Introduction to Computer Vision

Lab 4: Corner Detection in Computer Vision

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1 Introduction

In this lab, we explore a foundational technique in computer vision: **corner detection**. A corner is a point where image intensity changes significantly in two orthogonal directions, making it a stable feature that can be reliably re-identified under different viewpoints. Corners are essential for tasks such as image matching, tracking, 3D reconstruction, and object recognition.

The algorithm we will implement is the **Harris corner detector**, introduced by Harris and Stephens in 1988. It quantifies the local intensity structure using the **structure tensor** (also called the second-moment matrix) and classifies each pixel as a corner, edge, or flat region based on the eigenvalues of this matrix.

By the end of this lab, you will be able to:

- Understand the geometric interpretation of image gradients and how they define local structure.
- Implement the Harris response function from the structure tensor.
- Apply thresholding and non-maximum suppression to obtain clean, isolated corners.
- Compare your implementation with OpenCV's optimized version.
- Perform a hyperparameter search to understand parameter sensitivity.
- Visualise the complete detection pipeline.

2 Lab Instructions

Throughout the notebook, you will find `# TODO` cells that require your implementation, and markdown cells labelled **Your Answer:** where you must provide written responses to con-

ceptual questions. Read every explanation carefully — the mathematics you saw in lecture is directly applied here.

Deliverable & Submission Rules

- Submit a **single PDF** on Connect UIR — the completed notebook only, no separate report.
- Your **name and Student ID** must appear in the first cell of the notebook.
- All **written answers** must be filled in the `Your Answer:` fields directly in the notebook.
- Run all cells (`Runtime` → `Run all`) and make sure every output is visible before exporting.
- Convert your `.ipynb` to PDF via https://www.vertopal.com/en/convert/ipynb-to-pdf, then upload the PDF to Connect UIR.
- **Do not send your submission by email. (I won't correct it)**