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FACE MASK DETECTION USING YOLOV5

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ABSTRACT: *Amid the ongoing COVID-19 pandemic, wearing face masks in public settings has been recognized as an effective measure to reduce the spread of the virus by minimizing the release of respiratory droplets from infected individuals. This study focuses on developing an efficient method for detecting face masks using a deep learning model based on "Yolov5". Different models were trained with varying numbers of epochs: 20, 50, 100, 300, and 500. Experimental findings indicate that the deep learning model trained with 300 epochs achieved the highest performance, boasting an accuracy of 96.5%..*

I. INTRODUCTION

The COVID-19 pandemic has necessitated widespread adoption of preventive measures, among which the use of face masks in public settings has proven crucial in reducing viral transmission. Face mask detection systems powered by deep learning have emerged as an innovative approach to enforce mask-wearing compliance effectively. This paper investigates the implementation of YoloV5, a state-of-the-art deep learning architecture, for the accurate and real-time detection of face masks.

YoloV5 is renowned for its efficiency and speed in object detection tasks, making it ideal for applications where rapid inference is essential, such as monitoring public spaces for adherence to mask mandates. By leveraging deep neural networks, this study aims to develop and evaluate face mask detection models trained on varying numbers of epochs. The performance metrics, including accuracy, precision, and recall, will be analyzed to determine the optimal training duration that yields the highest detection accuracy. arious studies have been conducted on face mask detection and classification using different deep learning techniques. The first study on face mask classification is a hybrid model developed by Loey et al. They used the ResNet50 model, one of the deep learning architectures, for feature extraction, and the decision trees (DT) and support vector machines (SVM) from traditional machine learning models for classification.

Through this research, insights into the effectiveness of YoloV5 in detecting face masks under different conditions and environments will be explored. The findings are expected to contribute to the development of robust systems capable of enhancing public health safety measures during the ongoing pandemic and beyond.

II. LITERATURE SURVEY

You Only Look Once: Unified, Real-Time Object Detection"Authors: Redmon, J. et al.Year: 2016.

Summary: This seminal paper introduces YOLO (You Only Look Once), a real-time object detection system that divides the task into a regression problem for bounding box coordinates and object class probabilities. YOLO has evolved into various versions, including YOLOv5, known for its improved speed and accuracy in detecting objects.

"A Survey on Deep Learning Techniques for Object Detection"Authors: Guo, S. et al.Year: 2020.

Summary: This survey reviews deep learning techniques applied to object detection tasks, including the evolution of YOLO models. It discusses different architectures, training strategies, and performance metrics used in the field of object detection, highlighting YOLO as a leading approach.

"Real-Time Face Mask Detection Using YOLOv4-tiny"Authors: Nguyen, H. et al.Year: 2021.

Summary: This study presents a real-time face mask detection system using YOLOv4-tiny, a variant of YOLO optimized for speed and efficiency. The authors demonstrate the effectiveness of YOLO in detecting face masks in various environments, contributing to public health safety measures during the COVID-19 pandemic.

"Deep Learning-Based Face Mask Detection System Using YOLOv3"Authors: Li, Z. et al.Year: 2020.

Summary: Li et al. propose a face mask detection system based on YOLOv3, another version of the YOLO architecture. The study evaluates different training strategies and model

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configurations to achieve accurate detection of face masks, emphasizing real-time performance and scalability.

III.SYSTEM ANALYSIS

Existing system: Most publications predominantly concentrate on facial recognition and identity verification while individuals wear face masks. However, our research shifts its emphasis towards identifying individuals who are not wearing face masks, aiming to reduce the transmission and spread of COVID-19. Existing systems primarily rely on machine learning techniques for detecting face masks, but they face significant challenges in accurately identifying individuals without face masks.

Disadvantages of existing system:

- The major drawback is the classical machine learning methods to get highest consume time and lowest accuracy.
- It involves very lengthy and complicated procedure of calculations and analysis.
- Algorithms: Random forest, Naivebyes

Proposed system: To determine the optimal epoch for training the YoloV5 model, a dataset of 682 images categorized into "With_Mask," "Without_Mask," and "Incorrect_Mask" classes was used. The dataset was trained using epochs set at 20, 50, 100, 300, and 500. Precision and recall metrics were calculated for each model. Additionally, a validation set of 85 face mask images was employed to assess the precision and recall for each class. Plots depicting the precision and recall values for each model are presented. Specifically, the results indicate that the model trained with 300 epochs achieved the highest performance compared to models trained with other epochs.

Advantages of proposed system**:** The experimental results for face mask detection obtained from the deep learning models with different epochs, including 20, 50, 100, 300 and 500, were examined and discussed in Section.

1) incorrect mask in a one-person image.

2) with mask in a people image.

3) with/without mask in a crowd image.

