Image Feature Extraction: Traditional and Deep Learning Techniques

Brief write up focused on giving an overview of the traditional and deep learning techniques for feature extraction

Krut Patel Sep 9, 2020 · 4 min read ★

Feature Extraction is an important technique in Computer Vision widely used for tasks like:

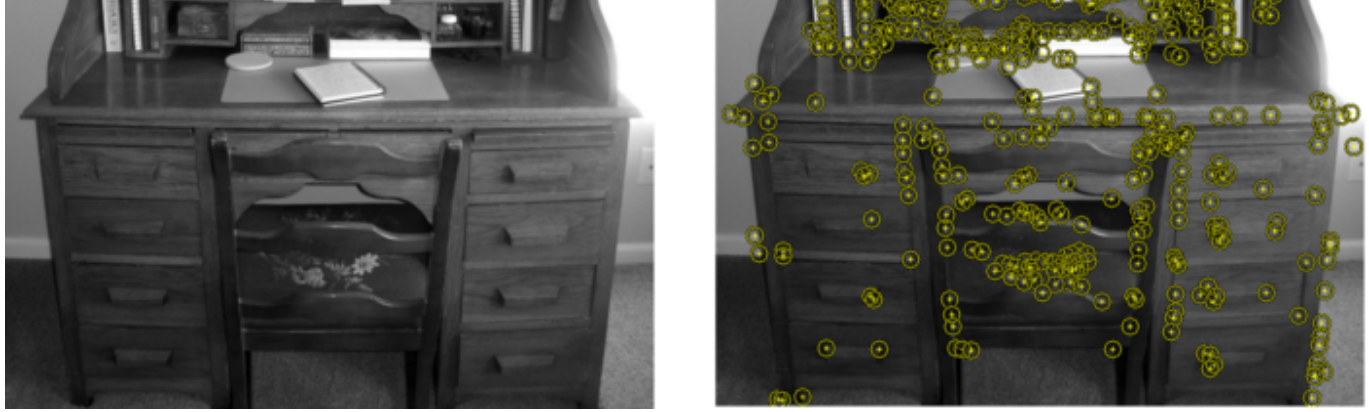
- Object recognition

- Image alignment and stitching (to create a panorama)
- 3D stereo reconstruction
- Navigation for robots/self-driving cars
- and more…

What are features?

Features are parts or patterns of an object in an image that help to identify it. For example — a square has 4 corners and 4 edges, they can be called features of the square, and they help us humans identify it's a square. Features include properties like corners, edges, regions of interest points, ridges, etc.

As shown in the image below the yellow points show the features detected using a technique called Harris Detection.



(src:https://commons.wikimedia.org/wiki/File:Writing_Desk_with_Harris_Detector.png)

Glimpse of Traditional feature detection techniques

Traditional Computer Vision techniques for feature detection include:

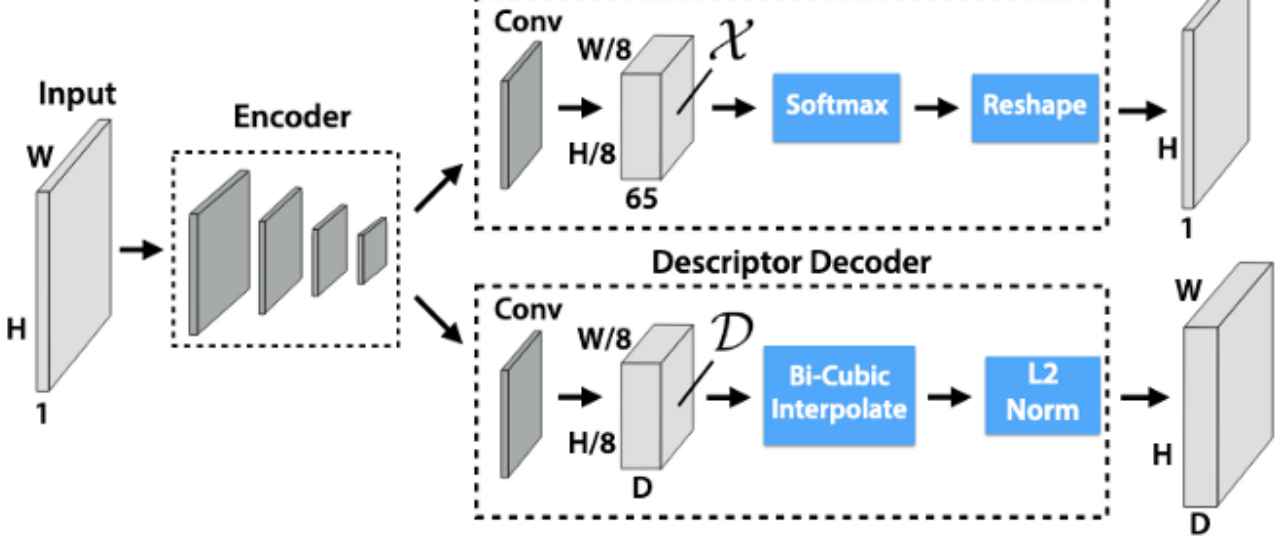
- **Harris Corner Detection —** Uses a Gaussian window function to detect corners. (read more)
- **Shi-Tomasi Corner Detector —** The authors modified the scoring function used in Harris Corner Detection to achieve a better corner detection technique (read more)
- **Scale-Invariant Feature Transform (SIFT) —** This technique is scale invariant unlike the previous two. (read more)
- **Speeded-Up Robust Features (SURF) —** This is a faster version of SIFT as the name says. (read more)
- **Features from Accelerated Segment Test (FAST) —** This is a much more faster corner detection technique compared to SURF. (read more)

