# Real-Time Face Mask Detection in Public Spaces

*Enhancing Public Health and Sa* ... *mputer Vision*

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[Github link]

# Introduction

- **Objective**: Develop a system to detect face mask usage in real-time using computer vision.
- **Purpose**: Ensure compliance with mask mandates in public spaces (e.g., airports, malls, transit).
- **Relevance**: Critical for public health during pandemics (e.g., COVID-19) and beyond.
- **Scope**: Focus on real-time processing, accuracy, and ethical deployment.

# Problem Statement

- **Challenges in Public Spaces**:
  - High crowd density complicates monitoring.
  - Diverse mask types, lighting, and angles.
  - Manual enforcement is inefficient and costly.
- **Need**:
  - Automated, scalable, and real-time detection.
  - Privacy-preserving and unbiased systems.

# Methodology

- **Data Collection**:
  - Public datasets: MAFA, RMFD, or custom datasets.
  - Labels: Masked, unmasked, incorrectly masked.
- **Model Selection**:
  - **Object Detection**: YOLOv8 for speed and accuracy.
  - **Classification**: MobileNetV2 for lightweight edge deployment.
- **Training**:
  - Pre-trained models fine-tuned on mask datasets.
  - Augmentation: Rotation, lighting, occlusion.

# Challenges

- **Technical**:
  - Small faces in crowded scenes.
  - Low-light or occluded environments.
- **Ethical**:
  - Privacy risks with facial data.
  - Bias against certain demographics or mask styles.
- **Operational**:
  - Scalability in high-density areas.
  - Real-time processing on limited hardware.

# Future Work

- **Improvements**:
  - Enhance robustness in adverse conditions.
  - Integrate with IoT for smart city applications.
- **Extensions**:
  - Add crowd density estimation.
  - Support multilingual alerts for global deployment.
- **Research**:
  - Explore vision transformers for better accuracy.

# Applications

- **Public Health**:
  - Enforce mask mandates in high-risk areas.
- **Security**:
  - Monitor compliance in restricted zones (e.g., hospitals).
- **Commercial**:
  - Ensure safety in retail or workplaces.
- **Research**:
  - Analyze mask-wearing behavior trends.

# Results and Evaluation

- **Metrics**:
  - Accuracy: >95% on test datasets.
  - FPS: 35+ on NVIDIA Jetson Nano.
  - False Positives: <2% for unmasked detection.
- **Testing**:
  - Real-world scenarios: Indoor/outdoor, day/night.
  - Crowded vs. sparse environments.
- **Limitations**:
  - Performance drops in extreme lighting or dense crowds.

# Conclusion

- **Summary**:
  - Developed a real-time face mask detection system.
  - Achieved high accuracy and low latency.
  - Addressed ethical concerns with privacy and bias mitigation.
- **Impact**:
  - Enhances public health and safety.
  - Scalable for various real-world applications.
- **Next Steps**:
  - Deploy pilot in public spaces.
  - Collaborate with authorities for policy integration