Algorithm:face mask detection, deep learning, Yolov5.

IV.METHODOLGY

- **Data Collection and Preparation**:

  Dataset Compilation: A dataset comprising 682 images categorized into three classes ("With_Mask," "Without_Mask," and "Incorrect_Mask") is compiled from various sources.
- **Data Augmentation**: Images are augmented to increase the diversity and size of the dataset, including techniques such as rotation, flipping, and brightness adjustment.
- **Annotation**: Ground truth annotations are created for each image to specify the location and class label (mask types) of objects (faces) using bounding boxes.
- **Model Selection and Configuration**:

  YoloV5 Implementation: YoloV5 is chosen as the deep learning framework for its efficiency and effectiveness in object detection tasks.
- **Model Architecture**: The YoloV5 architecture is configured and optimized for the face mask detection task, considering the input image size, backbone network (e.g., CSPDarknet53), and detection head specifications.
- **Training Procedure**:

  Epoch Selection: The dataset is trained with different numbers of epochs (20, 50, 100, 300, and 500) to determine the optimal training duration that maximizes model performance.
- **Loss Function**: The model is trained using a predefined loss function (e.g., Cross-Entropy loss) to minimize the discrepancy between predicted and ground truth bounding boxes and class labels.
- **Optimizer**: A suitable optimizer (e.g., Adam optimizer) is employed to update model parameters during training based on computed gradients.
- **Model Evaluation**:

  Validation Set: A separate validation set comprising 85 images is used to evaluate the trained models.
- **Metrics Calculation**: Precision and recall metrics are computed for each class ("With_Mask," "Without_Mask," and "Incorrect_Mask") to assess the model's accuracy in detecting different mask types.

- **Visualization**: Plots and visual representations of precision-recall curves and other performance metrics are generated to analyze and compare model performance across different epochs.
- **Results Analysis**:

  Optimal Epoch Determination: The precision-recall curves and overall performance metrics are analyzed to identify the epoch that yields the highest detection accuracy for face mask detection.
- **Discussion**: The implications of the results are discussed, including the model's effectiveness in real-world scenarios, limitations, and potential improvements.
- **Implementation and Deployment**:

  Deployment Considerations: Considerations for deploying the trained YoloV5 model in real-time applications, including computational requirements and integration with existing systems.
- **Future Directions**: Recommendations for future research and enhancements to further improve the accuracy and robustness of the face mask detection system.

Real-time application for detecting and recognizing faces with the use of the YOLO method. YOLO is a proven object detection algorithm with state-of-the-art features. According to the results of the experiments, yolo-based face detection is more robust and faster at detecting faces. Excellent detection accuracy is ensured even in complex settings. The detection speed and real-time detection requirements can coexist simultaneously. This is a relatively trivial problem that can be solved by human beings and by classical feature-based techniques like the cascade classifier. A recent study on a standard benchmark dataset for face detection revealed state-of-the-art results from deep learning techniques.

Pooling:

The pooling layer is actually a type of down sampling. There are various forms of nonlinear pooling functions, among which "maximum pooling" is the most common. It divides the input image into several rectangular regions and outputs the maximum value for each sub region. This mechanism is effective because after discovering a feature, its precise position is far less important than its relative position with other features. The pooling layer continuously reduces the spatial size of the data, resulting in a decrease in the number of parameters and computational complexity, which to some extent also controls overfitting. Generally speaking, pooling layers are periodically inserted between the convolutional layers of deep learning.

V. CONCLUSION

In conclusion, this study explored the application of YoloV5, a robust deep learning framework, for the development of a face mask detection system aimed at enhancing public health safety during the COVID-19 pandemic. Through a methodical approach encompassing dataset compilation, model configuration, training with varying epochs, and evaluation on a validation set, several key findings have emerged.

The experimental results demonstrate that training the YoloV5 model with 300 epochs yielded the highest performance, achieving significant accuracy in detecting faces with and without masks. Precision and recall metrics validated the model's ability to distinguish between "With_Mask," "Without_Mask," and "Incorrect_Mask" categories effectively, crucial for enforcing mask compliance in public settings.

Furthermore, the study highlighted the importance of dataset quality and augmentation techniques in improving model robustness and generalization. Visualizations of precision-recall curves underscored the model's reliability and provided insights into its operational characteristics across different training durations.

Looking forward, the deployment of this face mask detection system holds promise for integration into real-world applications, contributing to public health measures and mitigating the transmission of respiratory diseases. Future research directions may focus on enhancing the model's adaptability to diverse environmental conditions and exploring additional optimizations to further elevate its performance.

In essence, leveraging YoloV5 for face mask detection represents a significant advancement in utilizing deep learning for public health safety, with implications extending beyond the current pandemic to future challenges in healthcare and safety monitoring.

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