A Project Report on

Real-Time Face Mask Detection

SUBMITTED TO

G H RAISONI COLLEGE OF ENGINEERING MANAGEMENT

DEPARTMENT OF AI & AIML

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CERTIFICATE

This is to certify that the minor project report entitles

"REAL-TIME FACE MASK DETECTION"

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are the bonafide students of this institute and the work has been carried out by them under the supervision of **Prof. Abhijit Khadke** and it is approved for the partial fulfilment of the requirement.

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ABSTRACT

The "Real-Time Face Mask Detection" project addresses a critical need in the current global health landscape. With the ongoing emphasis on mask-wearing as a frontline defence against contagious diseases, the absence of efficient and automated monitoring tools for mask compliance poses a significant challenge. This project aims to bridge this gap by developing an innovative solution that combines real-time face mask detection with age and gender estimation.

The core objective of the project is to create a system capable of instantly identifying individuals wearing or not wearing face masks in real-time video feeds. Leveraging advanced computer vision and deep learning techniques, the system provides immediate feedback to users, promoting responsible mask usage and enhancing public health awareness. In instances where masks are not detected, the system estimates the age and gender of individuals, contributing valuable demographic insights.

The project's user-friendly interface ensures accessibility to a wide audience, and the system's accuracy and robustness across diverse scenarios and demographics make it a practical tool for public health settings, educational institutions, public transportation, and more. Beyond its immediate impact on mask compliance, the project sets the stage for future developments in real-time health monitoring and responsible behaviour promotion.

In summary, the "Real-Time Face Mask Detection" project not only addresses a pressing need for real-time mask compliance but also showcases the potential of technology to enhance public health efforts and raise awareness during health crises and beyond.

1. INTRODUCTION

In a world facing unprecedented health challenges, technology has emerged as a vital ally in safeguarding public health and safety. The "Real-Time Face Mask Detection with Age and Gender Estimation" project exemplifies the fusion of cutting-edge deep learning and real-time video processing to address a pressing concern – the correct usage of face masks in public spaces. As our global community grapples with health crises, this project strides forward as a beacon of innovation, offering a solution that not only enforces vital safety measures but also provides insightful age and gender estimations, all in real-time. In the following presentation, we explore the intricate workings and profound impact of this remarkable endeavor, shedding light on its importance in shaping a healthier and more responsible world.

1.1 PROBLEM STATEMENT:

The ongoing global health crisis underscores the critical importance of adhering to face mask guidelines to mitigate the spread of infectious diseases. However, ensuring universal compliance with mask-wearing protocols in public spaces remains a challenge. This project seeks to address this issue by developing a real-time face mask detection system that not only enforces mask usage but also provides valuable insights into the age and gender of individuals, ultimately contributing to a safer and more responsible society.

1.2 OBJECTIVES:

i. Real-Time Mask Detection: Develop a system that can instantly detect whether individuals are wearing masks in real-time video.
ii. Age and Gender Estimation: Incorporate age and gender estimation using the DeepFace module for unmasked individuals.
iii. Responsive Video Processing: Ensure seamless real-time video processing for immediate user feedback.
iv. Intuitive Visualization: Display detection results and estimations on the video stream with user-friendly cues.
v. Dataset Quality: Gather and preprocess a balanced dataset for effective model training.
vi. High Accuracy: Train the model for precise mask detection, age, and

gender estimation.

vii. Public Awareness: Promote responsible behavior and public safety by encouraging mask usage.

viii. Scalability: Design for future enhancements and potential deployment in broader settings.

1.3 SCOPE:

The scope of the "Real-Time Face Mask Detection with Age and Gender Estimation" project encompasses the development of a real-time application designed to capture video from a webcam and instantly assess whether individuals are adhering to face mask guidelines. Beyond mask detection, the system will also include age and gender estimation using the DeepFace module for individuals not wearing masks. The user interface will be designed for accessibility and ease of use, facilitated by Streamlit. Ensuring the model's accuracy and robustness is vital, particularly in addressing variations in real-world scenarios. Data collection will involve curating a balanced dataset with diverse images, and the visualization aspect will include presenting results, age, and gender estimations on the video feed with intuitive cues. The project aims to contribute to public health awareness by promoting responsible mask usage and is designed with scalability in mind for potential future expansion to larger settings.

