Abstract

This project will create a Python-based panoramic image stitching tool that combines overlapping images into a seamless panorama. Using feature detection, homography, and blending techniques, the tool will align images and remove seams.

Automated Panoramic Image Stitching Tool: A Computational Photography Approach

Seamlessly Combining Overlapping Images Using Python and Advanced Image Processing Techniques

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In recent years, panoramic photography has gained widespread popularity, allowing users to capture wide-angle views by seamlessly combining multiple images. The goal of this project is to develop a panoramic image stitching tool using Python, leveraging computer vision techniques to automatically stitch a sequence of overlapping images into a single, wide-angle panoramic photograph.

This tool will use various algorithms and techniques to detect image features, align overlapping regions, and blend them into a cohesive final image. The user interface will be developed using **PySimpleGUI** to provide an intuitive way for users to upload images, view results, and adjust stitching parameters.

The project will be developed in **Python**, utilizing the following libraries and frameworks:

* **OpenCV**: For image processing, including feature detection, matching, homography calculation, and image warping.
* **NumPy**: For efficient matrix operations and image manipulations.
* **PySimpleGUI**: To create a simple graphical user interface (GUI) for image input/output and user interaction.
* **Matplotlib**: To visualize and display images during the development and debugging stages.

**Methodology and Algorithms**

The core of the panoramic stitching process involves several key steps and algorithms commonly used in the field of computer vision:

* ***Feature Detection and Matching***
  + The first step is detecting distinct key points in overlapping images. This will be achieved using algorithms like **SIFT** (Scale-Invariant Feature Transform) or **ORB** (Oriented FAST and Rotated BRIEF), both of which are well-suited for finding robust feature points in images. These key points will then be matched across overlapping images using feature matching algorithms such as **FLANN** or **Brute Force Matcher**.
* ***Homography Estimation***
  + Once corresponding feature points are identified, a **homography matrix** will be computed to map the coordinates of one image onto the corresponding points in another. This matrix is crucial for determining the transformation needed to align the images. The **RANSAC** (Random Sample Consensus) algorithm will be used to improve the robustness of this transformation by filtering out incorrect matches.
* ***Image Warping***
  + Using the computed homography, the images will be warped to align them correctly. This involves transforming each image so that overlapping regions are seamlessly aligned with one another.
* ***Blending***
  + To create a smooth transition between the overlapping areas of images, blending techniques will be applied. Basic approaches such as linear blending or feathering can be used

**Conclusion**

This panoramic image stitching tool is a strong fit for computational photography because it applies essential image processing techniques to solve real-world problems. By combining feature detection, homography, and image blending, the project demonstrates key concepts in computer vision. It offers practical value by creating seamless panoramic images, a common task in photography. This project not only enhances technical skills but also showcases the creative potential of computational approaches, making it a valuable addition to our portfolio and is an amazing and challenging learning experience.

**References**

GeeksforGeeks. (2024, June 17). *Image stitching with opencv*. https://www.geeksforgeeks.org/image-stitching-with-opencv/

Kommineni, V. (2020, November 14). *Image stitching using opencv*. Medium. https://towardsdatascience.com/image-stitching-using-opencv-817779c86a83

Morgan, J. (2023, March). *Panorama creation in opencv*. How to use OpenCV. https://www.opencvhelp.org/tutorials/advanced/panorama-creation/

Premsingh, P. (2024, August 20). *Image stitching using opencv - a step-by-step tutorial*. Medium. https://medium.com/@paulsonpremsingh7/image-stitching-using-opencv-a-step-by-step-tutorial-9214aa4255ec

Rosebrock, A. (2023, June 8). *Image stitching with opencv and python*. PyImageSearch. https://pyimagesearch.com/2018/12/17/image-stitching-with-opencv-and-python/