Learning Objectives

- Learn feature extraction, the first step of using image features for applications
- Learn what characteristics make good image features
- Learn about different algorithms used to extract features in images

Image Features: A General Process

Images from CITYSCAPES dataset: https://www.cityscapes-dataset.com/

$$\{f_1, \cdots, f_N\}$$

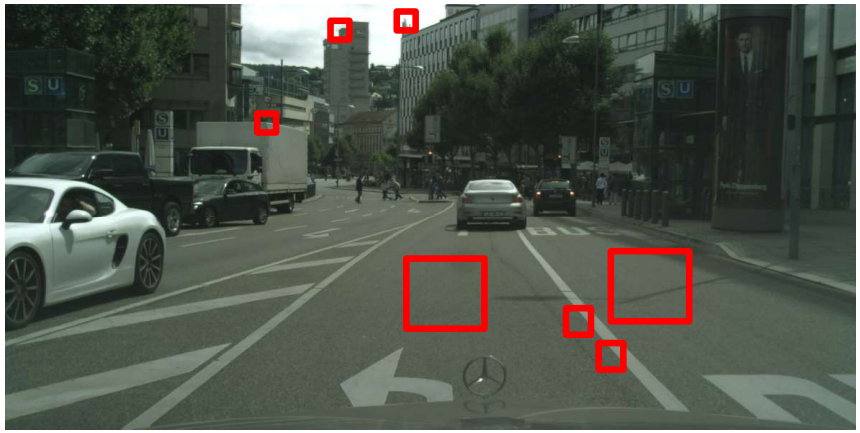
Feature Detection

- **Features** are **points of interest** in an image
- **Points of interest** should have the following characteristics:
  - **Saliency**: distinctive, identifiable, and different from its immediate neighborhood
  - **Repeatability**: can be found in multiple images using same operations
  - **Locality**: occupies a relatively small subset of image space
  - **Quantity**: enough points represented In the image
  - **Efficiency**: reasonable computation time

Points of interest

Feature Extraction

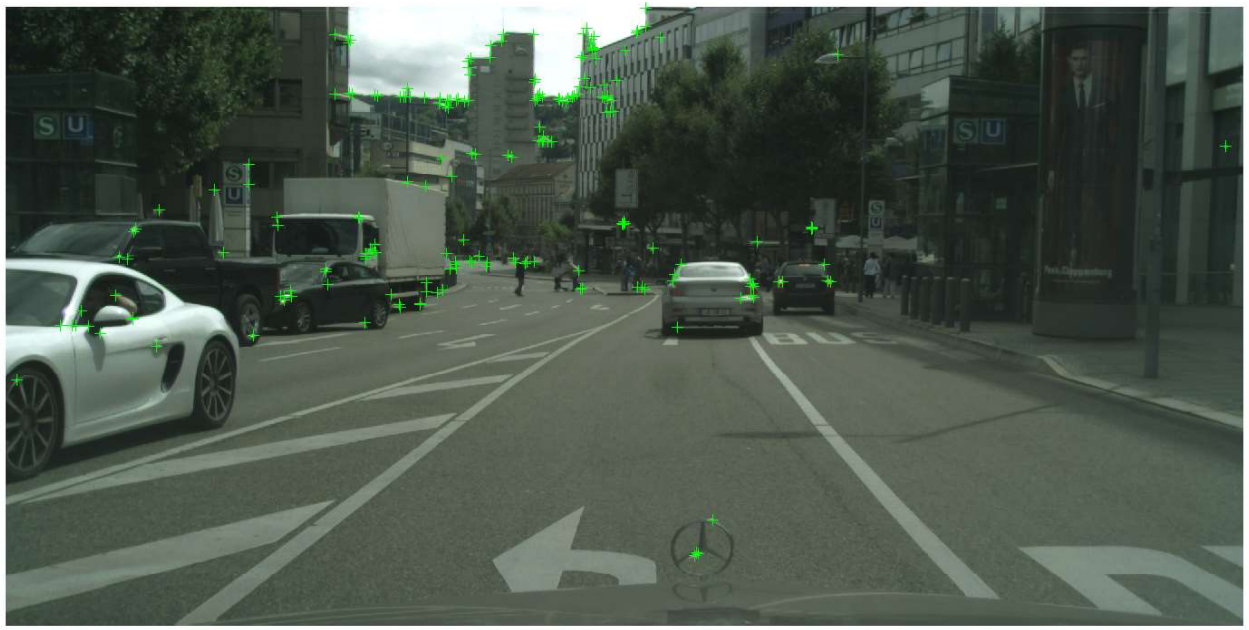
- Repetitive texture less patches are challenging to detect consistently
- Patches with large contrast changes (gradients) are easier to detect (edges)
- Gradients in at least two (significantly) different orientations are the easiest to detect (corners)



Feature Detection: Algorithms

- **Harris {corners}:** Easy to compute, but not scale invariant. [Harris and Stephens, 1988]
- **Harris-Laplace {corners}:** Same procedure as Harris detector, addition of scale selection based on Laplacian. Scale invariance. [Mikolajczyk, 2001]
- **Features from accelerated segment test (FAST) {corners}:** Machine learning approach for fast corner detection. [Rosten and Drummond, 2006]
- **Laplacian of Gaussian (LOG) detector {blobs}:** Uses the concept of scale space in a large neighborhood (blob). Somewhat scale invariant. [Lindeberg,1998]
- **Difference of Gaussian (DOG) detector {blobs}:** Approximates LOG but is faster to compute. [Lowe, 2004]

Feature Extraction: Harris Corners



Feature Extraction: Harris Laplace

Summary

- Good image features need to be **salient, repeatable, local, efficient, and numerous**
- Plenty of methods exist to extract features
- Empirical validation is required to choose the best extractor based on application

- **Next: Feature Descriptors**