CS 181 Program 1 Report

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1. Program Functions

- **Cylindrical Projection (cylindrical_projection)**: Applies inverse cylindrical warping to correct distortions before stitching.
- **Feature Detection & Matching (detect_and_match_features)**: Uses **SIFT feature extraction** and **FLANN-based matching** with **RANSAC filtering** to estimate image correspondences.
- **Image Warping (stitch_images)**: Computes **homographies** to transform images into a common coordinate space and blends them into a final panorama.
- **Main Execution (main)**: Reads input images, processes them sequentially, and saves the final stitched image.

2. How to Run

To execute the program, run the following command:

python prog1.py <input_image_directory> <output_panorama.jpg>

Example: python3 "CS 181/prog1.py" "CS 181/input.picture.directory/horizontal.left.right" "CS 181/output.panorama.image/panorama.jpg"

- Ensure **OpenCV** and **NumPy** are installed (pip install opencv-python numpy).
- If using CSIL, use module load python before execution.

3. Time Complexity Analysis

The computational complexity is primarily dependent on **image resolution** and **number of images** Through my testing:

- **Feature Detection & Matching:** $O(W * H + f \log f)$, where $W * H$ is the image resolution and f is the number of detected features.
- **Image Warping & Blending:** $O(W * H)$, as each pixel undergoes transformation.
- **Overall Complexity (for k images):**
  $O(k * W * H)$
  where k is the number of images.
- The program scales **linearly with the number of images** and **quadratically with image resolution**, making high-resolution images more computationally expensive and resource intensive.

4. Performance Notes

Through testing 4k, 1080p, 720p and 480p the program runs efficiently on **lower-resolution images(480p and below)** or under 5 4k images each around 5mb, but may slow down with large images/ large quantities due to high **pixel count.** Since time complexity depends on the number of pixels present. Between 480p and 4k, 4k has over 27 times more pixels. When trying to test 4k images, it is expected behavior for shell to kill the command because of how resource intensive it is.