COL780 / JRL780

Assignment-2: Creating Panoramas using Image Stitching

Deadline: 28 Feb 2023

1 Motivation

Panoramic photography produces images that capture a wider field of view than possible in a single standard camera shot. By stitching together multiple images rotated around the camera's vertical axis, impressive panoramic photos can be constructed showing an entire landscape or scene beyond what a single image could capture. A Panorama enables photographers to create immersive experiences and showcase sprawling vistas and environments. Furthermore, panoramas have applications in document scanning, satellite/aerial imaging, and other fields requiring the capture of wide fields of view.

2 Problem Statement

The objective of this assignment is to create an automated image stitching system that produces seamless panoramic images from either a set of images with overlapping fields of view or frames extracted from a short video. The system should take images/video frames as input and combine them into a single unified panorama spanning the full horizontal field of view captured. The output is a high-resolution panoramic image stitching the aligned images/frames together into a wide vista. We describe the task in detail in the next section.

3 Task Description

3.1 Image Preprocessing

The preprocessing stage is needed to enhance the image quality to ensure effective stitching. Following are some commonly used preprocessing techniques in image stitching. You can use some of the techniques specified below for image preprocessing if required.

- *Contrast Adjustment:* This is used to bring out details in different parts of the image. It is particularly important for scenes with varying lighting conditions.

- *Noise Reduction:* Noise reduction techniques mitigate the impact of artifacts introduced during image acquisition. This ensures a cleaner input for downstream algorithms.

<div align="center">(a) Image 1   (b) Image 2   (c) Image 3</div>

<div align="center">(d) Image 4   (e) Image 5   (f) Image 6</div>

Figure 1: Input images for Panorama Creation

- *Color Correction (if applicable):* Correction of color imbalances allows us to maintain a consistent color profile across all input images.

3.2 Image Registration

Image registration is the process of aligning images (estimating the transformation between image points) captured from different viewpoints so that they can be stitched together. in this section, you need to implement an algorithm to estimate the homography between two input images. The following techniques are generally used for Image Registration.

Figure 2: Panorama Image

- *Feature Based Methods* These involve identifying distinctive features in each image, such as corners or keypoints, and matching them across images to estimate the transform between them. Common feature-matching algorithms include SIFT (Scale-Invariant Feature Transform) or ORB (Oriented FAST and Rotated BRIEF).

- *Intensity-based Methods:* These methods involve optimizing a similarity metric to align pixel intensities between images. Common techniques include Normalized Cross-Correlation, Mutual Information, and Sum of Squared Differences. This approach is effective when distinct features are not prominent. Optimization techniques, such as gradient descent, can be used for intensity-based registration.

Experiment with the above methods to find the one that suits best for the given task. You can also any combination of the above techniques or some other approach for Image Registration.

3.3   Panorama Creation from Images

Using the Registration Algorithm that you implemented in the previous section, create a **Panorama** by stitching the image inputs together. You need to warp the images into a common coordinate system to align them and blend the images seamlessly together to produce a smooth output. Experiment with different blending methods like Alpha Blending, Laplacian Blending and 2-Band Blending

3.4   Panorama Creation from Videos

In this section, you will be given a short video of a scene. You need to extract images from the video and use your Algorithm for Panorama Creation implemented in the previous section.

3.5   Report and Evaluation

Prepare a detailed report describing your approach, challenges faced, and results obtained. Evaluate the quality of your Image Registration and Panorama Creation.

3.6 Bonus

- **Optical Flow for Registration** Explore the Lucas-Kanade Algorithm for Optical flow to track the movement of pixels between consecutive frames for Image registration.

- **Graph Cut Blending** Explore using Graph Cuts for Image Blending.

4 Submission Guidelines

- **Dataset:** The dataset for this assignment can be found **here**. You have been provided with 3 panoramic scenes with 6 images each and 1 video capture file to test your Panorama Creation Algorithms. We have a separate held-out test dataset which is similar to the one given to you. We will test the performance of your algorithms on that dataset.

- The entire code must be submitted in the form of python files, along with a `main.py` which will be executed in two parts during evaluation/demo as follows:

  ```
  python3 main.py <part_id> <input_path> <output_path>
  ```

  There are two tasks. `part_id` will be either 1 or 2 depending on the task. You need to write the panoramic image to the path specified by `<output_path>`.

  - For the first task, `<input_path>` will contain the location of the folder containing the images.

    ```
    python3 main.py 1 <img_dir> <output_path>
    ```

  - For the second part, `<input_path>` will contain the location of the video file.

    ```
    python3 main.py 2 <video_path> <output_path>
    ```

4.1 Instructions

- You can use OpenCV functions to read and write images. You **CANNOT** use other inbuilt image processing algorithms from OpenCV unless mentioned in the assignment description. Among other third-party libraries, only Numpy, Matplotlib, and PIL functions are allowed.

- Submit the code in the form of Python files only. You should have a main.py file which will be executed during the demo.

- You are required to submit the code, data, and a detailed report for this assignment and zip the contents with file name ENTRY NUMBER.zip on Moodle.

- This is an individual assignment. Mention the names of all the students you have discussed within the report. Any sort of plagiarism will lead to a zero in the assignment straightaway and stricter punishment depending on the case.