- **Binary Robust Independent Elementary Features (BRIEF) —** This is only a feature descriptor that can be used with any other feature detector. This technique reduces the memory usage by converting descriptors in floating point numbers to binary strings. (read more)
- **Oriented FAST and Rotated BRIEF (ORB)** — SIFT and SURF are patented and this algorithm from OpenCV labs is a free alternative to them, that uses FAST keypoint detector and BRIEF descriptor. (read more)

Glimpse of Deep Learning feature extraction techniques

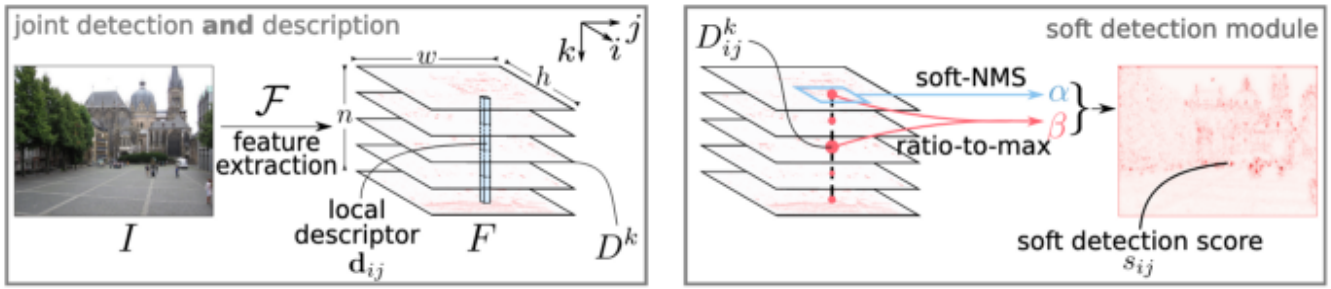
Traditional feature extractors can be replaced by a convolutional neural network(CNN), since CNN's have a strong ability to extract complex features that express the image in much more detail, learn the task specific features and are much more efficient. Multiple works have been done on this. Few of them are listed below:

- **SuperPoint: Self-Supervised Interest Point Detection and Description** (paper) — The authors suggest a fully convolutional neural network that computes SIFT like interest point locations and descriptors in a single forward pass. It uses an VGG-style encode for extracting features and then two decoders, one for point detection and the other for point description.



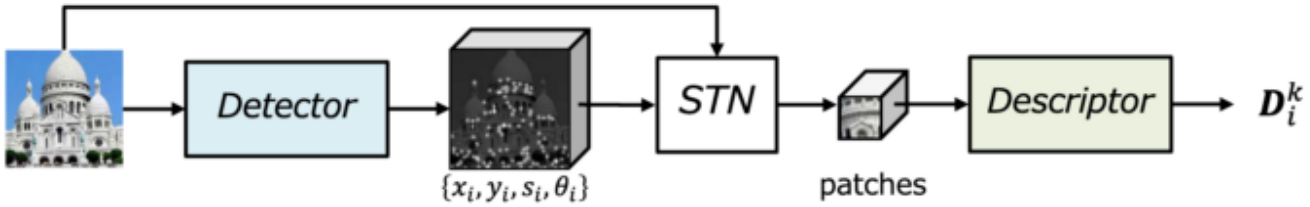
SuperPoint Architecture (src: https://arxiv.org/pdf/1712.07629.pdf)

- **D2-Net: A Trainable CNN for Joint Description and Detection of Local Features** (paper) — The authors suggest a single convolutional neural network that is both a dense feature descriptor and a feature detector.



