Computational Photography: CS 413
Project Proposals 2022

February 2022

IVRL

Below is a list of project proposals for the CS 413 course, Spring semester 2022. Clarifications about each proposal can be obtained from the corresponding supervisor TA. The deliverables explain what is expected from you to submit by the end of the semester, aside from presentations/reports.

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1 Improving an open-source microscope by adding multispectral imagery

Only one team can work on this project.

Synopsis: While RGB imaging captures data only for red, green and blue colors, multispectral imaging captures data at various different wavelengths, as visualized in figure 1. It could be useful in microscopy to distinguish materials that look the same in RGB imaging. Several works [1]-[2] have been using Raspberry Pi camera and LEDs of different colors to obtain multispectral data, by extracting one image under each LED color and combining them into one multispectral image. In this project, we want to modify an open-source 3D-printable microscope [3] (openflexure.org) to integrate such multispectral feature in. This microscope, visualized in figure 2, works with a Raspberry Pi camera and contains (for now) only a white LED for illumination.

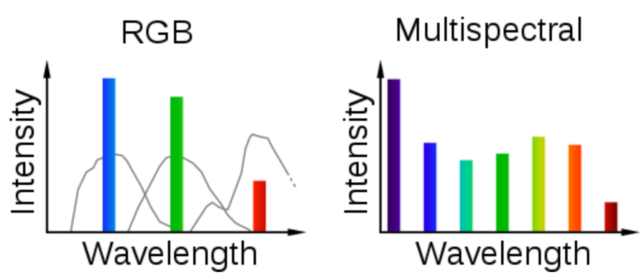

Fig. 1. Comparison of spectral sampling in RGB, and multispectral. wikimedia.org.

Prerequisites: A HDMI-monitor at home with USB keyboard/mouse to work on the Raspberry Pi. Basics of Python programming. Some knowledge of Raspberry Pi and/or 3D-printing would be a plus.
Learning objectives: Multispectral imagery. Use of Raspberry Pi. 3D piece designing/printing.
Deliverables: 3D-printed microscope, Demonstration of use, Code, Documentation, 3D-design files.
Supervised by: Martin Nicolas Everaert (martin.everaert@epfl.ch)

References

1. Gilson Augusto Helfer, Jorge Luis Victória Barbosa, Douglas Alves, Adilson Ben da Costa, Marko Beko, and Valderi Reis Quietinho Leithardt. Multispectral cameras and machine learning integrated into portable devices as clay prediction technology. *Journal of Sensor and Actuator Networks*, 10(3):40, 2021. URL: `https://www.mdpi.com/2224-2708/10/3/40/pdf`.
2. Nuria Lopez-Ruiz, Fernando Granados-Ortega, Miguel Angel Carvajal, and Antonio Martinez-Olmos. Portable multispectral imaging system based on raspberry pi. *Sensor Review*, 2017. URL: `https://www.emerald.com/insight/content/doi/10.1108/SR-12-2016-0276/full/html`.

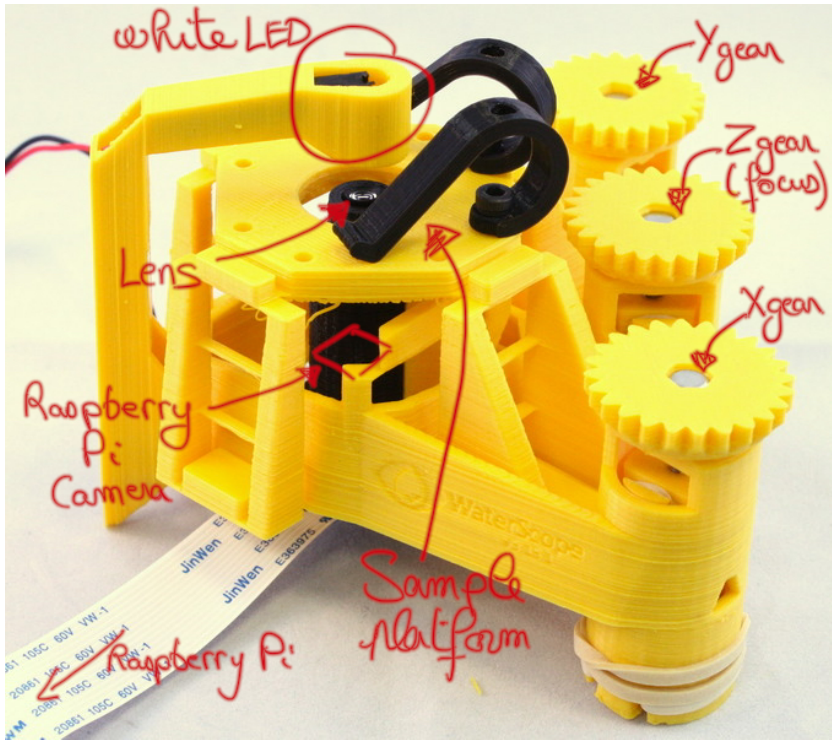

Fig. 2. The open-source 3D-printable microscope currently only contains a single white LED. openflexure.org.

