Zagazig University - Faculty of Engineering
Department of Electronics and Communications Engineering
Image Processing Course (ECE228) - 2024/2025

High-Precision Face Detection using MATLAB with GUI Application

PRESENTED TO

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CONTENT

1. Problem Definition

The objective of this project is to design and implement a system that accurately detects human faces in digital images using MATLAB. The system utilizes a custom-built algorithm rather than relying on high-level built-in functions, focusing on skin tone segmentation, shape symmetry, and geometric filtering. A desktop GUI application was developed to facilitate user interaction with the detection process.

2. Selected Algorithm and Mathematical Foundation

The implemented face detection algorithm is based on color segmentation and geometric analysis. The main steps include:

1- **Image Smoothing** using a Gaussian filter to reduce noise.
2- **Color Space Conversion** from RGB to YCbCr, which separates luminance from chrominance components for better skin detection.
3- **Skin Mask Extraction** based on defined thresholds in the Cb and Cr channels.
4- **Mask Cleanup** using morphological operations like hole filling and small object removal.
5- **Region Property Extraction** using **regionprops** to analyze candidate regions.
6- **Face Verification Criteria:**

Elliptical Shape Matching: Comparing the candidate region to an ideal ellipse.

Horizontal Symmetry: Measuring pixel-level symmetry between the left and right halves.

Eccentricity Check: Ensuring the region shape is not overly stretched.

3. Step-by-Step Implementation

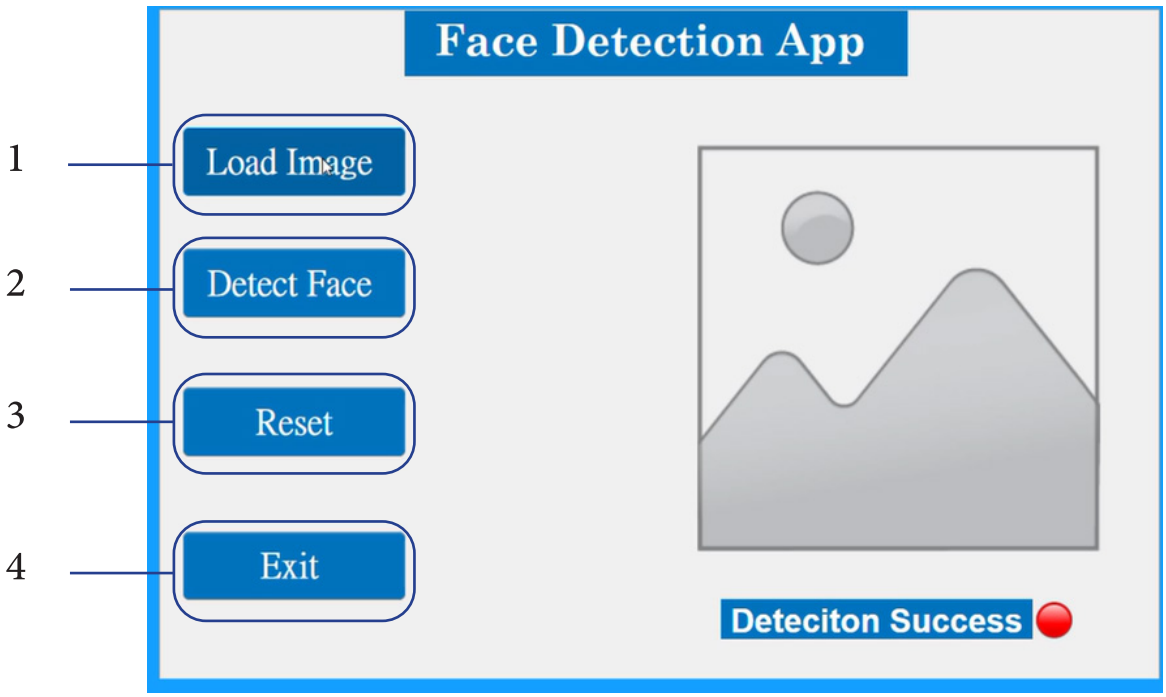
- The GUI was developed in MATLAB with the following buttons and their functionalities:

1-Load Image: Opens a file dialog to select and display an image.

