Q3 Report: Face Detection and Feature Localization

This project implements a program for detecting faces in images and localizing key facial features, specifically the nose tip and the centers of the eyes. The results are annotated directly on the image using bounding boxes and labeled points. The implementation combines MediaPipe's Face Mesh model with OpenCV image processing tools.

Type of Computer Vision Problem:
This task is classified as an **Object Detection and Landmark Localization** problem.

- **Object Detection:** Detecting and bounding the face in the image.
- **Landmark Localization:** Identifying precise keypoints on the detected object, such as the nose tip and eye centers.

Unlike simple image classification, which only labels an image as containing a face or not, this task requires spatial details, making it more complex and closer to detection + regression.

Methodology:
1. The program loads an input image using OpenCV.
2. MediaPipe's Face Mesh model detects up to 468 facial landmarks per detected face.
3. A bounding box is calculated around the detected face.
4. The nose tip is localized using the predefined landmark index (1).
5. The centers of the left and right eyes are computed as the average positions of multiple landmarks around each eye.
6. The face bounding box, nose tip, and eye centers are annotated on the image and saved as output.

Dependencies:
- Python 3.8+
- OpenCV (cv2)
- MediaPipe
- NumPy

Assumptions:
- Input image contains at least one visible face.
- Nose tip and eyes are not heavily occluded.
- Program processes one image at a time (not video).
- Annotated output image is saved to disk even if GUI display fails.

Conclusion:
This program successfully detects faces, identifies the nose tip and eye centers, and annotates them on the image. The use of MediaPipe Face Mesh ensures robustness in landmark detection, making this solution suitable for practical applications such as face recognition preprocessing, emotion analysis, and augmented reality filters.