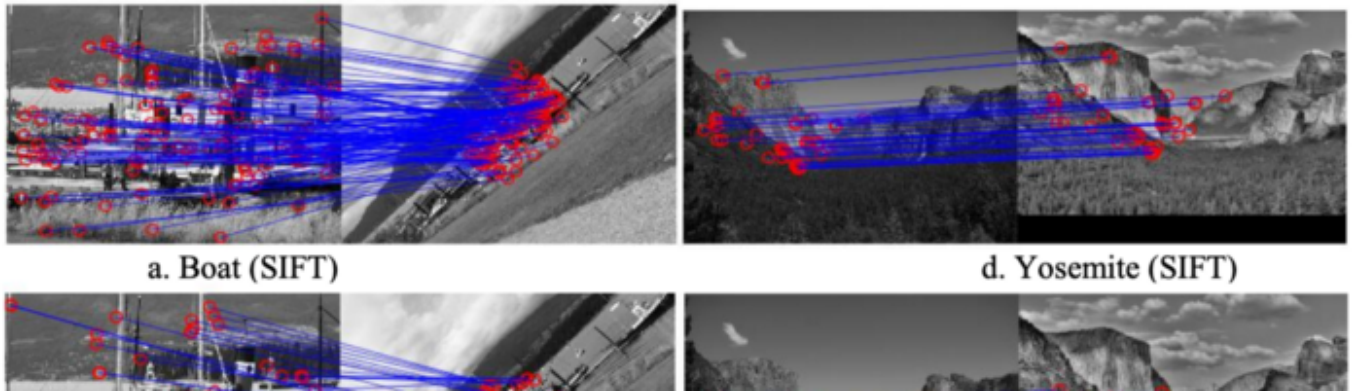
Detect and Describe D2 network (src: https://arxiv.org/pdf/1905.03561.pdf)

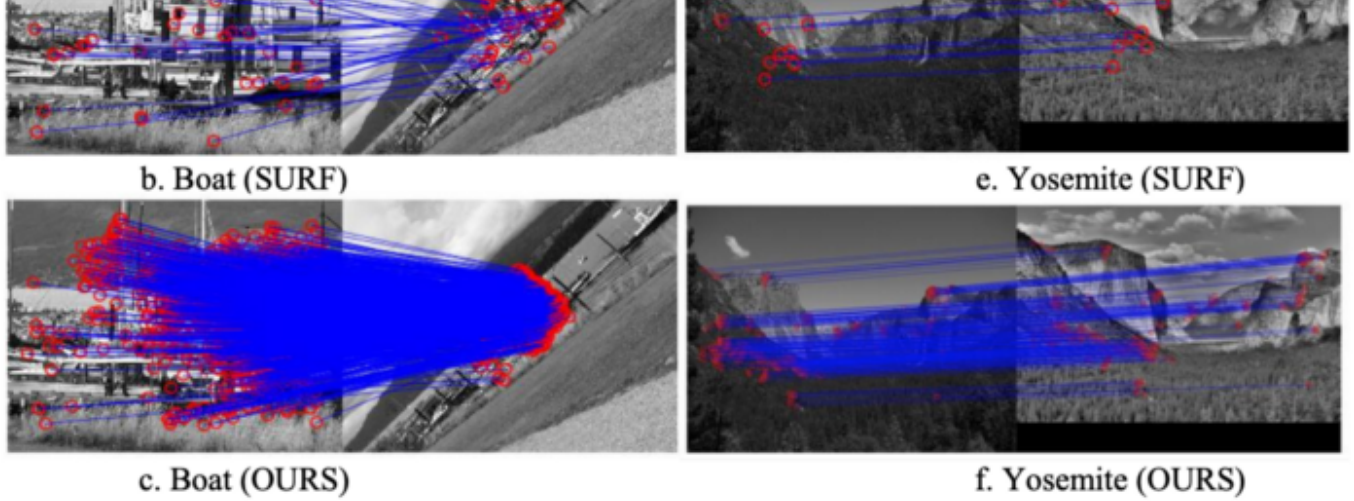
- **LF-Net: Learning Local Features from Images** (paper) — The authors suggest using a sparse-matching deep architecture and use an end-to-end training approach on image pairs having relative pose and depth maps. They run their detector on the first image, find the maxima and then optimize the weights so that when run on the second image, produces a clean response map with sharp maxima at the right locations.



