Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Department of Artificial Intelligence & Machine Learning
Academic Year 2023-2024

Name: Abhay Mathur **SAPID:** 60017210016
Batch: A1

Experiment No. 5A

Aim: Feature Detection in Images

Objective: Develop a program to detect features in an Image (Edge)

Theory:

Image feature extraction involves identifying and representing distinctive structures within an image. Reading the pixels of an image is certainly one. But this is a low-level feature. A high-level feature of an image can be anything from edges, corners, or even more complex textures and shapes.

Features are characteristics of an image. With these unique characteristics, you may be able to distinguish one image from another. This is the first step in computer vision. By extracting these features, you can create representations that are more compact and meaningful than merely the pixels of the image. It helps further analysis and processing.

An edge is defined as a gradient on the pixel intensity. In other words, if there is an abrupt color change, it is considered an edge

The Laplacian filter comes under the derivative filter category. It is a second-order filter used in image processing for edge detection and feature extraction.

Problem Definition

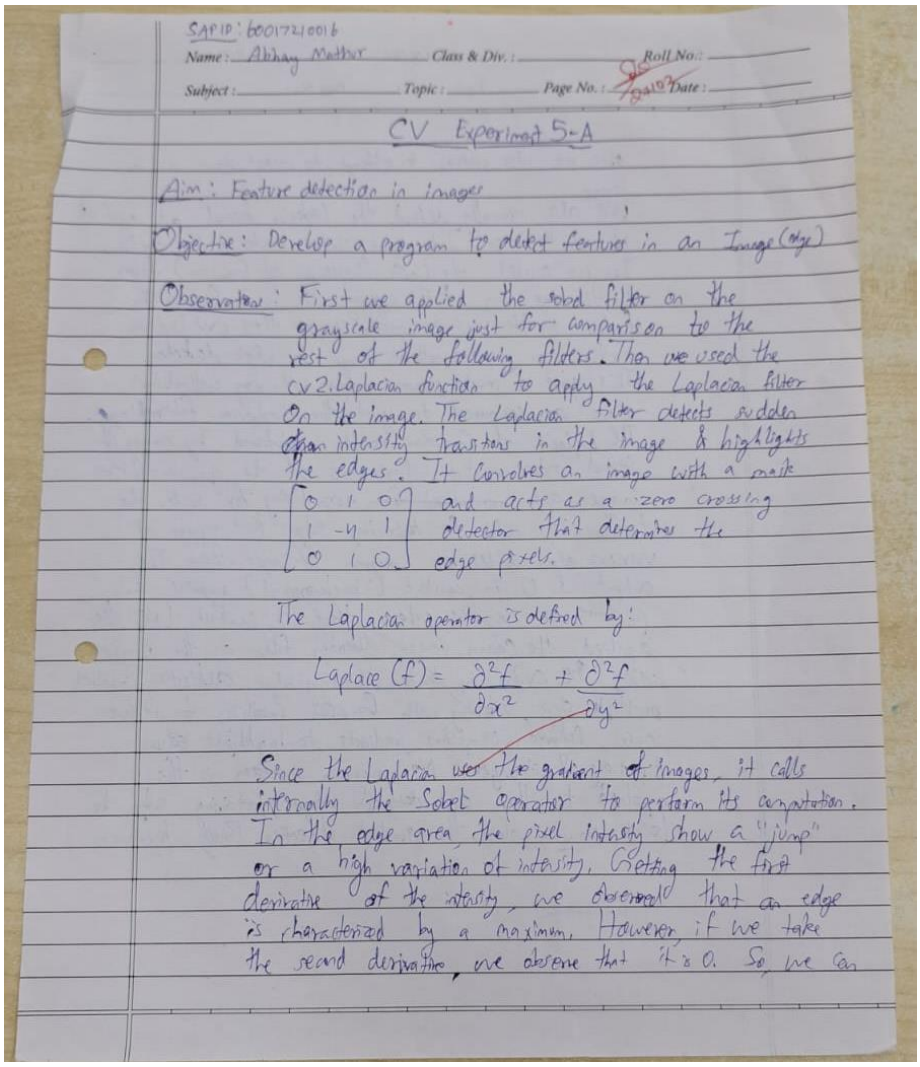
- Edge Detection (Sobel-x, Sobel-y, Sobel-Combined)
- Edge Detection using Laplacian
- Edge Detection using Laplacian of Gaussian
- Edge Detection using Canny Filter
- Compare Results

