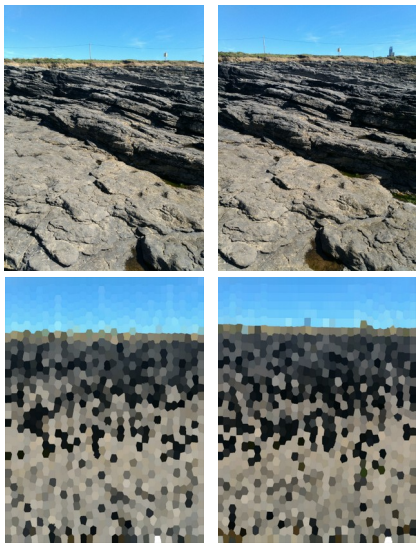
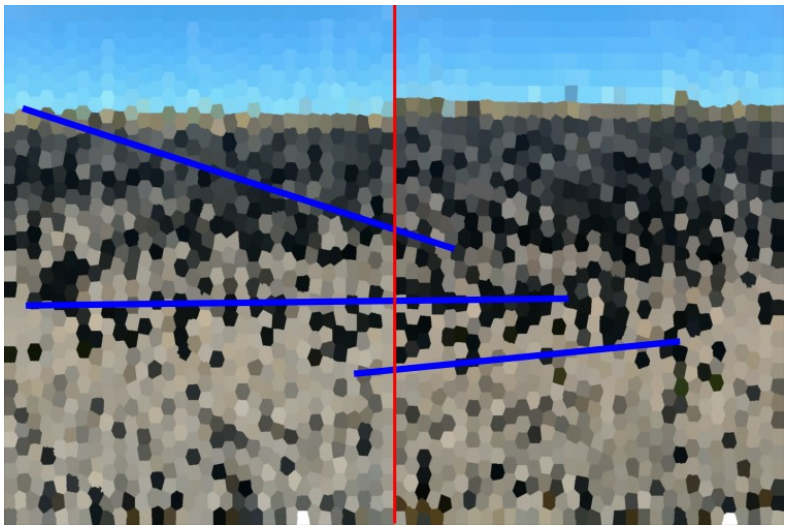
Using regional image descriptors for reconstructing image series





A common task in image processing and its further application in Computer Vision- and Graphics is the connecting and registration of related images in an image series. While this can be rather simple for artificial- or domain-specific images with limited difference, this co-registration task is still not solved for general, real-world, high-resolution photographs. Challenges here emerge not just from significant image offsets and transformations, but also of considerable radiometric differences between images. Recent, AI-based co-registration approaches (e.g. FlowNet, CNN-Features, HomographyNet) are more precise and less domain-dependent than traditional approaches, though still relying on *distinct objects* to be detected in the scene. A general observation here is as follows: because all those approaches rely on *pixels*, their matching and their displacement extraction, they are limited in the degree of movement allowed for the detection.

That said, images do not need to be described exclusively by pixels. Instead, they can also be described as *coherent regions*, as *vector contours* and *curves*. Describing images as vectorized, radiometrically-coherent regions has the potential to easier establish regional correspondences between images, allowing a larger degree of motion between images, and also enable a radiometrically more robust processing of detected regions. These regions can be extracted via vectorization algorithms, superpixel region detectors or Voronoi partitions.

The goal of this project is to test the hypotheses that *(i) image regions are more versatile descriptors of natural photographs than individual pixels* and *(ii) regional image descriptors allow for scale-free, continuous interpolation of image series* for complex vision tasks. Task that benefit from a more scale-independent, continuous-regressable image series are (a) *video construction & compression*, (b) *panorama photography*, (c) *360-deg imaging*, (d) *time-lapse photography* and *(e) structure-from-motion (SfM) reconstruction*. Specifically, this project has the following objectives:

- implement common, separable functions (1) image-to-image registration and (2) homography extraction for both pixel-- as well as region-described images
- design an easily-interpretable user interface to assess and compare image matching approaches, e.g. by taking inspiration from side-by-side sliders, overlays and mosaics
- Assess and compare (both qualitatively and quantitatively) the registration accuracy between pixel-homography and region-homography for …
  - … synthesized (i.e. computer-generated) image series
  - … established benchmark image-registration datasets (e.g. KITTI)
  - … natural photo series of landscapes
- Facilitate continuous image interpolation of the co-registered image series
- Evaluate the use of those continuous image interpolations on one of the example applications listed above