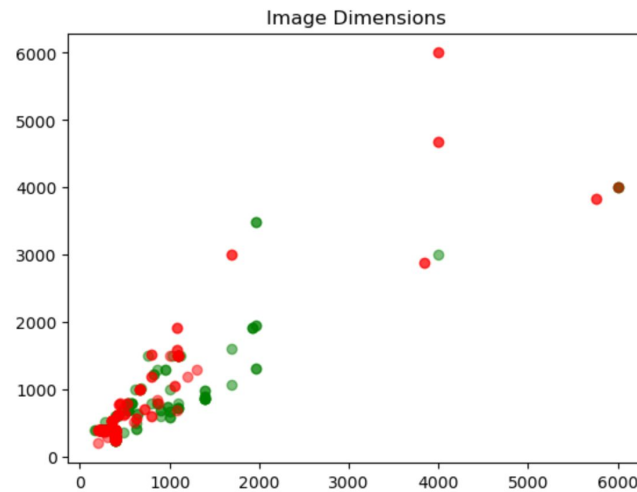
- [Employee Wearing Safety Gear](#)
- [Safety Helmet and Reflective Jacket](#)
- [Negative Dataset \(No Safety Gear\)](#)

kaggle

Exploratory Data Analysis (EDA)



- Class Distribution
 - (2:1) Training
 - (1:1) Test
- Varied Quality
- Different Object Focus
- Importance of all color channels



Methodology / Metrics

- Custom Convolutional Neural Network (CNN) for detecting PPE
 - Patterns: shapes, edges and texture
 - Learning features
 - Different pose, background and lighting



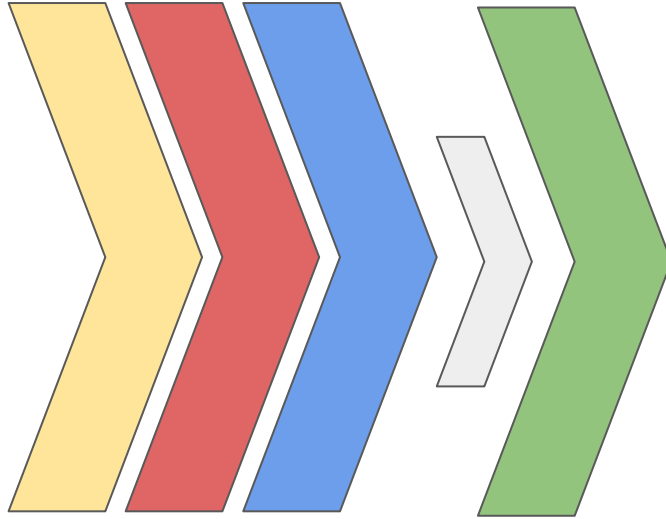
TensorFlow

- Preprocessing
 - Resizing
 - Random rotation
 - Random brightness
 - Contrast adjustments
- Build and train the model
- Performance Evaluation
- POC app

