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Subject : Machine Vision

Practical no: 06

Aim: To study Detecting and Recognizing Faces

Objective: To Conceptualizing Haar Cascades Getting Haar cascade data Using Open CV to Perform face detections performing face detection on still images

Theory:

Conceptualizing Haar Cascades:

Haar cascades are a machine learning-based object detection method used to identify objects in images or video. They were introduced by Viola and Jones in their 2001 paper. The fundamental idea behind Haar cascades is to use a series of progressively more complex classifiers to quickly eliminate areas in an image that are unlikely to contain the target object, thus reducing the computational load.

The key components of Haar cascades include:

Haar-like Features: These are simple rectangular filters that are applied to the image to capture variations in brightness. Haar features are computed at multiple scales and positions within the image.

Integral Images: To speed up the calculation of Haar-like features, integral images are used. Integral images allow for the rapid computation of Haar-like feature values for any image region.

Adaboost: Haar cascades use the Adaboost algorithm to select and weight a subset of Haar-like features. Adaboost combines weak classifiers (the Haar-like features) into a strong classifier.

Cascade Classifier: The cascade classifier is composed of multiple stages, each containing a subset of the Adaboost-trained weak classifiers. The stages are organized in a way that allows for quick rejection of non-object regions. If a region passes all stages, it is considered a positive detection.

Getting Haar Cascade Data:
To use Haar cascades for face detection or any other object detection task, you need pre-trained Haar cascade classifiers. These classifiers are trained on large datasets and are available for various objects, including faces. You can obtain Haar cascade data from online sources or use the ones provided by OpenCV. These XML file contain the information needed for the cascade classifier, including feature definitions and weights.

Using OpenCV to Perform Face Detection: Performing Face Detection on a Still Image:
OpenCV (Open Source Computer Vision Library) is a powerful open-source computer vision and machine learning software library. It provides tools and functions for various computer vision tasks, including face detection.

To perform face detection on a still image using OpenCV, you typically follow these steps:

- Load the Image: Read the still image from a file or capture it using a camera.

- Load the Haar Cascade Classifier: Load the pre-trained Haar cascade classifier for face detection using the cv2.CascadeClassifier function.

- Convert to Grayscale: Convert the input image to grayscale, which simplifies the face detection process.

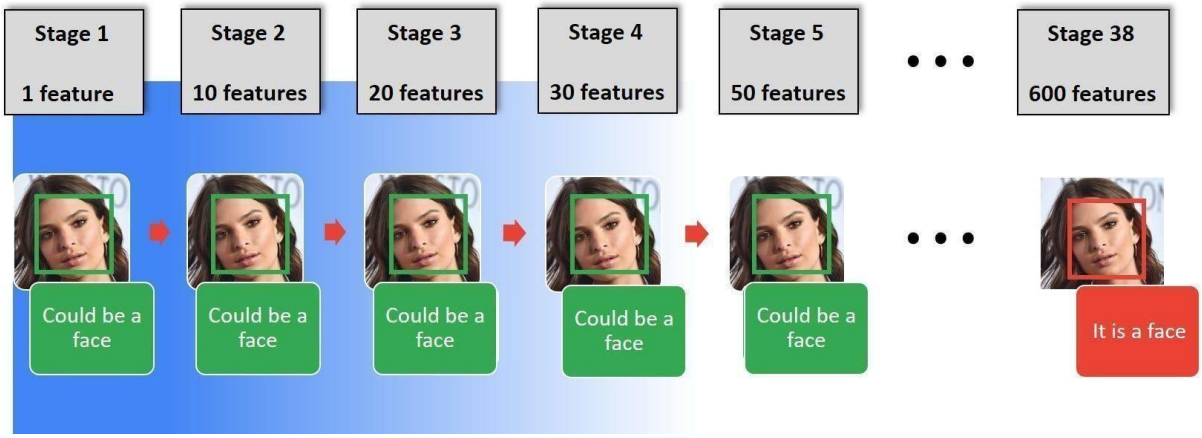
- Detect Faces: Use the detectMultiScale method of the cascade classifier to identify faces in the grayscale image. This method returns the coordinates of the detected faces.

- Draw Rectangles: Iterate through the detected faces and draw rectangles around them on the original image.

- Display the Result: Display or save the image with the detected faces marked.

Introduction

Discover object detection with the Haar Cascade algorithm using OpenCV. Learn how to employ this classic method for detecting objects in images and videos. Explore the underlying principles, step-by-step implementation, and real-world applications. From facial recognition to vehicle detection, grasp the essence of Haar Cascade and OpenCV's role in revolutionizing computer vision. Whether you're a novice or an expert, this article will equip you with the skills to harness the potential of object detection in your projects.



Why Use Haar Cascade Algorithm for Object Detection?

