International Institute of Information Technology Hyderabad
CS7.505: Computer Vision (Spring 2022)
Assignment 3: MRFs for Image Segmentation
Posted on: 21/03/2022
Due on: 23:55hrs, 01/04/2022

Guidelines

1. Follow the specified repository structure. `src` folder will contain the Jupyter notebooks used for the assignment. `images` folder will contain any images used for the questions.
2. Commit your work regularly to avoid losing progress. Make sure you run your Jupyter notebook before committing, to save all outputs.
3. The report should contain description of the problem, algorithms and results. It should be written in markdown, in the notebook itself.
4. Make sure that the assignment that you submit is your own work. **Any breach of this rule could result in serious actions including an F grade in the course**.
5. The experiments and report writing takes time. Start your work early and do not wait till the deadline.
6. You are not allowed to use inbuilt functions that directly solve the tasks assigned. Confirm with TAs regarding whether some function can be used, when in doubt.

Questions

1. **GrabCut**

    1. You will need to implement the GrabCut algorithm for this assignment. You are supposed to read and follow Rother et al paper. It will give you a detailed description of the algorithm.
    2. You only need to implement the iterative procedure described in Sec.3.1, Sec.3.2 and Sec.3.3 of the Rother paper to get a binary segmentation of the image. You do not need to implement border matting or foreground estimation in Sec.4.
    3. Please refer to Sec.2 of the Rother paper and the Boykov & Jolly paper for details regarding energy minimization based image segmentation.
    4. The provided boilerplate code implements the user interface. You can use GMM of standard libraries (sklearn etc) that would be required for implementing Sec.3.1
    5. **Deliverable 1 – Evaluation Metrics:** You need to evaluate the output of your algorithm using three metrics.
        - *Accuracy*: The number of pixels that are correctly labeled divided by the total number of pixels.
        - *Jaccard similarity*: The intersection over the union of your predicted foreground region with the ground truth.

- *Dice similarity coefficient*: It is 2 * the Area of Overlap divided by the total number of pixels in both images.

Refer to **this article** to understand more. You need to compute these values on all 30 images given (report the average across images), and also show the segmentation and report these values on at least six individual images: four images that your algorithm performs very well on and two images that your algorithm do not perform very well (if there is any). For these six images, also report the time taken to run your algorithm.

6. **Deliverable 2 – Report:** You are also supposed to write a report that must include a study of how changes in the various parameters affects the segmentation. You must study the ones that are in **bold**. Other than that, choose any 3 from the below list. You could come up with meaningful parameters of your own as well.
   - **The number of iterations of GMM updating and energy minimization.**
   - The number of mixture components in your GMM.
   - Whether to use soft GMM labels and do EM, and how that effects other parameters/results.
   - **Different ways to represent probabilities other than GMMs. 4-neighborhood or 8-neighborhood in your pairwise term.**
   - The choice of gamma.
   - Alternative ways of setting beta.
   - Effect of a tight initial bounding box or a loose bounding box.
   - Better ways of using the bounding box for segmentation.
   - Different color spaces or ways of representing pixels.
   - Co-segmentation.