Post Lab Question

Explain Laplacian, Laplacian of Gaussian, Canny Edge Filter. Explain Canny Edge Filter Algorithm in detail

Department of Artificial Intelligence & Machine Learning
Academic Year 2023-2024

Observations



SAP ID: 60017210016
Name: Abhay Mathur Class & Div.: Roll No.:
Subject: Topic: Page No.: Date:

CV Experiment 5-A

Aim: Feature detection in images

Objective: Develop a program to detect features in an Image (edge)

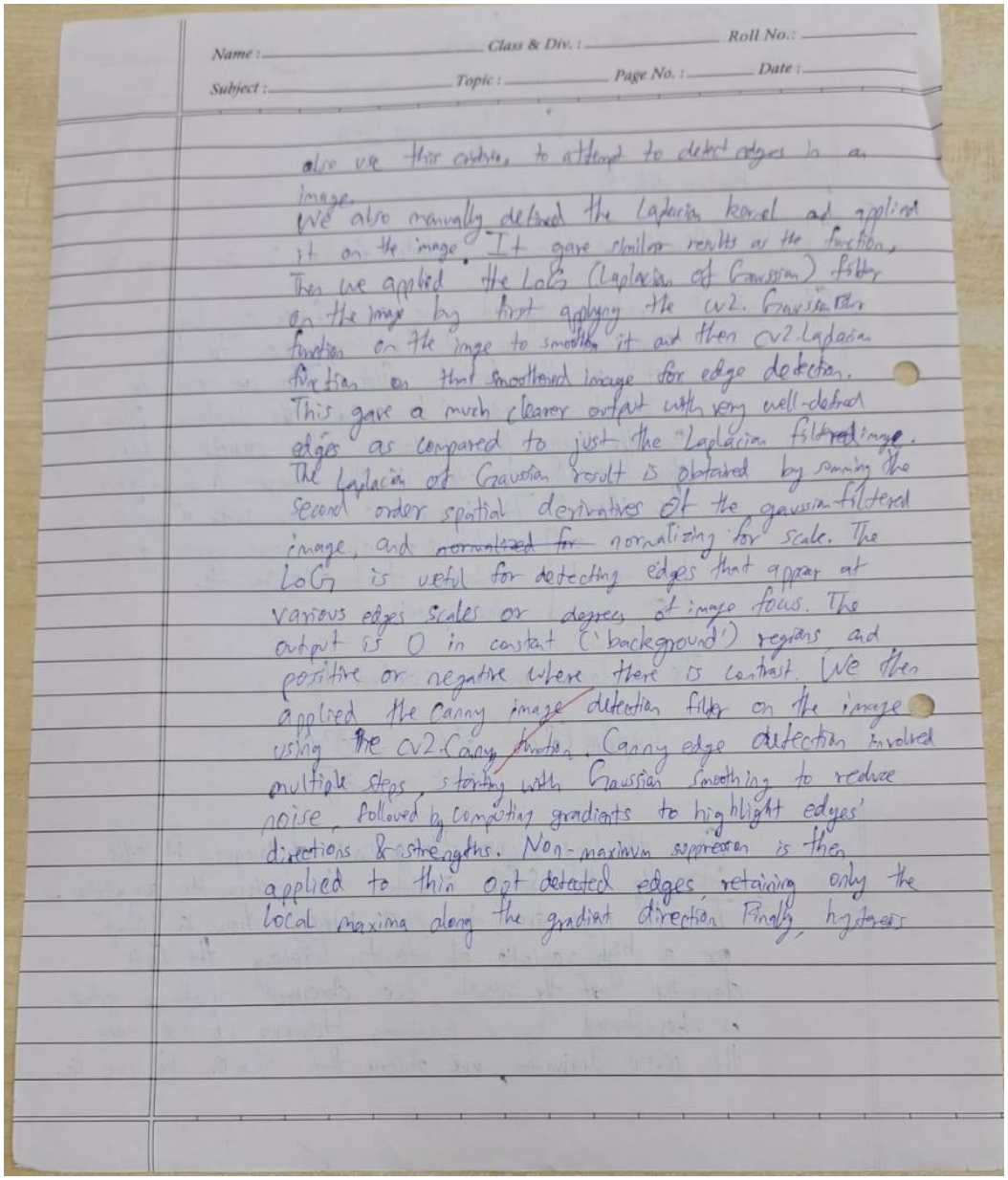
Observation: First we applied the sobel filter on the grayscale image just for comparison to the rest of the following filters. Then we used the cv2.Laplacian function to apply the Laplacian filter on the image. The Laplacian filter detects sudden intensity transitions in the image & highlights the edges. It convolves an image with a mask $\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ and acts as a zero crossing detector that determines the edge pixels.

