ETRO VUB-DEPARTMENT OF ELECTRONICS AND INFORMATICS

VUB VRIJE UNIVERSITEIT BRUSSEL

IMAGE PROCESSING

Projects 2023

Adrian Munteanu (course titular)
Yangxintong Lyu, Xinxin Dai and Olivier Ducastel (TAs)

Guidelines

The aim of your projects is to study, implement, test and demonstrate image processing algorithm(s).

- You should use Matlab, C/C++ or Python for your implementation, unless other method is proposed.
- You have **to write your own Matlab (or C/C++/Python) code**. Existing code may be partially used only if you completely understand how it works and what each line of code does; this has to be appropriately acknowledged in the project and the report.
- **Directly copying existing code from external sources without acknowledgement disqualifies the project, leading to a project score of 0 for the entire group.**
- You have to submit a written project report, 2000 words typical, 4000 words max
- Use IEEE conference paper as a template: http://www.ieee.org/conferences_events/conferences/publishing/templates.html
- Each group submits ONE report.
- Sections (obligatory): Introduction, Description of your algorithm, Experimental results, Conclusions, References, Appendix (listing briefly what each student did within the group).
- Failing to comply with these guidelines reduces your project grade by 2 for each of these.
- Bonus targets are entirely optional and will lead to bonus points when completed.

- **Project submission**
  Submit as pdf (along with the code, all in a zip file) to:
  lyangxin@etrovub.be, xdai@etrovub.be and oducaste@etrovub.be
  Deadline: end of the semester (TBA)

- **Grading**
  The project accounts for 40% of the final score for the image processing exam.
  The project grading is based on:
  - Technical quality (score per group)- 35%
  - Written report (score per group)- 25%
  - Oral defense (individual score)- 40%

  The oral presentation and Q&A (~15 minutes) will be done in groups with a single Power point presentation on the day of the exam. Your score will be based on your understanding of the image processing techniques you used in your project.

  Reference for all:
  Gonzalez, Woods, "Digital Image Processing"

Contents

1. Shadow detection and removal

Description

Shadows happen where light from a light source is blocked by an opaque object, and it's difficult to avoid. It leads to problems in scene understanding from an image, like object segmentation. Recent image processing techniques have shown that shadow can be detected and eliminated from a single image. In this project, you will try to implement your own method which is able to detect the shadows and remove them from an image.

Bonus targets

- Take images under several light conditions with your smartphone/webcam and show the corresponding results of your method.

Technologies

- Color spaces conversion.
- Image reconstruction.

References

- Xu, L., Qi, F. and Jiang, R., 2006, October. Shadow removal from a single image. In sixth international conference on intelligent systems design and applications (Vol. 2, pp. 1049-1054). IEEE.

2. Palette-based Photo recoloring

Description

Manufacturing image color style is an important and fundamental functions of many real-world applications. In this work, you will firstly extract the most k=5 essential colors from an image and recolor the image with one or more different colors by user input.

Bonus targets

- Create a GUI that lets a user manually select local region to be recolored.

Technologies

- Color palette
- Color transfer

References

- Chang, H., Fried, O., Liu, Y., DiVerdi, S., & Finkelstein, A. (2015). Palette-based photo recoloring. ACM Trans. Graph., 34(4), 139-1.
- Xiao, Xuezhong, and Lizhuang Ma. "Color transfer in correlated color space." Proceedings of the 2006 ACM international conference on Virtual reality continuum and its applications. ACM, 2006.

3. Image mosaic

Description

Image mosaic is a technique where a photograph is divided into tiled sections and each block is replaced with another photograph that matches the target photo. In this project, you will start with collecting an amount of images and implement your image mosaic method to match the collected images on the target image.

