Project Overview - Job Site Safety

Authors: Jason Raimondi, Jeremy Cryer, Maimuna Bashir
Business Name: PPE Vision Solutions
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Github Project Link: https://github.com/jerm914/Job-Site-Safety---AAI-540
Asana Board Link: https://app.asana.com/0/1206390072539638/1206390072539638

Project Background:

1-2 paragraphs describing, at a high level, the problem you are trying to solve. This should provide the reader context for the technical solution they will review. This should be a quick elevator pitch for your project. Be sure to answer the following:

- What is the model's objective?
- What type of Machine Learning problem will you be solving?

The ultimate objective of the project is to increase safety compliance, specifically adherence to wearing required Personal Protective Equipment (PPE) and reduce occurrences of serious injury on job sites. The objective of the model will be to detect, classify, and report instances of 'Helmet', 'Vest', and 'Head' from a provided input image. Instances of 'Head' may indicate absence of a required helmet being worn.

This is an object detection and classification Machine Learning problem to solve. First, the model will need to be able to sufficiently identify when these three types of objects are present in the image. Second, the model will need to be able to accurately classify the detected objects as the correct type or belonging to the correct category.

Technical Background:

1-2 paragraphs describing the technical details of the problem you are trying to solve. This should help the reader understand the project constraints. Be sure to answer the following:

- How will you evaluate your model?
- What is your data source?
    - How will you need to prepare your data?
    - How will you explore your data?
    - What do you hypothesize your main features will be?
- What type of model do you want to use?

To evaluate the model, a few different business metrics can be considered. First, the business can monitor and track instances of serious injury over time to see if the model implementation may be improving safety records (i.e., assuming business is intervening with employees when unsafe conditions are investigated). Second, the business can track instances of 'Head' being

detected in a given time period, work shift, etc. to see if their interventions are having a positive impact (i.e., instances of 'Head' reduced over time in favor of instances of 'Helmet'). Important model metrics include box loss (i.e., reduce error in object detection) and classification loss (i.e., reduce errors in classification).

The data source is from Kaggle:

HardHat-Vest Dataset
https://www.kaggle.com/datasets/muhammetzahitaydn/hardhat-vest-dataset-v3/data

The dataset contains 23,673 images, and there are at least 10,000 instances of each class available. Per Kaggle, the images should be consistently sized at 640x640 pixels, so resizing is not expected unless required for the model architecture. However, we plan to still validate the image sizing as claimed. Preparation should be minimal, assuming image annotations are of sufficient quality (expected to be, as the Kaggle usability rating is a 10.00). The dataset should be explored, minimally, by viewing sample images to gain an understanding of contents, considerations, and annotation quality. Bounding boxes will need to be applied to the images to inspect the quality and accuracy. Model features are hypothesized to be constructed via multiple Convolutional Neural Network (CNN) layers to obtain lower-level features and then higher-level features to ultimately support the classification task after detection. An initial suggestion would be to use a pre-trained YOLOv8 model architecture for this project, with fine-tuning for the specific dataset to improve the performance initially and to keep maintainability and adaptability in mind for ongoing use.

Goals vs Non-Goals:

Write a bulleted list of (3-5 points each) of goals and non-goals. This should help the reader understand the context that would factor into solution selections and trade-offs. Goals will help the reader understand what a successful outcome looks like. Non-goals will help limit the scope of your project and prevent scope creep.

Goals:

- Reduced instances of serious injury on construction sites (Business Metric)
- Increased safety compliance (wearing required PPE) (Business Metric)
- Low box loss (specific amount to be determined w/ company) (Model Metric)
- Low classification loss (focus on 'Helmet' and 'Head') (Model Metric)

Non-Goals:

- Resolving annotation issues / bounding boxes (if issues identified during exploration, discard from dataset)
- Model metrics for 'Vest' category (not the primary focus of this project to maintain simplicity)
- Use of multiple model architectures (also for simplicity)

Data Sources:

What is your data source?

Kaggle - HardHat-Vest Dataset
https://www.kaggle.com/datasets/muhammetzahitaydn/hardhat-vest-dataset-v3/data

What is your data volume?

23,673 images.

Why did you select this data set?

Our team has interest in the business problem that this dataset can help solve, and this dataset appears to be sufficient to support development of a solution to this problem. There are at least 10,000 instances of each class, including 'Helmet', 'Vest', and 'Head', which should provide a sufficient number of samples for our computer vision task.

Any risks (bias, sensitive features, etc)?

We are not aware of any bias or sensitive features present at this time. However, we will, minimally, inspect image samples and predictions to determine if there could be any considerations. For instance, we would want to make sure that we understand if performance may vary when detecting and classifying objects when considering different genders, race, skin tones, hairstyles, etc. Another risk we need to keep in mind is if there are any types of occlusions that could impact performance. If a worker is wearing sunglasses, a respirator, or if there is any other type of occlusion, does this affect the object being detected and/or classified correctly? This could also include other items such as ball caps and other items that are similar and may conflict with the PPE being detected in this problem. We need to be aware of any limitations such as this so that the solution can be advertised and implemented in suitable environments while providing us the necessary information to continually improve the solution.