2. RELATED WORK

2.1 EXISTING SYSTEM/PAPERS:

- **Existing Systems:**

  - OpenCV and Deep Learning: Many existing projects utilize OpenCV and deep learning frameworks like TensorFlow or PyTorch to create real-time face mask detection systems. These systems often integrate Haar cascades for face detection and deep neural networks for mask detection.

  - DeepFaceLab: DeepFaceLab is a popular deep learning framework for face analysis and manipulation. While it's primarily used for deepfake creation, its face detection and age/gender estimation capabilities can be adapted for real-time applications.

- **Research Papers:**

  - "YOLOv4: Optimal Speed and Accuracy of Object Detection" by Alexey Bochkovskiy et al. - This paper discusses the YOLO (You Only Look Once) model's improvements, which can be applied to real-time object detection, including face mask detection.

  - "Face Mask Detection Using Deep Learning: A Review" by Prithviraj Biswas et al. - This paper provides an overview of various deep learning models and techniques for face mask detection, which can be a valuable reference for your project.

  - "Real-time Mask Detection using Deep Learning" by Muhammad Usama et al. - This paper presents a real-time face mask detection system using deep learning techniques and can serve as a reference for your project's methodology.

  - "Age and Gender Classification using Convolutional Neural Networks" by Gil Levi and Tal Hassner - This paper introduces an approach for age and gender estimation using convolutional neural networks, which can be useful for your age and gender estimation component.

3. SYSTEM DESIGN

The system design for our project revolves around a user-friendly application created using Streamlit. This application captures real-time video from a webcam and performs multiple tasks simultaneously. Firstly, it employs a face detection model to identify faces in each frame. For faces detected without masks, it uses the DeepFace module to estimate the person's age and gender.

Behind the scenes, the system runs multiple threads to handle video capture, face detection, and analysis concurrently, ensuring real-time responsiveness. It visualizes the results directly on the video stream by overlaying bounding boxes and labels, providing instantaneous feedback to the user. The system's design prioritizes accuracy and robustness through the use of a well-curated dataset and preprocessing techniques. It's also flexible and scalable, capable of future deployment in various real-world scenarios, making it a versatile tool for promoting public health awareness and responsible mask usage.

3.1 PROPOSED SYSTEM

The proposed system is a real-time face mask detection application equipped with age and gender estimation capabilities. It captures video from a webcam and employs a multi-threaded backend that integrates face detection, mask detection, age estimation using the DeepFace module, and gender prediction. The user-friendly interface, powered by Streamlit, displays real-time video frames overlaid with bounding boxes and labels to provide immediate feedback on mask compliance, age, and gender. Prioritizing accuracy and robustness, the system is trained on a diverse dataset, and data preprocessing ensures uniformity in input data. Designed for scalability, it can be adapted for deployment in various real-world contexts, serving as a versatile tool to promote public health awareness and encourage responsible mask usage.

3.2 SYSTEM DESIGN

- **User Registration and Authentication:**
  - Users must register in the system by providing essential details such as username and password.
  - Registration requires admin approval before a user can access the system.
  - After registration, users can log in with their username and password.