Bonus targets

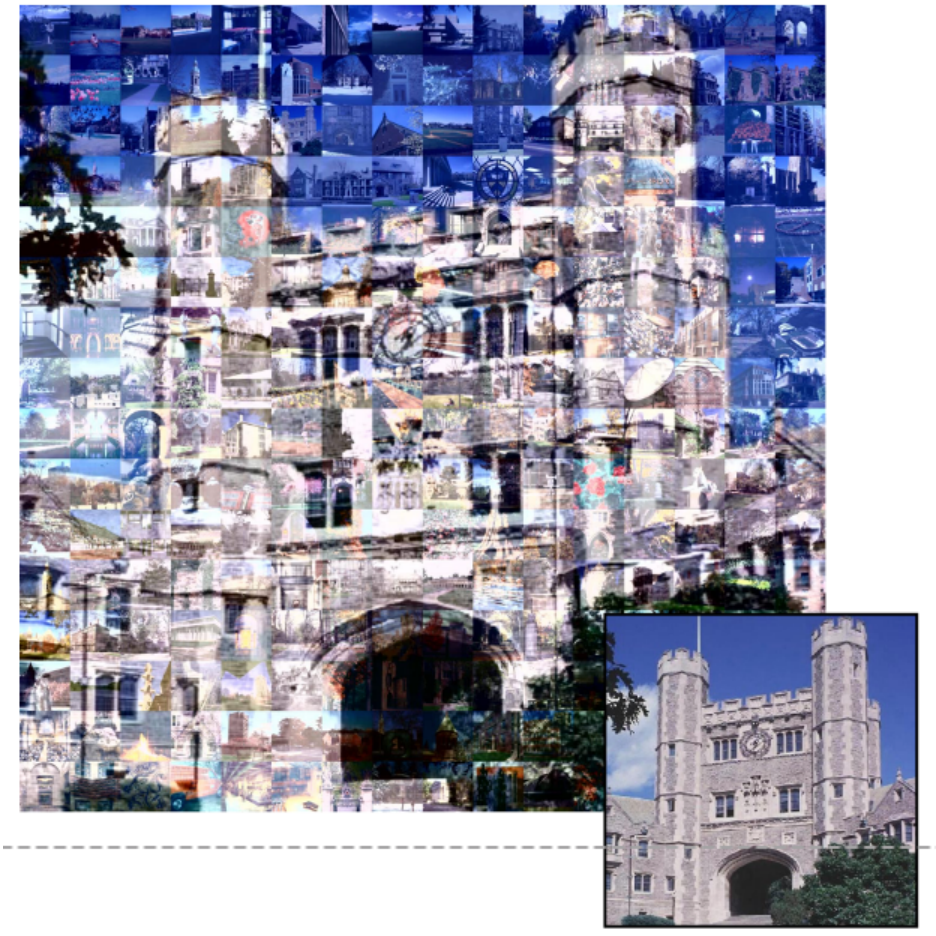
- Create GUI such that user can manually select arbitrary image region from the target image where the collected images are tiled to composite the final image.

Technologies

- Color correction.

References

- https://gfx.cs.princeton.edu/proj/mosaic/princeton-cs-tr-574-98.pdf
- Kim, J. and Pellacini, F., 2002. Jigsaw image mosaics. ACM Transactions on Graphics, 21(3), pp.657-664.



4. Color enhancement of Images

Description

MAGE enhancement is required mostly for better visualization or rendering of images to aid our visual perception. The dynamic range of the image may be too large to be accommodated by limited number of bit-planes of a display device, for example, when the illumination of the scene widely varies in the space, which means some places in image the appears to be too dark while in some other places it is too bright, the many details in images are not visible. In this project, the target is to improve image contrast to enhance sharpness of the details.

Bonus targets

- Create a GUI that lets the user can adjust intensity of color

Technologies

- discrete cosines transform
- DC and AC coefficients

References

- Mukherjee J, Mitra SK. Enhancement of color images by scaling the DCT coefficients. IEEE Transactions on Image processing. 2008 Sep 9;17(10):1783-94.