The Laplacian operator is defined by:

$$\text{Laplace}(f) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

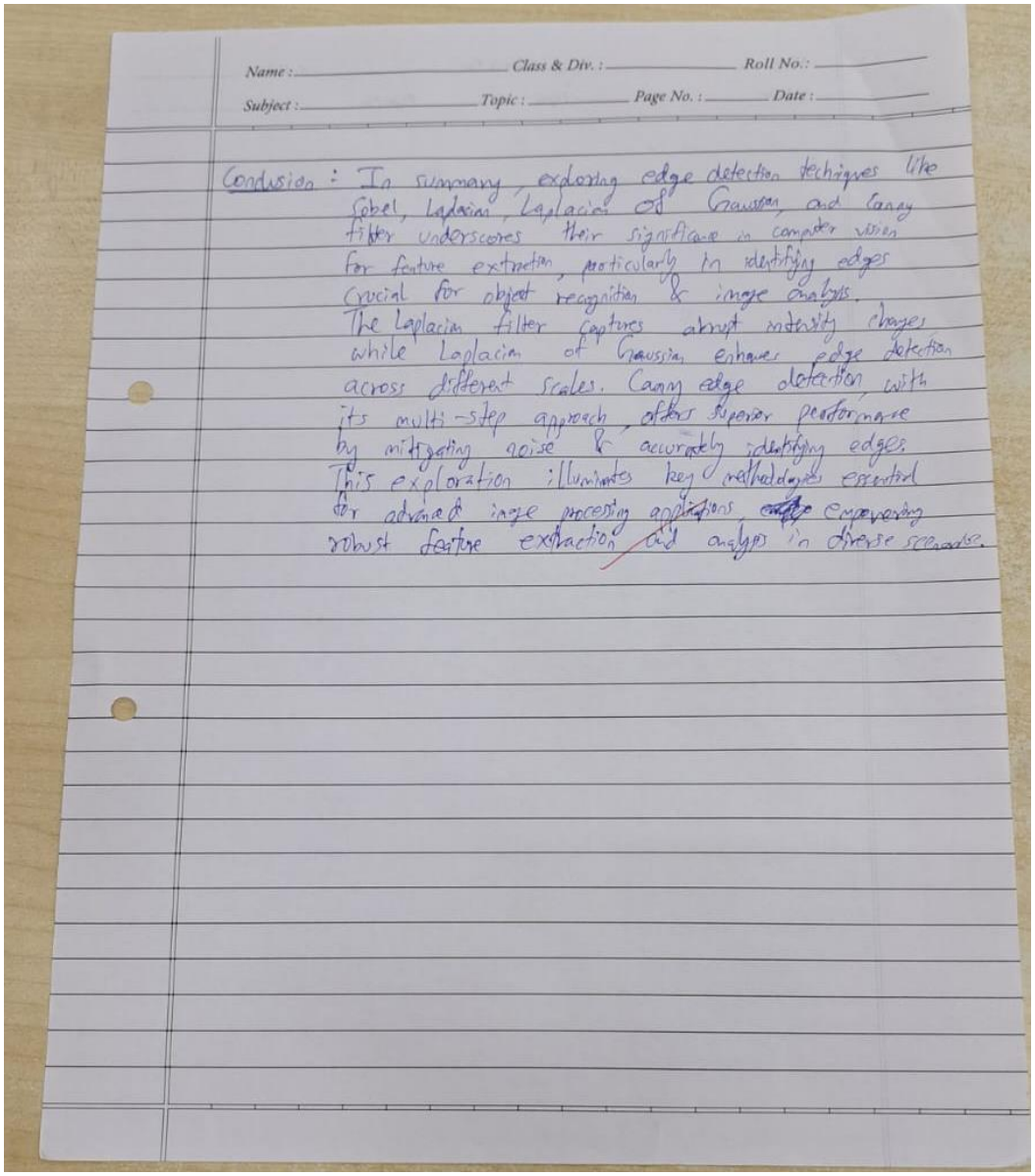
Since the Laplacian use the gradient of images, it calls internally the Sobel operator to perform its computation. In the edge area the pixel intensity show a "jump" or a high variation of intensity. Getting the first derivative of the intensity, we observed that an edge is characterized by a maximum. However if we take the second derivative, we observe that it's 0. So we can