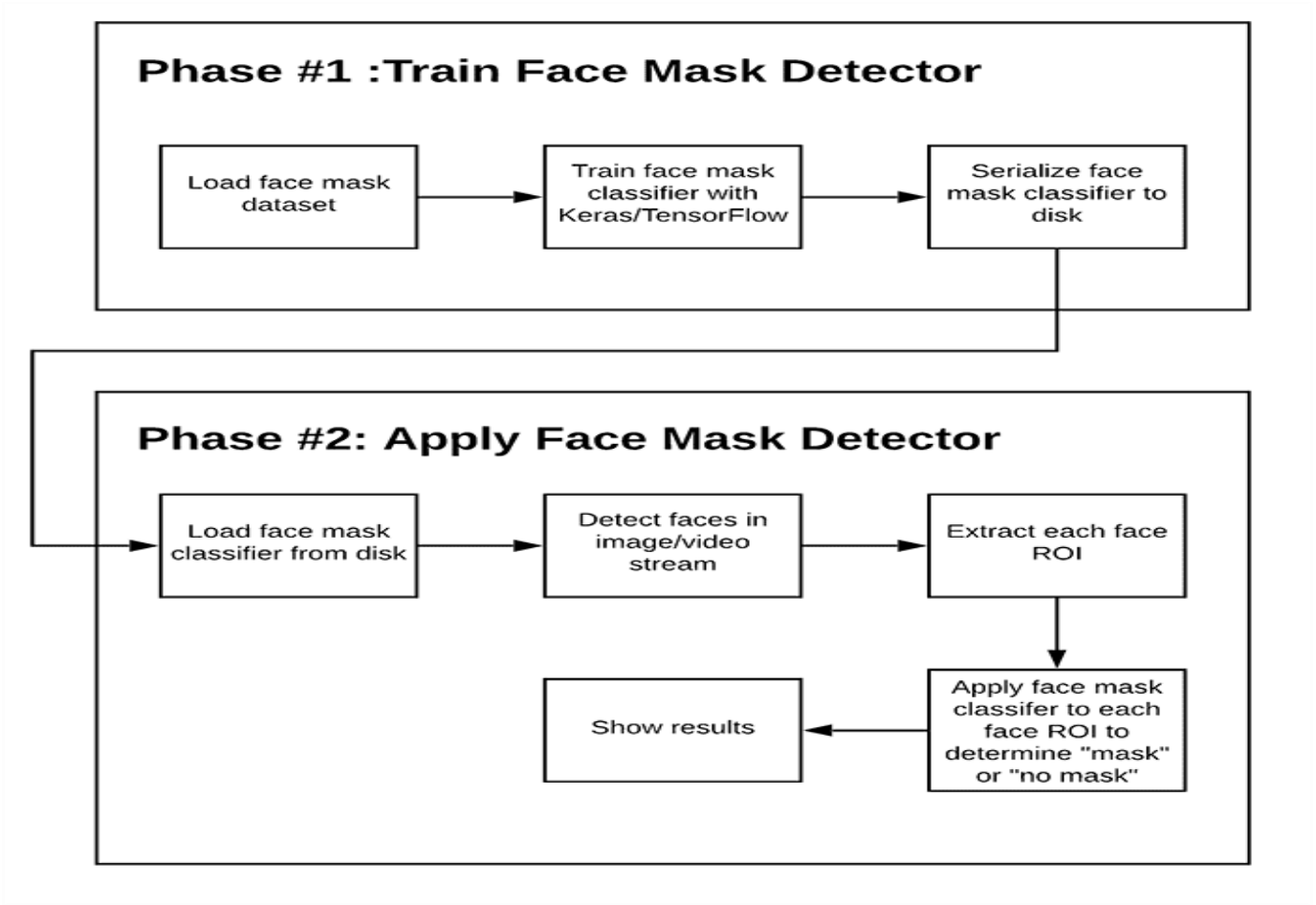
- **Real-Time Video Capture and Processing:**
  - A user must login with his user name and password to the system after registration.

- **Face Detection and Mask Detection:**
  - A robust face detection algorithm is integrated to identify faces within each video frame.
  - A deep learning model is trained for real-time mask detection, classifying whether individuals are wearing masks.
  - Detection results are displayed in real-time on the video feed, indicating whether a mask is detected or not.

