Advanced Lane Detection for Autonomous Driving

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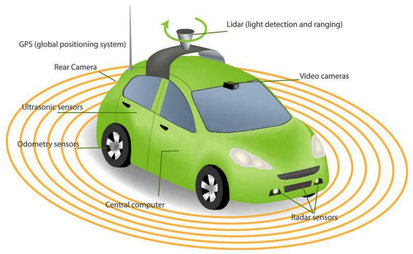
EECOMOBILITY (ORF) & HEVPD&D CREATE

PERCEPTION IN AD

An Autonomous Driving Vehicle is a vehicle able to perceive its environment and navigate it in partial or complete absence of human intervention.

The perception process aims at acquiring data from a variety of sensors installed on the car and interpret it in order to estimate the state of the environment.



According to the sense-plan-act paradigm, the capability of sensing, measuring and ultimately understanding the reality in which the vehicle is, namely the **perception process**, is a key aspect for the system.

Different sensors are used for the acquisition of the data. The most common in the field of Autonomous Driving Vehicles are **LiDAR**, **cameras** and **radars**. Sensor fusion techniques are applied to obtain a single, consistent, estimate from different sources.

CAMERAS

CCD or CMOS, monocular or stereo, frontal or rear, vision with **cameras** is a common component of the perception system of Autonomous Driving Vehicles.

Pros	**Cons**
Cost-effective	• Computationally expensive
Detects colors and texture	• Less effective on shapes and depth
Mimics human vision	• Affected by weather conditions

LANE DETECTION

Because of their capability of detecting colors and textures, one of the major applications of cameras is in the detection of road elements, including traffic signs and road lanes.

Lane detection aims at recognizing the horizontal road markings in order to:
- identify the shape of road and lanes to maintain the correct trajectory;
- recognize other horizontal markings, such as stop signs and lane directions, to follow their indication.

Computer Vision and **Machine Learning** techniques are usually adopted.

Data acquisition
from camera (and additional sensor)

Preprocessing
enhance features and remove irrelevant data

Model fitting
estimate position and shape of markings

Tracking
increase confidence on the estimates

COMPUTER VISION

Computer Vision (CV) is a branch of Artificial Intelligence that focuses on the analysis of visive inputs (images and videos) to extract high-level features. Although several Image Processing tools are commonly used in intermediate steps, the final objective of Computer Vision is to obtain relevant information from the analyzed scenes.

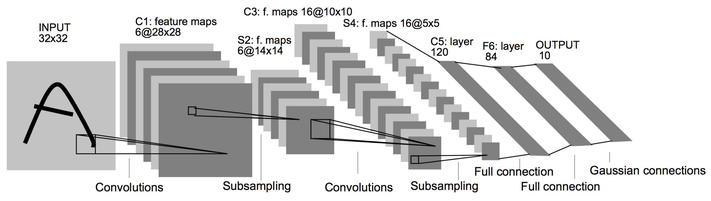
Popular examples of applications of Computer Vision span from face detection and recognition, used in smartphones and social media, to the perception of the environment for robotics and automotive applications.

Image of Lena Söderberg, widely used in Image Processing and Computer Vision as a test image, and examples of applications.

MACHINE LEARNING

Machine Learning (ML) is a branch of Artificial Intelligence that studies how machines can learn to recognize patterns and perform tasks directly from some data when provided with a priori information.

Among all Machine Learning techniques, **Artificial Neural Networks** (ANN) and variations such as **Recursive Neural Networks** (RNN) and **Convolutional Neural Networks** (CNN) are widely used and studied for their capabilities of reaching high accuracy and robustness to noise, at the cost of a computational intensive training phase.



Y. LeCun, L. Bottou, Y. Bengio and P. Haffner: Gradient-Based Learning Applied to Document Recognition, Proceedings of the IEEE, 86(11):2278-2324, November 1998

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