Department of Artificial Intelligence & Machine Learning
Academic Year 2023-2024



Name : Class & Div. : Roll No.:
Subject : Topic : Page No. : Date :

also we this attribute, to attempt to detect edges in an image.
We also manually defined the Laplacian kernel and applied it on the image. It gave similar results as the function. Then we applied the LoG (Laplacian of Gaussian) filter on the image by first applying the cv2. Gaussian function on the image to smoothen it and then cv2 Laplacian function on that smoothened image for edge detection. This gave a much clearer output with very well-defined edges as compared to just the "Laplacian filtered image. The Laplacian of Gaussian result is obtained by applying the second order spatial derivatives of the gaussian-filtered image, and ~~normalized for~~ normalizing for scale. The LoG is useful for detecting edges that appear at various edges scales or degrees of image focus. The output is 0 in constant ('background') regions and positive or negative where there is contrast. We then applied the Canny image detection filter on the image using the cv2.Canny function. Canny edge detection involved multiple steps, starting with Gaussian smoothing to reduce noise, followed by computing gradients to highlight edges' directions & strengths. Non-maximum suppression is then applied to thin out detected edges, retaining only the local maxima along the gradient direction. Finally, hysteresis


Name : Class & Div. : Roll No.:
Subject : Topic : Page No. : Date :

Conclusion : In summary, exploring edge detection techiques like Sobel, Laplacian, Laplacian of Gaussian, and Canny filter underscores their significance in computer vision for feature extraction, particularly in identifying edges crucial for object recognition & image analysis. The Laplacian filter captures abrupt intensity changes while Laplacian of Gaussian enhances edge detection across different scales. Canny edge detection, with its multi-step approach, offers superior performance by mitigating noise & accurately identifying edges. This exploration illuminates key methodologies essential for advanced image processing applications, empowering robust feature extraction and analysis in diverse scenarios.

Conclusion

In summary, exploring edge detection techniques like Sobel, Laplacian, Laplacian of Gaussian, and Canny filter underscores their significance in computer vision for feature extraction, particularly in identifying edges crucial for object recognition and image analysis. The Laplacian filter captures abrupt intensity changes, while Laplacian of Gaussian enhances edge detection across different scales. Canny edge detection, with its multi-step approach, offers superior performance by mitigating noise and accurately identifying edges. This exploration illuminates key methodologies essential for advanced image processing applications, empowering robust feature extraction and analysis in diverse scenarios.