2-Start Detection: Applies the detection algorithm and displays bounding boxes around detected faces.

3-Reset: Clears the current image and results.

4-Exit: Closes the application.



The GUI

Detection Logic:

-Apply Gaussian smoothing.

-Convert to YCbCr color space.

-Extract skin mask based on Cb/Cr thresholds.

-Use imfill and bwareaopen to refine the mask.

-Use regionprops to extract region features.

- Apply geometric and symmetry-based filters to detect valid faces.

4. Challenges and Solutions

Challenge	Solution
Noisy or low-light images	Gaussian blur for smoothing
Accurate skin segmentation	YCbCr color space used instead
False positives in detection	combined symmetry, shape matching, and eccentricity constraints
Avoiding high-level functions	Manual implementation using basic MATLAB functions

5. Results and Evaluation

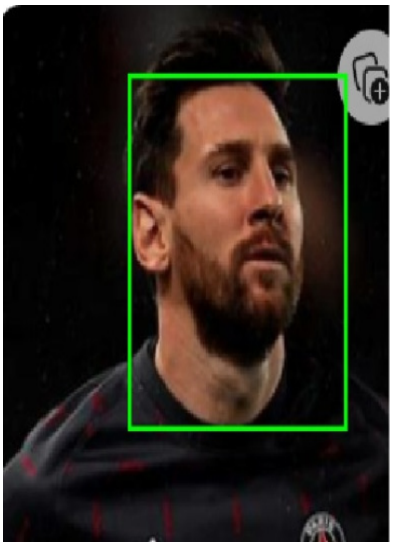
The system was tested on a set of images with varying lighting conditions and backgrounds. The results were as follows:

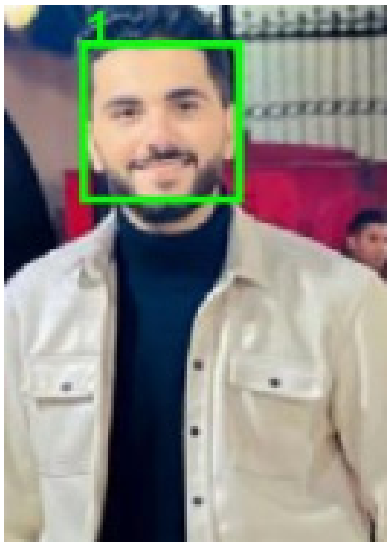
Detection Accuracy: High for frontal faces in well-lit images.

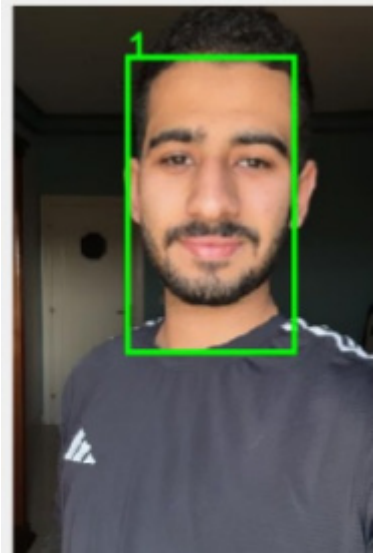
False Positive Rate: Low due to strict verification criteria.

Speed: Acceptable for real-time GUI interaction.

6. Screenshots







7. Team Collaboration

The work was carried out collaboratively, with each member contributing:
Algorithm design and MATLAB coding
GUI development and integration.
Testing and optimization.
Documentation and report writing.

8. Conclusion

The project successfully achieved its goal of building a high-precision face detection system using MATLAB without high-level functions.
The combination of color space analysis, geometric verification, and a user-friendly GUI

9 - OUR TEAM

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2- Abdelrahman Mohamed Saad

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THANKS