DEVELOPING A MULTI-CLASS FACE MASK DETECTION SYSTEM FOR PUBLIC HEALTH

Ritika Jain
Department of Data Science and Engineering
IISER Bhopal, India
{ritika21}@iiserb.ac.in

ABSTRACT

The COVID-19 pandemic has highlighted the need for automated systems to monitor public health measures such as mask-wearing. This project reports on the development of a machine-learning model capable of detecting and classifying individuals' mask-wearing status in images. By employing a pretrained ResNet34 model and adapting it for multi-class classification, we aim to contribute to the containment of respiratory illnesses by enabling rigorous monitoring of mask adherence.

1 INTRODUCTION

The global pandemic has underscored the critical importance of face masks as a fundamental tool in curbing the spread of contagious diseases. In the interest of public health, the widespread adoption of face masks in various settings has become a pivotal strategy to mitigate the transmission of respiratory infections. In this context, the development of automated face mask detection systems has emerged as a valuable technological advancement with the potential to enhance monitoring and enforcement of mask-wearing protocols. This project delves into the design, development, and evaluation of a multi-class face mask detection system, aimed at contributing to public health efforts by accurately identifying not only the presence or absence of face masks but also distinguishing between various mask-wearing scenarios, such as proper mask usage, improper mask usage, and mask absence. By harnessing state-of-the-art computer vision and machine learning techniques, this project seeks to bridge the gap in existing face mask detection technologies, offering a versatile and robust solution to aid in maintaining public health and safety.

2 DATASET

This dataset comprises 853 images with annotations in PASCAL VOC format, divided into three classes: "With mask," "Without mask," and "Mask worn incorrectly." It facilitates the development of a precise model for detecting individuals wearing masks correctly, those without masks, and those with masks worn improperly. This dataset is instrumental in improving face mask detection systems, crucial for public health and mitigating respiratory diseases like COVID-19.

Figure 1: Sample Image from Dataset

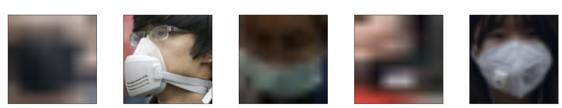


Figure 2: Detected Faces from Image

Figure 3: Combined Images

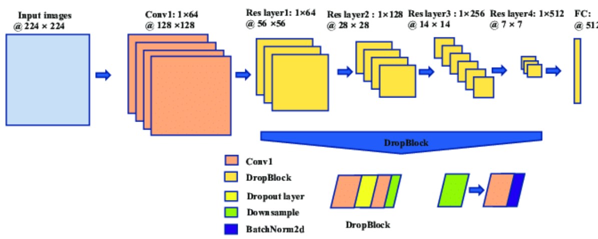
3 Methodology:

3.1 Dataset and Preprocessing

The initial phase involved curating a dataset with a diverse range of images annotated with XML files containing bounding boxes and class labels. The dataset was categorized into three classes with the following distributions: 79.37% with masks, 17.61% without masks, and 3.02% masks worn incorrectly. Preprocessing steps included separating the images from their annotations and analyzing the class distributions to understand the dataset's balance and characteristics.

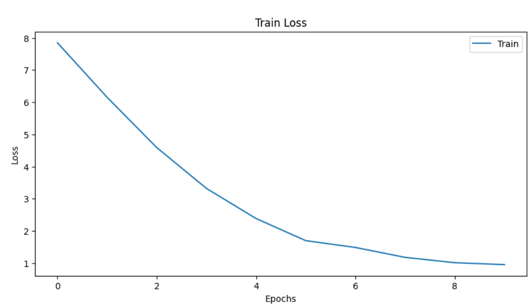
3.2 Model Architecture and Training

The model's architecture is based on the **ResNet34**, a convolutional neural network pretrained on the ImageNet dataset. We modified the output layer to classify three categories. During training, the model parameters were fine-tuned using a **cross-entropy loss** function and the **Adam optimizer** with a learning rate of 0.01. Model training was performed on a GPU to leverage accelerated computing resources, with checkpoints saved at each epoch.

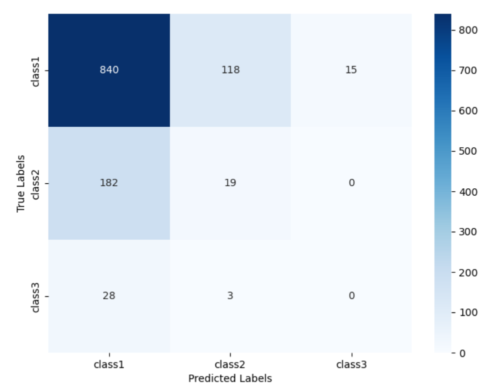


4 Results & Discussion

Preliminary results from the training process indicate an **overall accuracy of approximately 69.89**%. The confusion matrix from the model's predictions revealed an uneven distribution of accuracy across classes, attributed to the imbalance in the dataset.
The **dataset's class imbalance** presents a significant challenge, often leading to a *bias towards the majority class*. Future work will involve exploring algorithmic enhancements, such as cost-sensitive learning or synthetic data generation, to address this imbalance. We will also consider exploring different ResNet variants and incorporating advanced data augmentation techniques to improve the model's generalization capabilities.



(a) Training Loss Curve



(b) Confusion Matrix

5 Conclusion

The project has successfully navigated through data collection, preprocessing, and initial stages of model training. With planned enhancements and evaluations, the project is poised to achieve its objective of developing a face mask detection system that can significantly aid public health measures.