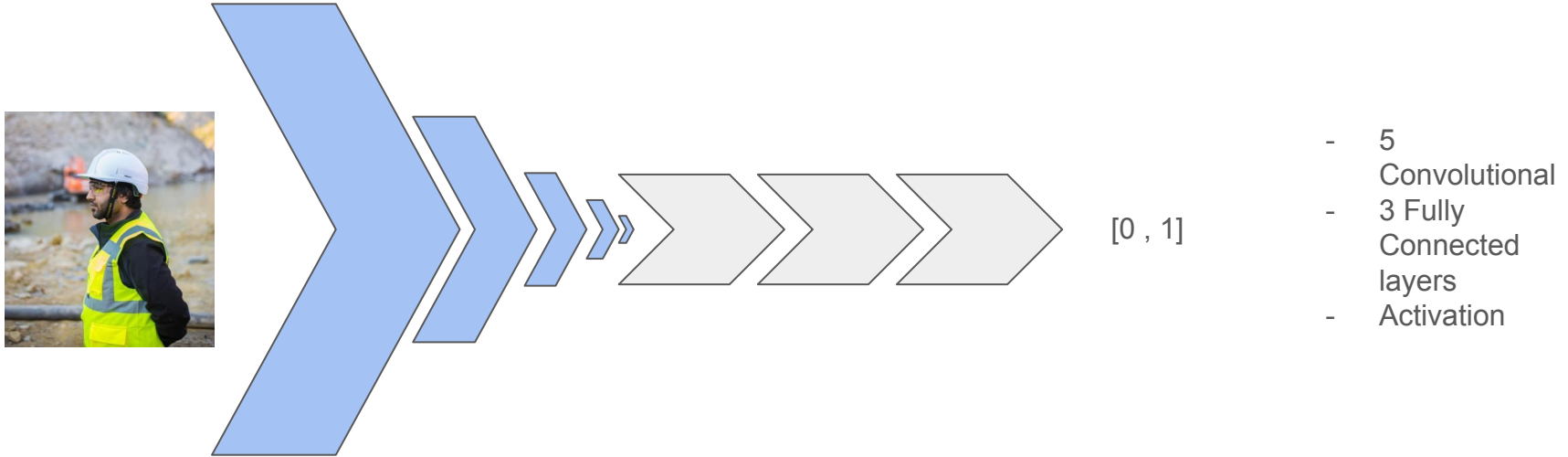
Metric : Accuracy

Model Architecture (Convolutional Layer)

- Max Pooling
- Drop Out
- Conv
- Activation (Relu)
- Batch Normalization



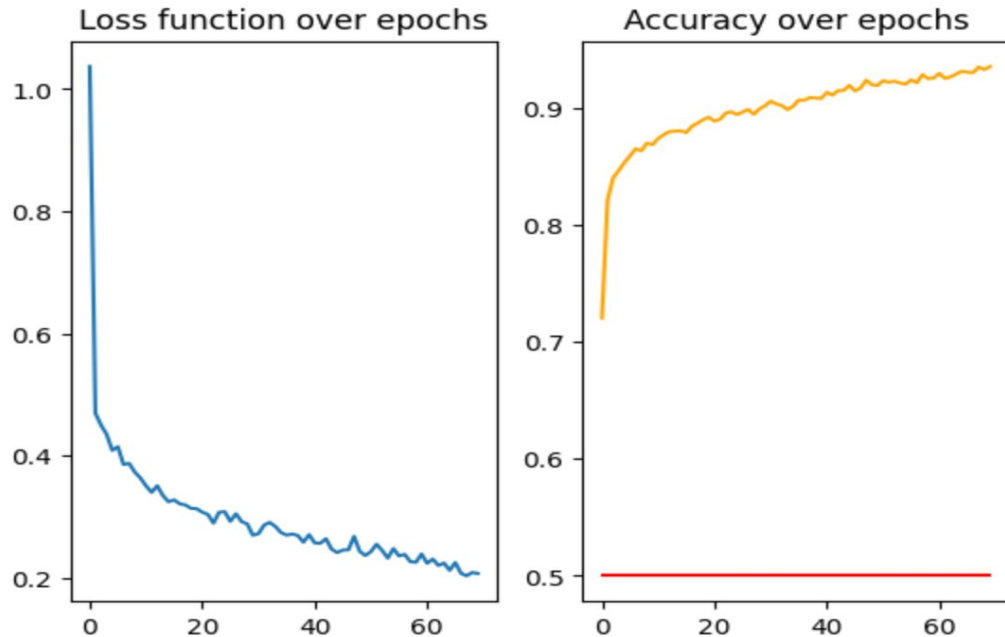
Model Architecture



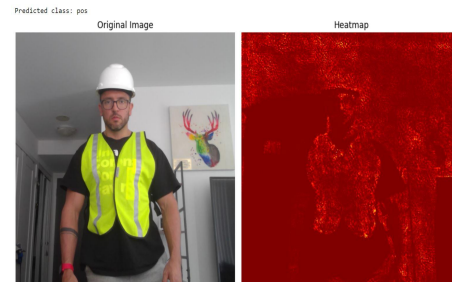
- Loss function: Binary Cross-Entropy
- Optimizer: Adam with a learning rate of 0.001.
- Epochs: 70, Batch size: 32.



Results



- Training Accuracy 93.79%
- Test Accuracy 90.02%

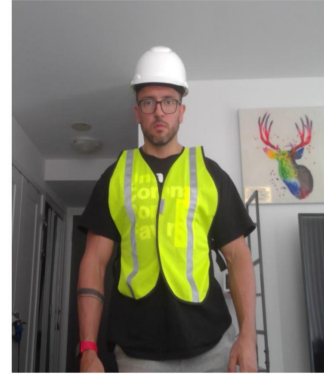


Feature Analysis

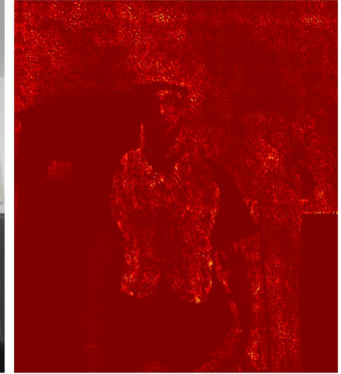
- Gradient based heatmaps
 - Vest primary focus
 - Complex background gets recognized
 - Lack of focus
- Future focus on retraining on site