LF-Net (src: https://papers.nips.cc/paper/7861-lf-net-learning-local-features-from-images.pdf)

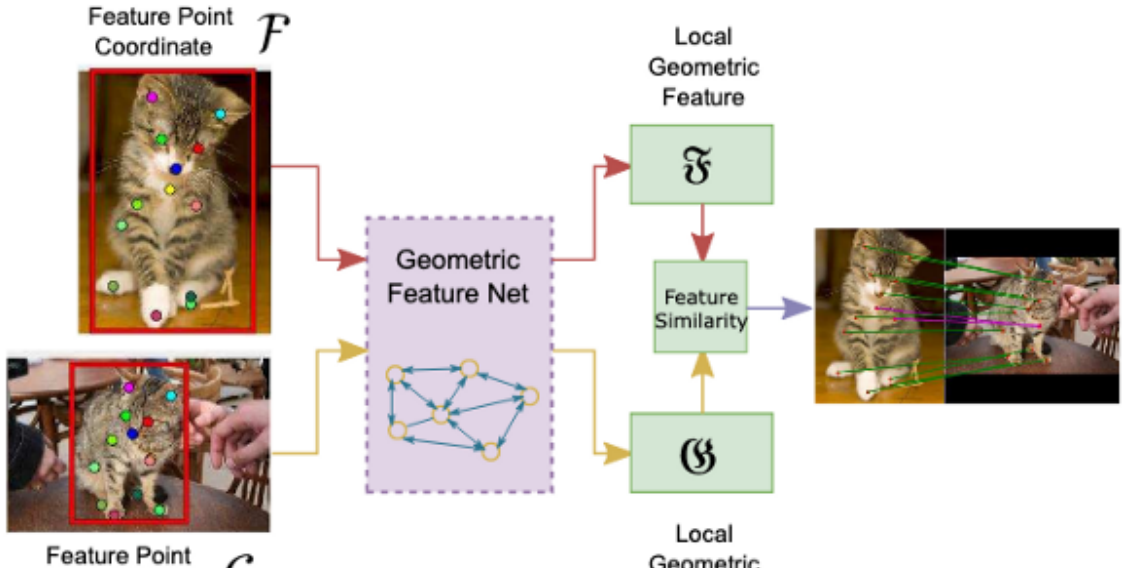
- **Image Feature Matching Based on Deep Learning** (paper) — They adopt a deep Convolutional neural network (CNN) model, which attention on image patch, in image feature points matching.





Results compared to SIFT and SURF (src: https://ieeexplore.ieee.org/abstract/document/8780936)

- **Deep Graphical Feature Learning for the Feature Matching Problem** (paper) — They suggest using a graph neural network to transform coordinates of feature points into local features, which would then make it easy to use a simple inference algorithm for feature matching



Graph neural network (src: https://openaccess.thecvf.com/content_ICCV_2019/papers/Zhang_Deep_Graphical_Feature_Learning_for_the_Feature_Matching_Problem_ICCV_2019_paper.pdf)

Conclusion

Though it may look like deep learning techniques for feature extraction are more robust to scale, occlusion, deformation, rotation, etc and have pushed the limits of what was possible using traditional computer vision techniques doesn't mean the computer vision techniques are obsolete.

Disclaimer

This is a brief write up focused on giving an overview of the traditional and deep learning techniques for feature extraction. If you think I might have missed an algorithm that should have been mentioned, do leave it in the comments (will add it up here with proper credits).

References

https://www.cs.ubc.ca/research/flann/uploads/FLANN/flann_manual-1.8.4.pdf

https://arxiv.org/pdf/1712.07629.pdf

https://arxiv.org/pdf/1905.03561.pdf

https://arxiv.org/ftp/arxiv/papers/1910/1910.13796.pdf

https://papers.nips.cc/paper/7861-lf-net-learning-local-features-from-images.pdf

https://ieeexplore.ieee.org/abstract/document/8780936

https://openaccess.thecvf.com/content_ICCV_2019/papers/Zhang_Deep_Graphical_Feature_Learning_for_the_Feature_Matching_Problem_ICCV_2019_paper.pdf

https://docs.opencv.org/3.4/dc/d0d/tutorial_py_features_harris.html

https://docs.opencv.org/3.4/d4/d8c/tutorial_py_shi_tomasi.html

https://docs.opencv.org/3.4/da/df5/tutorial_py_sift_intro.html

https://docs.opencv.org/3.4/da/df5/tutorial_py_sift_intro.html

https://docs.opencv.org/3.4/df/dd2/tutorial_py_surf_intro.html

https://docs.opencv.org/3.4/df/d0c/tutorial_py_fast.html

https://docs.opencv.org/3.4/dc/d7d/tutorial_py_brief.html

https://docs.opencv.org/3.4/d1/d89/tutorial_py_orb.html

Deep Learning | Machine Learning | Computer Vision | Feature Extraction | Opencv