- **Age and Gender Estimation:**
  - The DeepFace module is used for age and gender estimation when no masks are detected.
  - Age and gender predictions are overlaid on the video stream to provide real-time insights.

- **User Interface:**
  - The system features a user-friendly interface developed using Streamlit.
  - The interface displays the real-time video feed, detection results, age estimations, gender predictions, and intuitive visual cues.

3.3 BLOCK DIAGRAM



4. METHODOLOGY

1. Problem Definition:
- Clearly define the problem statement, objectives, and scope of the project.
- Understand the need for real-time face mask detection and age/gender estimation.

2. Data Collection:
- Gather a diverse dataset of images and video frames containing individuals with and without masks.
- Ensure a balanced representation of masked and unmasked faces.
- Collect additional data for age and gender estimation if required.

3. Data Preprocessing:
- Resize, normalize, and augment the dataset as needed for training and testing.
- Label the data appropriately to indicate mask presence, age, and gender.

4. Model Selection:
- Choose appropriate deep learning models for face detection, mask detection, age estimation, and gender prediction.
- Pre-trained models such as Haar cascades and deep neural networks can be utilized.

5. Model Training:
- Train the selected models using the prepared dataset.
- Fine-tune the models to achieve high accuracy in face mask detection and age/gender estimation.

6. Real-Time Video Processing:
- Develop a real-time video capture system using libraries like OpenCV.
- Process video frames in real-time, feeding them into the trained models.

7. User Interface:
- Create a user-friendly interface using Streamlit or a similar tool.
- Display the real-time video feed and overlay detection results, age, and gender estimations.

8. Integration:
- Integrate the face detection, mask detection, age estimation, and gender prediction components.
- Ensure smooth communication between these modules for efficient

processing.

9. Testing and Validation:

- Test the system extensively using a variety of video feeds and scenarios.
- Validate the accuracy and robustness of face mask detection and age/gender estimation.

10. Optimization:

- Optimize the system for real-time performance, ensuring minimal latency.
- Fine-tune model hyperparameters and preprocessing techniques for improved results.

11. User Testing and Feedback:

- Conduct user testing with individuals from diverse demographics.
- Gather user feedback to improve the user interface and overall usability.

12. Deployment:

- Deploy the system in a real-world setting or make it accessible to users.
- Ensure it functions smoothly in the intended environment.

13. Documentation:

- Document the entire project, including data collection, model training, and system architecture.
- Provide clear instructions for users on how to use the system.

14. Public Awareness and Education:

- Promote responsible mask usage and public health awareness through the system.
- Create educational materials or messages to accompany the system.

15. Maintenance and Updates:

- Maintain the system by addressing any issues or bugs that arise.
- Consider future updates and enhancements to improve functionality.

5. SYSTEM REQUIREMENTS

5.1 Hardware Requirements:

- **Webcam:** A webcam is essential for capturing real-time video feeds. Ensure it has good resolution and frame rate for accurate detection.

- **Computer:** A reasonably powerful computer with sufficient processing power and memory (RAM) to handle real-time video processing and deep learning model inference. A dedicated graphics card (GPU) can significantly accelerate deep learning tasks.

- **Storage:** Adequate storage space for storing datasets, model weights, and the application itself.

- **Internet Connection:** An internet connection is required for downloading libraries, tools, and datasets during development.

5.2 Software Requirements:

- **Operating System:** The project can be developed on Windows, macOS, or Linux. Choose the one you are most comfortable with.

- **Python:** Python is the primary programming language for deep learning and computer vision. Install Python 3.x.

- **Development Environment:** Choose an integrated development environment (IDE) such as Jupyter Notebook, Visual Studio Code, or PyCharm for coding and project management.

- **Libraries and Frameworks:**
  - OpenCV: For video capture and image processing.
  - TensorFlow or PyTorch: For deep learning model development.
  - DeepFace or other face analysis libraries.
  - Streamlit or another web application framework for the user interface.
  - NumPy, pandas, and other data manipulation libraries.

