

Image Feature Descriptors

Course 3, Module 2, Lesson 2



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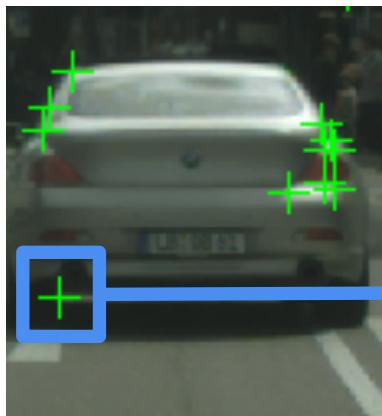
Image Features: A General Process



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

Feature Descriptors

- **Feature:** Point of interest in an image defined by its image pixel coordinates $[u, v]$
- **Descriptor:** An **N-dimensional** vector that provides a **summary** of the image information around the detected feature

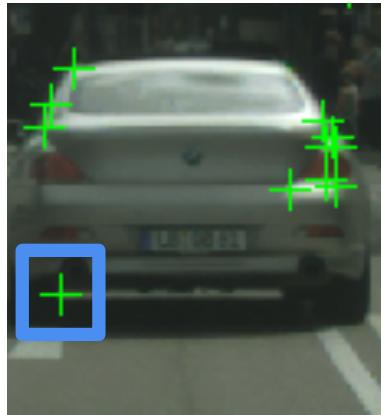


Position: $[u, v]$

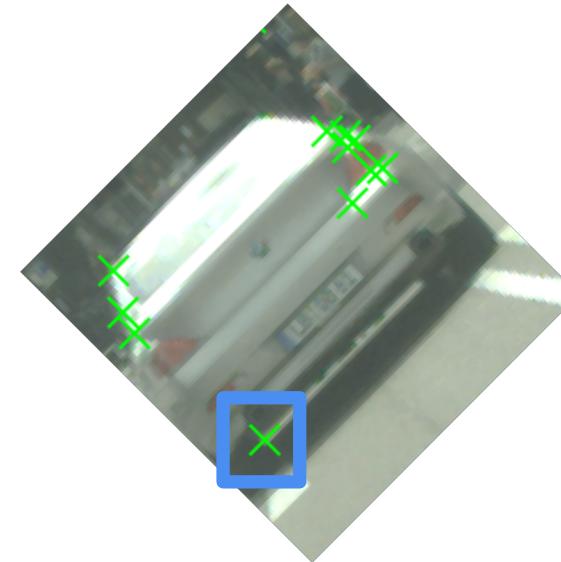
Descriptor: $\{f_1 \dots \dots \dots f_N\}$ *feature #*

Feature Descriptors

- **Feature descriptors** should have the following characteristics:
 - **Repeatability:** manifested as **robustness and invariance** to translation, rotation, scale, and illumination changes

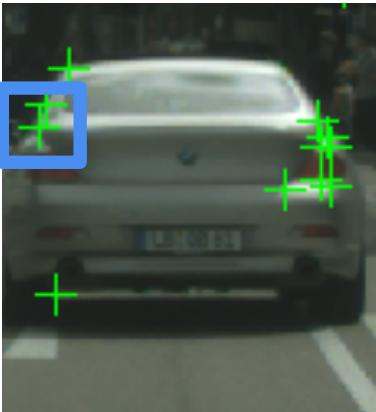


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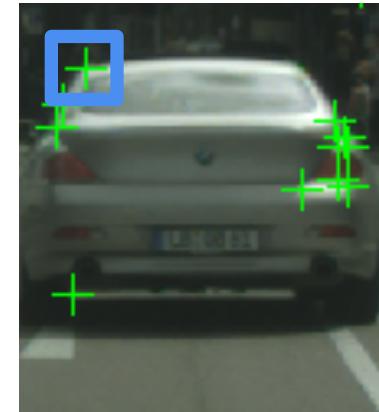


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 - **Distinctiveness:** should allow us to distinguish between two close by features, very important for matching later on



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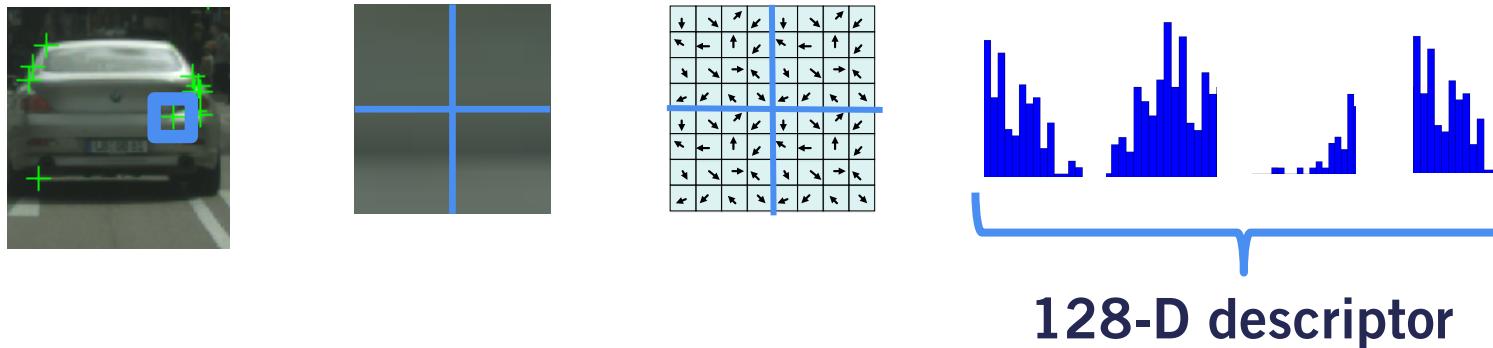


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 - **Repeatability:** manifested as **robustness and invariance** to translation, rotation, scale, and illumination changes
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 - **Compactness & Efficiency:** reasonable computation time

Designing Invariant Descriptors: SIFT

- Scale Invariant Feature Transform (SIFT) descriptors:
[Lowe 1999]
 1. 16 x 16 window around detected feature
 2. Separate into 4 cells, each comprised of 4 x 4 patch of pixels
 3. Compute **edge** orientation of each pixel in the cell
 4. Suppress **weak edges** using a predefined threshold
 5. Construct **32** dimensional **histogram of orientations** for each cell, then concatenate to get **128 dimensional descriptor**



Scale Invariant Feature Transform

- SIFT is an example of a very well human engineered feature descriptor, and is used in many state-of-the-art systems
- The above process is usually compute on rotated and scaled version of the 16×16 window, allowing for better scale robustness
- Combined with the DOG feature detector, SIFT descriptors provide a scale, rotation, and illumination invariant detector/descriptor pair

Difference of Gaussian

Other Descriptors

- **Speeded-Up Robust Features (SURF)**
- **Gradient Location-Orientation Histogram (GLOH)**
- **Binary Robust Independent Elementary Features (BRIEF)**
- **Oriented Fast and Rotated Brief (ORB)**
- Many more !