CP467: Course Project

Objective:
The purpose of this project is to immerse you in foundational image processing techniques, particularly feature detection, object identification, and image stitching. By crafting coherent visual representations from fragmented datasets, you will enhance your critical thinking, problem-solving abilities, and innovative approaches, ensuring a holistic understanding and practical application in real-world imaging scenarios.

Data Collection:

- Create a cluttered scene containing 15-20 everyday objects such as books, toys, kitchen items, electronic gadgets etc.
- Take (around 20-30) images of the scene from different distances and viewpoints. Most of these images contain only a part of the scene.
- The images are taken such that for every image, there is at least one other image that has some overlap with that image.
- Declutter the scene. Isolate each object and take a good quality frontal image of each object (optionally, you can take the sideview images if necessary). You may manually crop these images to remove the background, but you are not allowed to do any manual changes to the scene images.
- Now you have two datasets – a dataset of objects and a dataset of scenes. Name your scene images S1, S2, … Sn and object images O1, O2, … Om (if you are using more than one images for an object, name them O1_1, O1_2 etc.

Note: You may use a tripod or a stable platform to ensure the consistency of camera angles and reduce motion blur.

Tasks:

1. For each scene image, identify which objects are in the scene. Make a table of results showing number of true positives, false positives, true negatives, and false negatives for each scene. Calculate and show the precision, recall, F1-score, and accuracy for the complete dataset.
2. Construct a larger scene image by stitching together the individual scene images and identifying the location of each object in the stitched scene image. Ensure that there are no visible seams or inconsistencies in the stitched image.

Report:
The report includes:

- A small literature review that discusses past and current methods on how to perform Tasks (1) and (2) and discuss the advantages and disadvantages of each approach.
- The methods and algorithms you have used for feature detection, matching and image stitching, and why did you select those?
- A table of results for Task (1) as mentioned earlier.

- The challenges faced and how they were addressed.
- A section for possible improvements or future work.

The report should not be more than 5 pages excluding images and tables.

Deliverables

Submit a zip file containing:

- A folder named “Code” with the complete source code, ensuring it's executable on another system without additional modifications. This can include Python files (.py) or Jupyter Notebooks (.ipynb).
- A folder named “Scenes” containing the scene images from your dataset.
- A folder named “Objects” containing the object images from your dataset.
- A folder named “Detected_Objects” containing the scene images with each detected object marked by a box. Name the images Sx_detected where x is the corresponding scene number. Also annotate the detected objects with the corresponding object name (like "book", "toy") to make evaluation more systematic.
- A folder named “Keypoints” containing the scene and object images with keypoints shown. Name the images Sx_keypoints and Ox_keypoints where x is the corresponding scene or object number.
- A folder named “Matches” containing the scene images with keypoints matches shown for a specific object. Name the images Sx_Oy_matches where x and y are the corresponding scene and object numbers, respectively.
- The final stitched panoramic image of the scene named “Stitched_Scene”.
- A PDF file named “Project_Report” for documentation. The most important component of the report is your table of results.

Instructions

- Questions about the exam will be entertained during lectures in the presence of the entire class. If you have any questions, then please ask them during these lectures, when everyone is present. For fairness, the instructors will not answer questions about the project in person, by email, or outside of lectures.
- While you are free to employ a variety of techniques to fulfill the project requirements, the use of Machine Learning is not recommended. Should you choose to incorporate a Machine Learning approach, ensure that the model is retrained specifically for the unique objects in your dataset (e.g., a specific 'Gonzalez book' rather than a generic 'book'). Additionally, when using Machine Learning, segregate your scene dataset into development, validation, and test sets. Ensure that the test set remains untouched and is submitted alongside your project materials.
- You may use high-level functions from OpenCV, NumPy or other libraries. Provide a requirements.txt file listing all the dependencies.
- Store all images a “.png” for consistency.
- You can also use code from Internet as long as:

    a. The source is properly cited in your report.
    b. Your report clearly describes how the code operates.
- Use Python version > 3.6 and OpenCV version > 3.4
- All code that you submit should either be original or, if sourced from the internet, properly cited as indicated above.
- Submit all materials to MLS in a single zip file.

Marking Scheme

Task	**Marks**
Data Collection	10
Object Identification	30
Image Stitching and Object Location in Stitched Scene	30
Report	25
Code Structure and Execution	5
Total	**100**

A rubric for detailed marks distribution is attached with the project description on MLS.