An Automatic System to Monitor the Physical Distance and Face Mask Wearing of Construction Workers in COVID-19 Pandemic

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INTRODUCTION

- COVID-19 pandemic has caused many shutdowns in various industries
- Infrastructure construction and maintenance projects cannot be suspended due to Covid
- Due to the high density of workers in construction projects, there is a high risk of the infection spread in construction sites [1]
- To enhance construction workers' safety, systematic safety monitoring that ensure maintaining the physical distance and wearing face masks seemed vital
- The online video capturing in construction sites can be used for safety purposes
- An automatic system can utilize computer vision techniques to capture real-time safety violations from online videos to enhance infrastructure project workers' safety
- Faster R-CNN model was developed to detect workers who:
  - ❖ Don't wear a face mask
  - ❖ Don't maintain the physical distance in road projects

- **Objective : To develop a computer vision system to automatically detect the violation of face mask wearing and physical distancing among construction workers**
- **Contribution: To assure construction workers safety on infrastructure projects during the pandemic**

METHODOLOGY

1. Data Collection:

- 853 images of face masks was obtained from MakeML website [2]
- 1,000 other images with their annotations were added to increase the training data
- The total of 1,853 images was used as the facemask dataset
- The images were already annotated with faces
  - ❖ With a mask,
  - ❖ Without mask,
  - ❖ Incorrect mask wearing (Fig. 1)

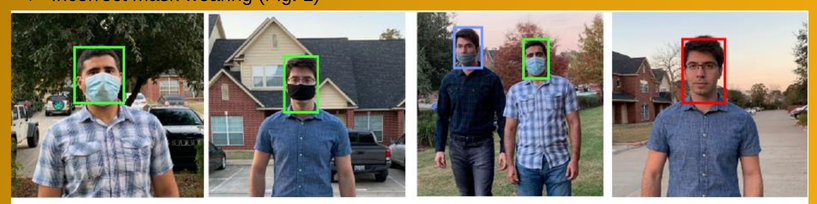

Figure 1. Examples of images in the facemask database

2.Face mask detection

- Five different object detection models in the TensorFlow object detection model were trained and tested [3]
- Among these five models, the Faster R-CNN Inception ResNet V2 800*1333 was selected because it resulted in the highest accuracy, i.e., 99.8%.

3. Physical distance detection

- Distancing detector model developed by [4] detects the physical distancing in three steps; people detection, picture transformation, and distance measurement.
- Original image captured from a perspective was transformed to the vertical view of bird's eye, which is shown in the Fig. (2) [4]

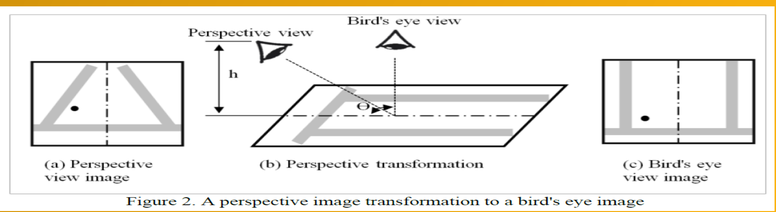

Figure 2. A perspective image transformation to a bird's eye image

4. Faster R-CNN model

Faster R-CNN consist the Region Proposal Network (RPN) and the Fast R-CNN as the detector network as shown in Fig. 3

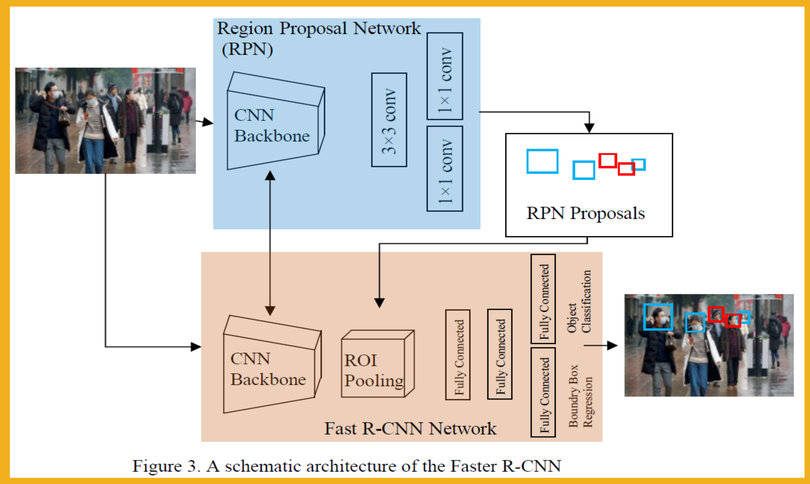

Figure 3. A schematic architecture of the Faster R-CNN

RESULTS

Face detection

- Batch size of 1
- The momentum optimizer of value 0.9
- Cosine decay Learning rate (learning rate base of 0.008) (Fig.4)

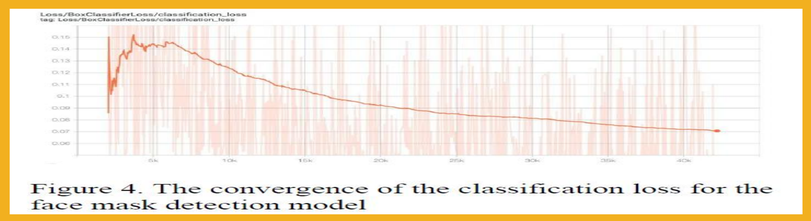

Figure 4. The convergence of the classification loss for the face mask detection model

- The model highlights who violates the safety rules (Fig. 5)

Face detection:

- A worker without a mask with 99% accuracy
- A worker wearing a mask with 97% accuracy.

- **Physical distance detection:**
- Red box : a person who don't practice physical distancing with a indicating a zone with a high risk of infection
- Green box: a person far from others, suggesting a safe zone

Figure 5. The application of the model on four road construction cases

DISCUSSION

- To evaluate the combined model, four videos of actual road maintenance projects were used.
- The output of the four cases showed an average of more than 90% accuracy in detecting
- Various types of mask wearing in construction workers were detected
- The model accurately detected workers who didn't follow the physical distancing
- The output cases resulted a reliable accuracy of face mask detection and physical distance detection of workers in road projects.

CONCLUSION

- For face mask detection, a FasterR-CNN Inception ResNet V2 network was chosen among various models since yielded the accuracy of 99.8%.
- For physical distance detection, the Faster R-CNN Inception V2 was utilized to detect workers.
- To remove the effect of the camera angle on actual distance, transformation matrix was utilized.
- Model results can be utilized in road construction projects to monitor workers to avoid infection and improve workers' safety.

FUTURE WORKS

- The model can be employed on other construction projects such as building projects.
- Other detection models can be developed and the hyperparameters can be tuned in a way that will increase the detection accuracy.

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- More information can be found here: https://arxiv.org/abs/2101.01373

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