Predicted class: pos

Original Image



Heatmap

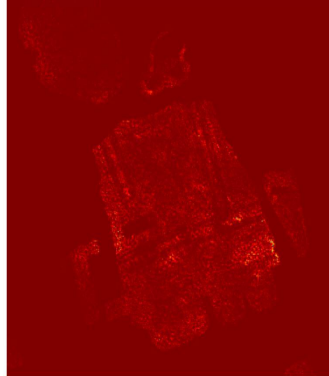


Predicted class: pos

Original Image



Heatmap

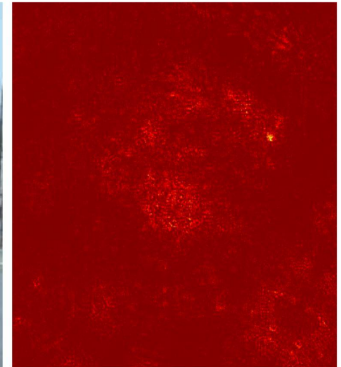


Predicted class: pos

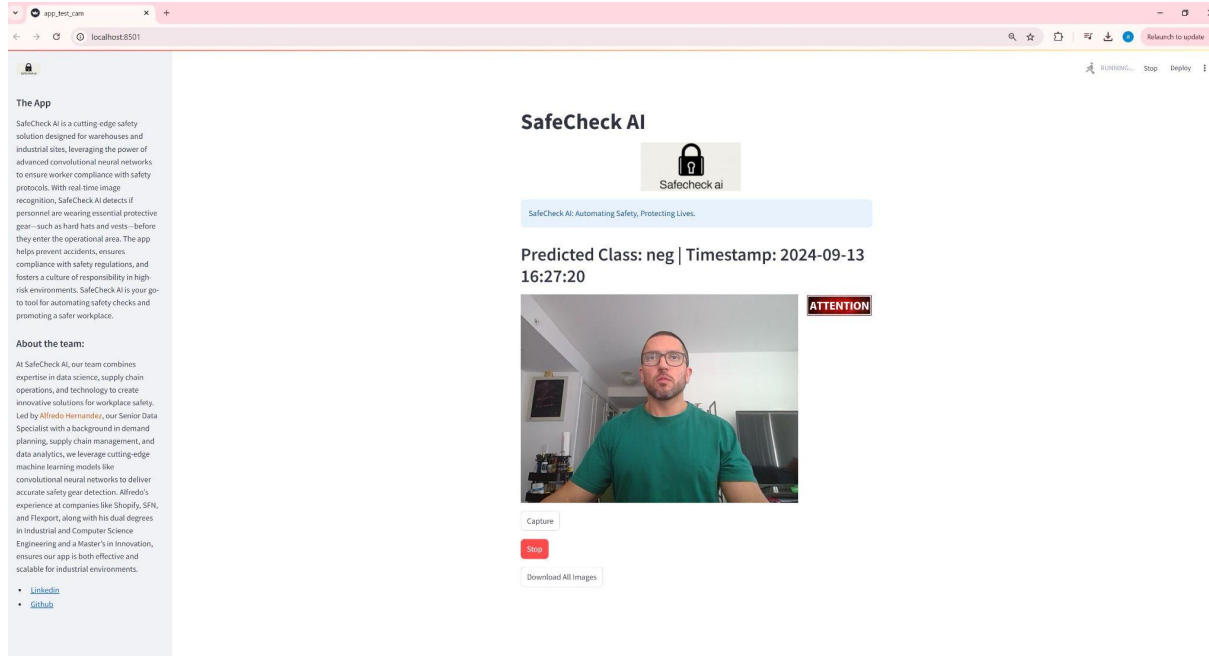
Original Image



Heatmap



Proof of Concept App



- Streamlit
 - Opencv-python
 - Custom CNN (Safecheck AI)
-
- Real time image capturing
 - Real time prediction
 - Image saving
 - Historical download

Conclusions and next steps

Safecheck AI successfully demonstrates how convolutional neural networks (CNNs) can be applied to improve workplace safety by automating the detection of essential safety gear like helmets and vests. With an accuracy of 93.79%, the model has shown strong potential in identifying workers without the proper protective equipment, providing a reliable tool for real-time safety monitoring

- **Deployment**
 - in real environment for better testing
- **Re-Training Schedule**
 - Model should be re-trained using locally acquired images from the warehouse to better recognize environmental factors specific to the location.
- **Background Handling**
 - Further refinement of the algorithm is needed to reduce the occurrence of false positives due to complex backgrounds.
- **Feature Expansion**
 - Future iterations may include multi-class classification to detect other forms of PPE beyond helmets and vests.

Q&A