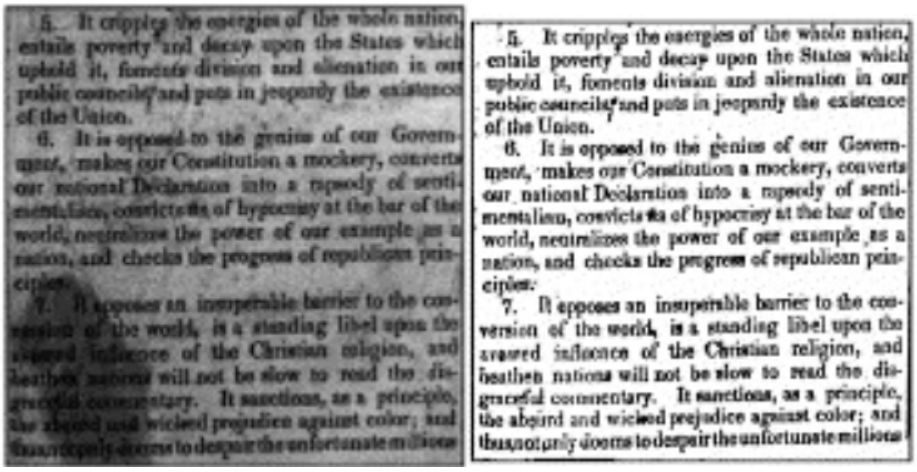
5. Adaptive degraded document image binarization

Description

Document image binarization refers to the conversion of a gray-scale image into a binary image. It is the precondition step of most document image analysis and understanding systems since its performance affects quite critically the degree of success in a subsequent character segmentation and recognition. In this project, the target is to find an adaptive threshold to separate the document images pixels into foreground (text) and background

Bonus targets

- Try to extend your method to process the more complex text, for example some text is obscured by ink.



Technologies

- binarization
- texture description
- threshold

References

- Sehad A, Chibani Y, Cheriet M, Yaddaden Y. Ancient degraded document image binarization based on texture features. In2013 8th International Symposium on Image and Signal Processing and Analysis (ISPA) 2013 Sep 4 (pp. 189-193). IEEE.
- Gatos B, Pratikakis I, Perantonis SJ. Adaptive degraded document image binarization. Pattern recognition. 2006 Mar 1;39(3):317-27.


Man lese:
Seite 6. Zeile 24. statt — Deklamationen — Deklamation.
S. 6. Z. 24. statt — Gläubigen.
— 8. in der Note, statt — hyperpolische — hyperbolische.
— in der Note, statt — sittli- — sittlichen.
Z. 2. statt — hebräische — hebräischgriechische.


E. BERLINER'S
GRAMOPHONE.
DIRECTIONS FOR USERS OF THE SEVEN-INCH
AMERICAN HAND MACHINE.

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6. Solving a Jigsaw Puzzle

Description

Solve a jigsaw puzzle by image processing

Bonus targets

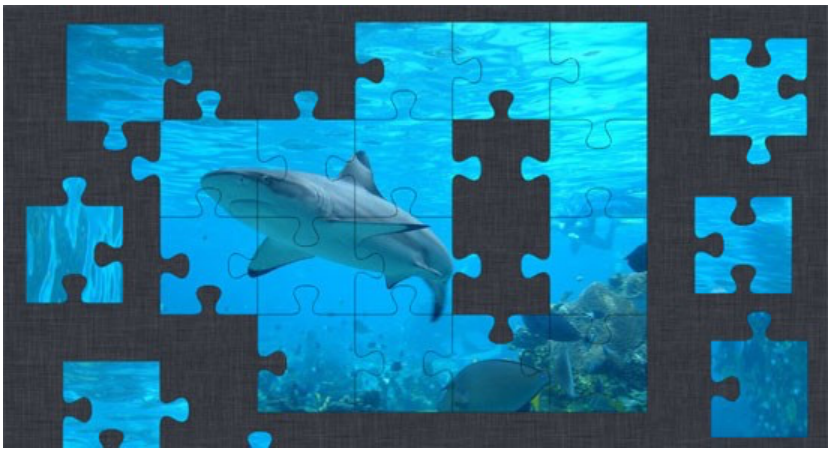
- Create another user interface that lets users create their own jigsaw puzzle from an image.

Technologies

- Region labeling, template matching, Eigenimages, Edge Detection
- Take an image, separate it to puzzle pieces based on a puzzle template, Make an image with all the pieces in random positions, do segmentation and feature extraction for the pieces and match their edges, solve the puzzle by identifying the correct position of the sub-images.