3. James P Sharkey, Darryl CW Foo, Alexandre Kabla, Jeremy J Baumberg, and Richard W Bowman. A one-piece 3d printed flexure translation stage for open-source microscopy. *Review of Scientific Instruments*, 87(2):025104, 2016. URL: `https://aip.scitation.org/doi/10.1063/1.4941068`.

2 Low-level image transformations for image aesthetics

Synopsis: Many works [4]-[6]-[3]-[7]-[2] found low-level image features that impact the image aesthetics. Different datasets [1]-[4]-[5] provide aesthetics groundtruth values for various images using emotions taxonomy (as visualized in figure 3 from the Cornell Emotion6 dataset [5]). In this project, you will find which low-level features affect which emotions. Then, you will propose a method based on low-level image transformations (e.g. modification of brightness or contrast) to freely modify the emotions of images. Keeping in mind that the datasets use different sets of emotions, you will evaluate the effect of your image transformations for one emotion on other emotions. In addition, the datasets cover different domains (artworks for [1], emotional photographs for [5], abstract paintings and artistic photographs for [4]) and you will evaluate which transformations are the most adapted for each domain.

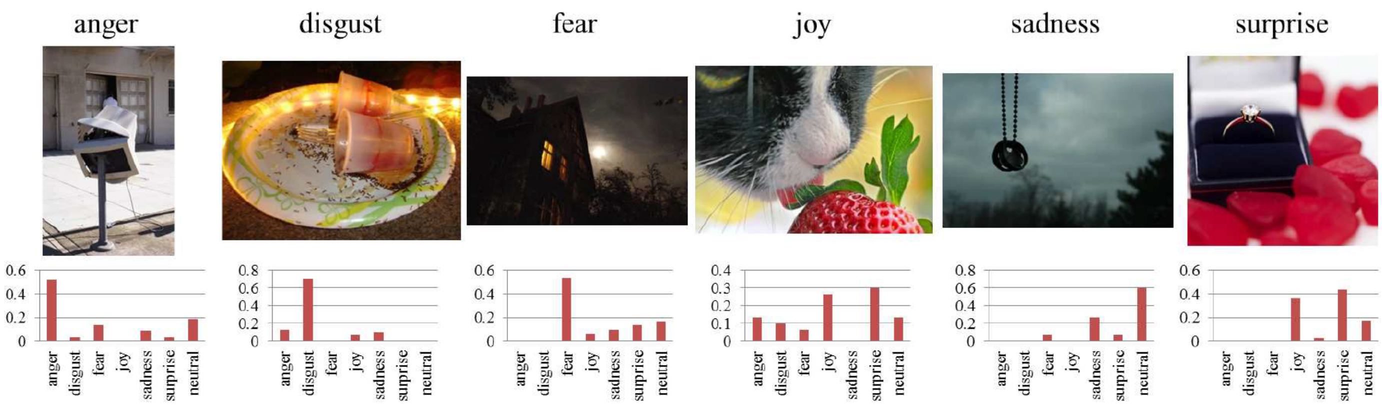

Fig. 3. Example images of the Cornell Emotion6 dataset with the corresponding ground-truth emotions.

Prerequisites: Basics of Machine Learning. Basics of Python programming.
Learning objectives: Computational aesthetics, Machine Learning, Image transformation.
Deliverables: Set of relevant low-level image features and their effect on emotions, Comparison of the different sets of emotions, Comparison of the different image domains, Comparison of various image transformation techniques for emotion modification.
Supervised by: Martin Nicolas Everaert (martin.everaert@epfl.ch)

References

1. Panos Achlioptas, Maks Ovsjanikov, Kilichbek Haydarov, Mohamed Elhoseiny, and Leonidas Guibas. ArtEmis: Affective Language for Visual Art. *arXiv:2101.07396 [cs]*, January 2021. arXiv: 2101.07396.

2. Ritendra Datta, Dhiraj Joshi, Jia Li, and James Z Wang. Studying aesthetics in photographic images using a computational approach. In *European conference on computer vision*, pages 288–301. Springer, 2006.
3. Lore Goetschalckx, Alex Andonian, Aude Oliva, and Phillip Isola. Ganalyze: Toward visual definitions of cognitive image properties. In *Proceedings of the IEEE/CVF International Conference on Computer Vision*, pages 5744–5753, 2019.
4. Jana Machajdik and Allan Hanbury. Affective image classification using features inspired by psychology and art theory. In *Proceedings of the international conference on Multimedia - MM '10*, page 83, Firenze, Italy, 2010. ACM Press.
5. Kuan-Chuan Peng, Tsuhan Chen, Amir Sadovnik, and Andrew Gallagher. A mixed bag of emotions: Model, predict, and transfer emotion distributions. In *2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 860–868, Boston, MA, USA, June 2015. IEEE.
6. Katja Thömmes and Ronald Hübner. Instagram Likes for Architectural Photos Can Be Predicted by Quantitative Balance Measures and Curvature. *Frontiers in Psychology*, 9:1050, June 2018.
7. Patricia Valdez and Albert Mehrabian. Effects of color on emotions. *Journal of experimental psychology: General*, 123(4):394, 1994. Publisher: American Psychological Association.