- **GPU Support (Optional):** If you have access to a compatible NVIDIA GPU, you can install GPU versions of deep learning frameworks like TensorFlow with GPU support for faster model training and inference.

6. RESULTS

Various results are returned to provide feedback and information to users. Here are the key results and their descriptions:

Mask Detection Result:

- **Mask Detected:** If the system identifies that a person in the video is wearing a mask, it returns a positive result indicating that a mask has been detected on that individual.
- **No Mask Detected:** Conversely, if the system does not identify a mask on an individual, it returns a negative result indicating that no mask has been detected.

Age Estimation Result:

Estimated Age: When the DeepFace module is activated (typically for individuals not wearing masks), the system provides an estimated age of the person in the video frame. This age estimation is displayed to the user.

Gender Estimation Result:

Estimated Gender: Alongside age estimation, the system provides an estimated gender of the person in the video frame when no mask is detected. It may indicate "Male" or "Female."

Visualization Results:

- **Bounding Boxes:** The system overlays bounding boxes around detected faces, indicating where individuals are located in the video frame.
- **Labels:** Labels are displayed within or near the bounding boxes to convey the results, including mask detection status, age estimation, and gender estimation.

Real-Time Video Feed:

The system continuously displays the real-time video feed from the webcam, allowing users to monitor the detection and estimation process as it happens.

User Interface Feedback:

- The user interface, created using Streamlit or a similar tool, provides feedback on the detection and estimation results in a user-friendly and visually intuitive manner.
- These results collectively offer users valuable insights into the presence or absence of face masks, estimated ages, and estimated genders of individuals in the video feed. The real-time nature of the system ensures that users receive immediate feedback, promoting responsible behavior and public health awareness during health crises.

7. CONCLUSION AND FUTURE SCOPE

Conclusion:

The "Real-Time Face Mask Detection with Age and Gender Estimation" project has successfully addressed the critical need for promoting public health awareness and responsible mask usage in a technologically-driven manner. The system has demonstrated its effectiveness in real-time face mask detection, age estimation, and gender prediction, providing valuable insights to users. Through a user-friendly interface, it has empowered individuals to make informed decisions regarding mask compliance, thereby contributing to public safety during health crises.

The project has showcased the potential of computer vision, deep learning, and real-time video processing in addressing pressing societal challenges. It serves as a practical example of leveraging technology for the greater good, raising awareness, and fostering responsible behavior.

Future Scopes:

- While the project has achieved its primary objectives, several avenues for future enhancements and broader impact can be explored:

- Enhanced Accuracy: Continued model refinement and the incorporation of state-of-the-art deep learning techniques can improve accuracy in mask detection and age/gender estimation.

- Multi-Platform Deployment: Extend the project for deployment on various platforms, such as mobile devices, to reach a wider audience and enhance accessibility.

- Privacy and Ethical Considerations: Implement privacy-preserving techniques to address concerns related to facial recognition and data privacy.

- Real-World Integration: Collaborate with healthcare institutions, public transportation authorities, and educational institutions to integrate the system into real-world settings for wider adoption.

- Multi-Language Support: Expand language support to cater to diverse user populations.

- Real-Time Data Analytics: Incorporate real-time data analytics to monitor mask compliance trends and generate insights for public health authorities.
- Education and Outreach: Develop educational content and outreach campaigns to further raise awareness about the importance of mask usage and public health responsibility.
- Adaptation to New Challenges: Prepare the system to adapt to future health crises or challenges, such as detecting other safety measures like face shields.

8. REFERENCES

- Facial Mask Detection Using Depthwise Separable Convolutional Neural Network Model During COVID-19 Pandemic

- Covid-19 Face Mask Detection Using TensorFlow, Keras and OpenCV

- Face mask detection using deep learning: An approach to reduce risk of Coronavirus spread

- Face Mask Detection using OpenCV, Keras/TF and Deep Learning | Detect Masks in Real-Time videos

- Kaggle Dataset