References

- Feng-Hui Yao, Gui-Feng Shao, "A shape and image merging technique to solve jigsaw puzzles"
- Daniel J. Ho, Peter J. Olver, "Automatic Solution of Jigsaw Puzzles"
- http://www.mathworks.com/help/images/functionlist.html



7. Panorama from video

Description

Since modern smartphones, a panorama image is easily created by sweeping the camera in a regular motion. Internally, this involves stitching several frames from the captured video, by first matching key feature points and detection translation/rotation between frames. In this project, you implement a method that creates the maximal panorama from a video sequence. The method should work for a varying framerate and motion, and the scene can be assumed to contain only non-moving objects.

Bonus targets

- Shoot your own video sequence
- Implement robustness to lens distortion

Technologies

- Feature points
- Image registration

References

- Steedly, Drew, Chris Pal, and Richard Szeliski. "Efficiently registering video into panoramic mosaics." *Tenth IEEE International Conference on Computer Vision (ICCV'05) Volume 1*. Vol. 2. IEEE, 2005.
- Perazzi, Federico, et al. "Panoramic video from unstructured camera arrays." *Computer Graphics Forum*. Vol. 34. No. 2. 2015.

8. Image retargeting & object removal using seam carving

Description

- Define new size for an image,
- Mark areas that need to be removed or that are not allowed to be edited
- Automatically resize and remove marked objects

Bonus targets

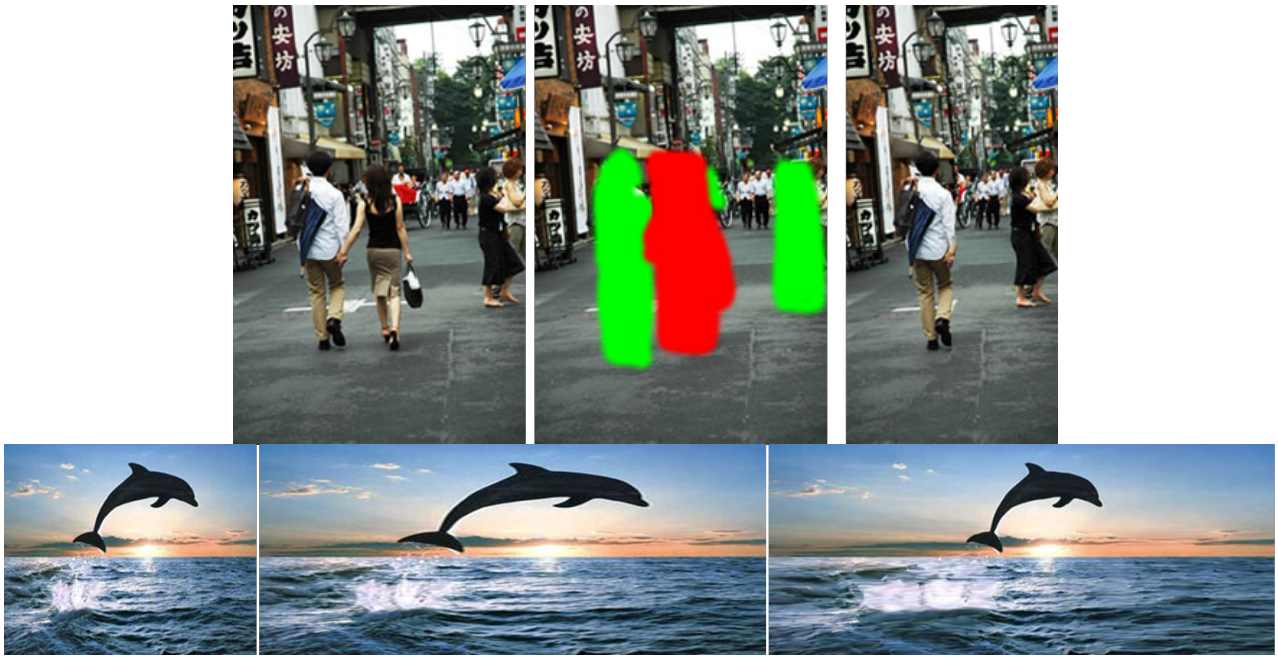
- Explore the same technology for video editing. User selections need to be transferred to the next frame to limit interactions.