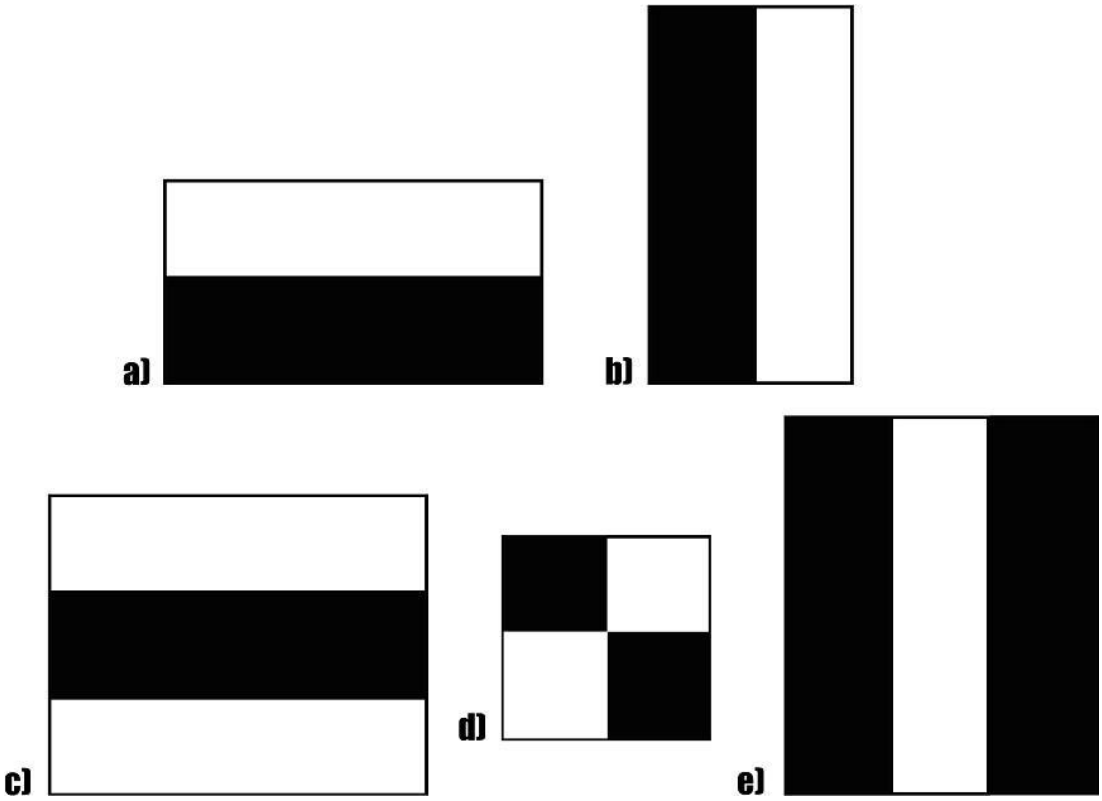
Identifying a custom object in an image is known as object detection. This task can be done using several techniques, but we will use the haar cascade, the simplest method to perform object detection in this article.

What is Haar Cascade Algorithm?

Haar cascade is an algorithm that can detect objects in images, irrespective of their scale in image and location.

This algorithm is not so complex and can run in real-time. We can train a haarcascade detector to detect various objects like cars, bikes, buildings, fruits, etc.

Haar cascade uses the cascading window, and it tries to compute features in every window and classify whether it could be an object.

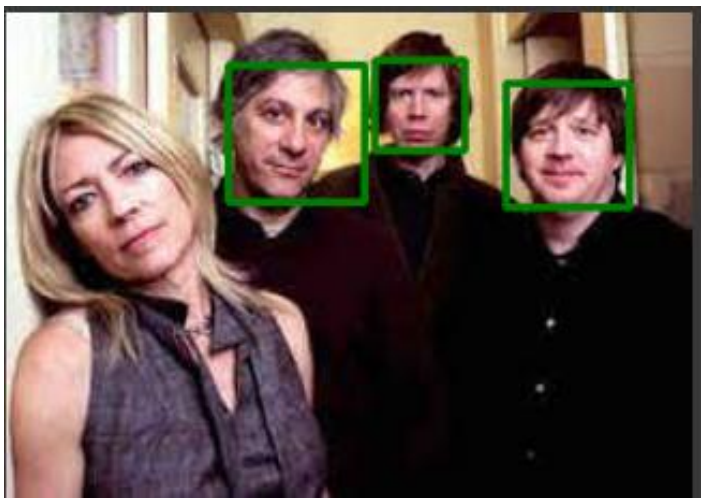


Haar cascade works as a classifier. It classifies positive data points → that are part of our detected object and negative data points → that don't contain our object.Haar cascades are fast and can work well in real-time.Haar cascade is not as accurate as modern object detection techniques are.Haar cascade has a downside. It predicts many false positives.Simple to implement, less computing power required.

Code:

```
import cv2
from google.colab.patches import cv2_imshow

# Load the pre-trained Haar Cascade for face detection
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')

# Load the image you want to perform face detection on
image_path = '/content/download (1).jpeg'
image = cv2.imread(image_path)

# Convert the image to grayscale (Haar cascades work on grayscale images)
gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

# Perform face detection
faces = face_cascade.detectMultiScale(gray, scaleFactor=1.3, minNeighbors=5, minSize=(30, 30))

# Draw rectangles around detected faces
for (x, y, w, h) in faces:
    cv2.rectangle(image, (x, y), (x+w, y+h), (0, 128, 0), 2)

# Display the result
cv2_imshow(image)
```

Output:



Conclusion:

In conclusion, Haar Cascade face detection stands as a widely adopted and efficient technique for identifying faces in images and videos. Its operation relies on pre-trained classifiers and a cascade of simple classifiers to pinpoint facial features. While it excels in speed and effectiveness for real-time applications, it may encounter challenges when confronted with variations in pose, lighting, or obstructions. Nevertheless, Haar Cascade face detection remains a valuable resource for numerous practical applications, particularly when prioritizing real-time performance.

OpenCV, on the other hand, represents a versatile and potent toolkit for the detection and recognition of faces. Its adaptability, exceptional performance, and robust community support establish it as a highly valuable asset for researchers and developers operating within this domain.