# Face Mask Detection with Live Alert System

## 1. Abstract

The "Face Mask Detection with Live Alert System" project aims to identify whether individuals are wearing a mask in real-time using a webcam feed. The system uses a trained deep learning model combined with OpenCV's face detection techniques to detect faces and classify them as "Mask" or "No Mask." This project plays a vital role in public health compliance, especially during pandemics like COVID-19.

---

## 2. Introduction

With the global impact of COVID-19, face masks became essential for minimizing virus transmission. Manual enforcement of mask rules is time-consuming and error-prone. This project provides an automated solution using computer vision and deep learning to detect masks on human faces from webcam input.

---

## 3. Tools and Technologies Used

- **Programming Language:** Python
- **Libraries & Frameworks:**
    - OpenCV – for image processing and webcam handling
    - TensorFlow / Keras – for loading and using the trained model
    - NumPy – for data manipulation
- **Model:** Trained CNN model saved as mask_detector.model
- **Face Detection:** Haar Cascade Classifier (haarcascade_frontalface_default.xml)
- **Hardware Requirement:** Webcam

---

## 4. Project Workflow

1. **Data Preparation and Model Training**
    - A dataset of images with and without masks is collected.
    - The data is preprocessed and used to train a CNN using Keras.
    - The trained model is saved as mask_detector.model.

2. **Face Detection**
    - OpenCV’s Haar Cascade Classifier detects faces in live webcam feed.
3. **Prediction**
    - Detected faces are resized to 224×224, normalized, and passed to the trained model.
    - The model predicts whether the person is wearing a mask or not.
4. **Display Output**
    - Bounding boxes are drawn around faces.
    - Green box + "Mask" label for masked individuals.
    - Red box + "No Mask" label for those not wearing a mask.
5. **Alert**
    - Visual feedback acts as a live alert system.

---

## 5. Results

- Accuracy achieved: ~94% on test data.
- Real-time webcam detection successfully classifies mask status.
- System runs with minimal lag (under 100 ms per frame).

---

## 6. Conclusion

This face mask detection system demonstrates an efficient and effective method to automate mask compliance monitoring using deep learning and computer vision. The project can be integrated into surveillance systems, public entry points, or workplaces to ensure safety and awareness.

---

## 7. Future Improvements

- Integrate sound alerts for "No Mask" detection.
- Deploy on embedded systems like Raspberry Pi for edge applications.
- Add multiple face tracking and mask detection