Technologies

- Seam carving
- Create a GUI for the manual user interactions

References

- Avidan, S., & Shamir, A. (2007). Seam carving for content-aware image resizing. In ACM SIGGRAPH 2007 papers (pp. 10-es).



Resized

Resized with seam carving

9. Multi-Focus Image Fusion

Description

The capability of a camera to capture a complete and detailed representation of a scene is inherently limited due to the restricted depth of focus of its optical lens. As a result, only objects positioned within the camera's focal length can be focused and rendered clearly, while other parts of the image appear blurred and lack definition. To overcome this limitation, Multi-Focus Image Fusion (MFIF) employs multiple input images captured at varying focus depths to create a single output image that retains all pertinent information.

Bonus targets

- Capture your own multi-focus data samples with a webcam or a smartphone and apply the method you developed to fuse them.
- Implement a second MFIF method from the literature and compare your fused results both qualitatively and quantitatively (justify your choice of quality assessment metrics).

Technologies

- Transform-based image fusion
- Image quality assessment

References

- Haghighat, Mohammad Bagher Akbari, Aghagolzadeh, Ali and Seyedarabi, Hadi. "Multi-focus image fusion for visual sensor networks in DCT domain". *Computers & Electrical Engineering. Special Issue on Image Processing*. 2011, pp. 789–797.
- S. Savić and Z. Babić, "Multifocus image fusion based on the first level of empirical mode decomposition," *2012 19th International Conference on Systems, Signals and Image Processing (IWSSIP)*, Vienna, Austria, 2012, pp. 604-607.
- Dataset : https://github.com/sametaymaz/Multi-focus-Image-Fusion-Dataset

(First Input)

(Second Input)

(Fused Image)

10. Pixel-art converter

Description

Pixel art was first made popular by arcade games, at a time where high pixel density displays were not an option. Nowadays, pixel art are still used as a nostalgic gimmick. In this project, you will turn a regular image into pixel art. This conversion is a lot trickier than a simple low-resolution filter, as semantic details need to be preserved, so that the result is esthetic and easy to understand for the viewer.

Bonus targets

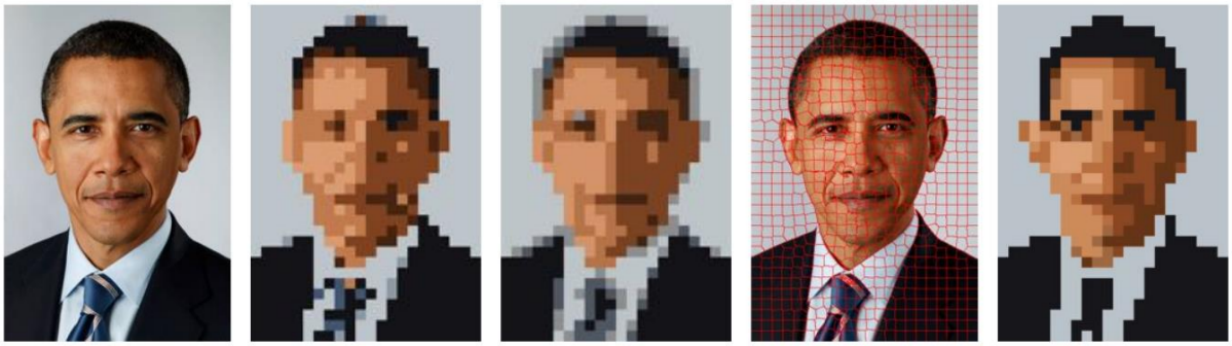
- Create an intuitive GUI that lets a user turn a picture into pixel art, with fine-tuning parameters.
- Try to extend your method to short videos. Be careful with inter-frame consistency

Technologies

- Color palette
- Re-sampling

References

- Gerstner, T., DeCarlo, D., Alexa, M., Finkelstein, A., Gingold, Y. I., & Nealen, A. (2012, June). In Expressive (pp. 29-36).



(a) original (b) naive nearest (c) naive cubic (d) superpixels (e) our result