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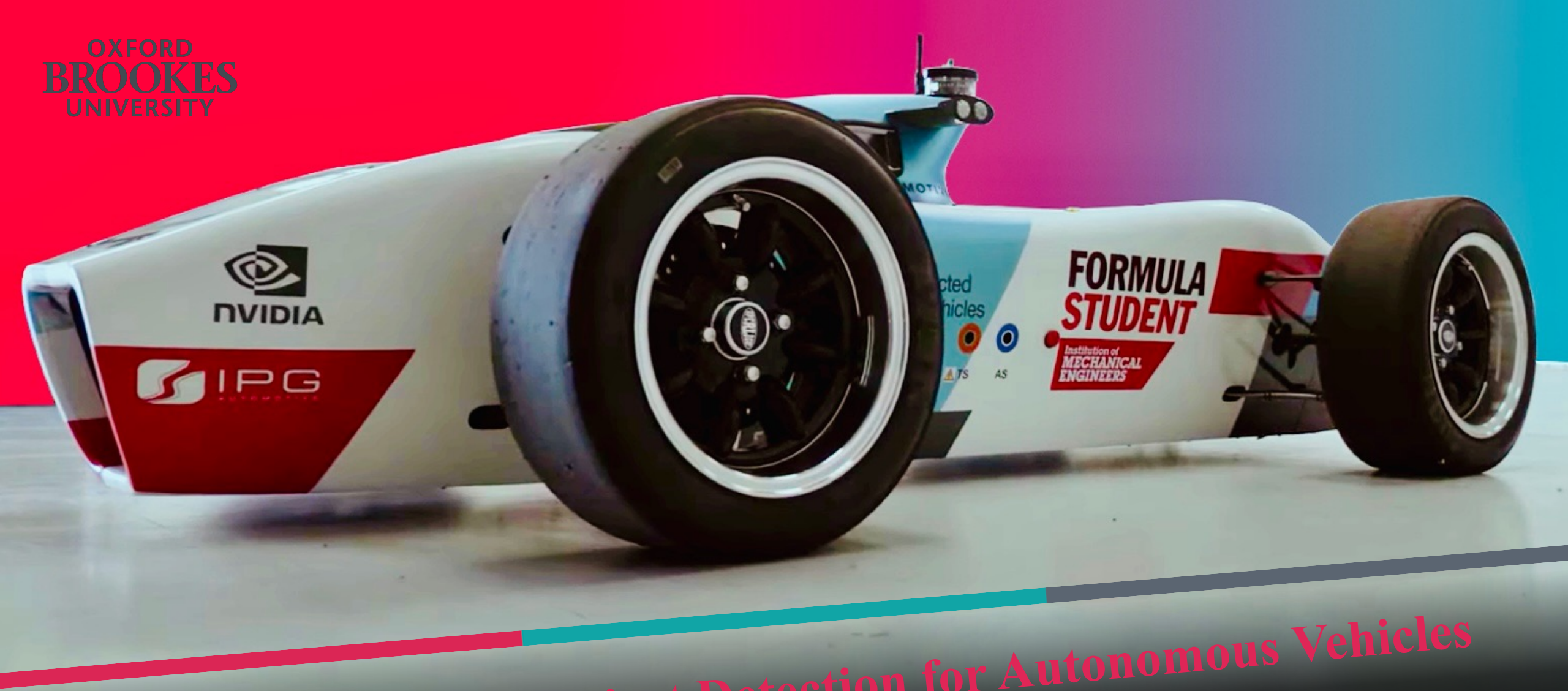
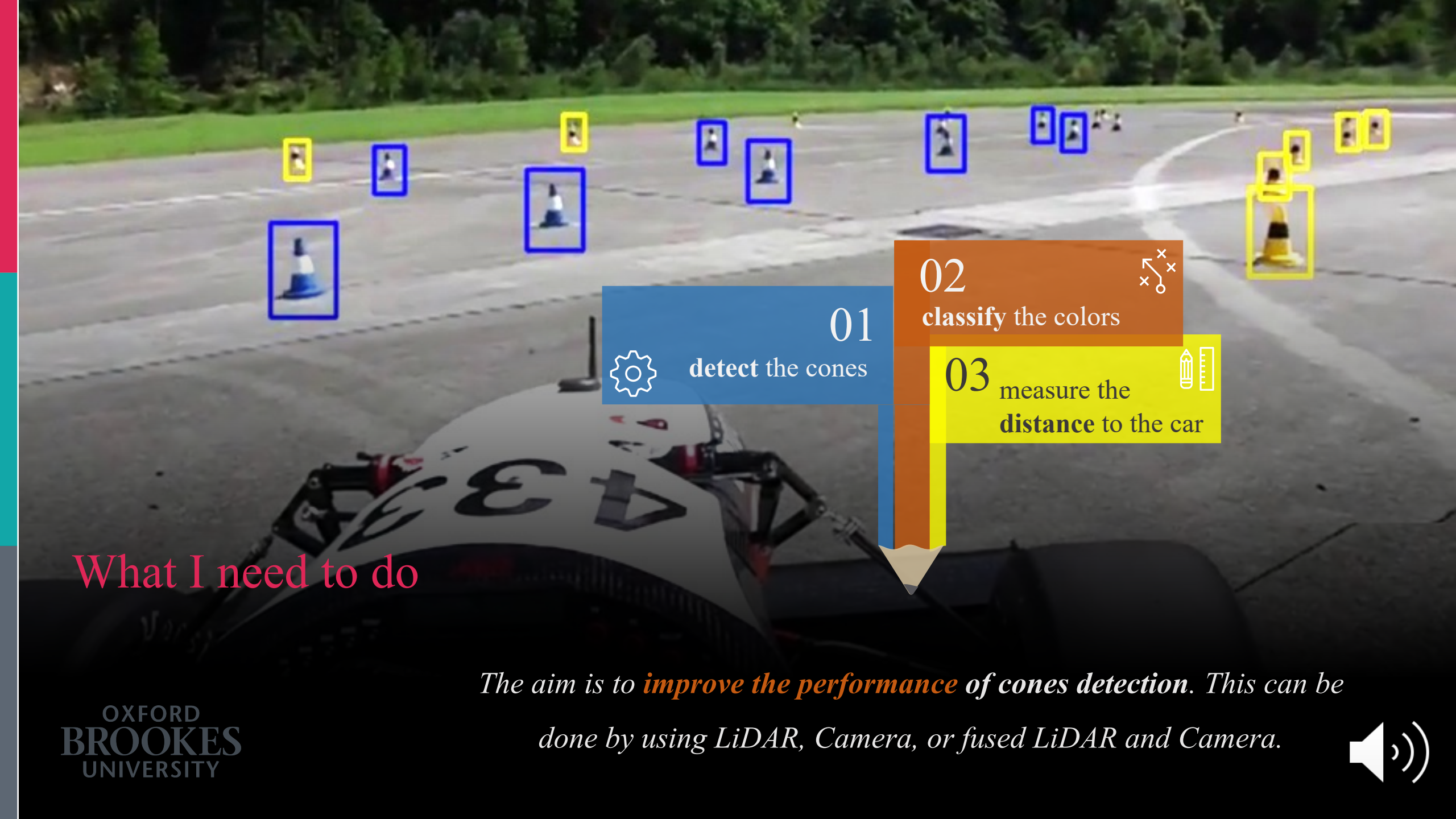


3D Object Detection for Autonomous Vehicles

Mai Do | MSc Data Analytics 2020

Supervisors: Peter Ball & Andrew Bradley

Table of contents



What I need to do

*The aim is to **improve the performance** **of cones detection**. This can be done by using LiDAR, Camera, or fused LiDAR and Camera.*

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Related works

fusion on the **pixel level** which combines the measurements to create a new type of data

(J. R. Schoenberg et al., 2010)

fusion on the **feature level** that integrates features coming from data from different sensors

(H. Cho et al., 2014) and (M. Liang et al., 2018)

fusion on the **decision level** which combines the classified results from the data of each sensor

(S.-I. Oh et al., 2017) and (A. Asvadi et al., 2017)

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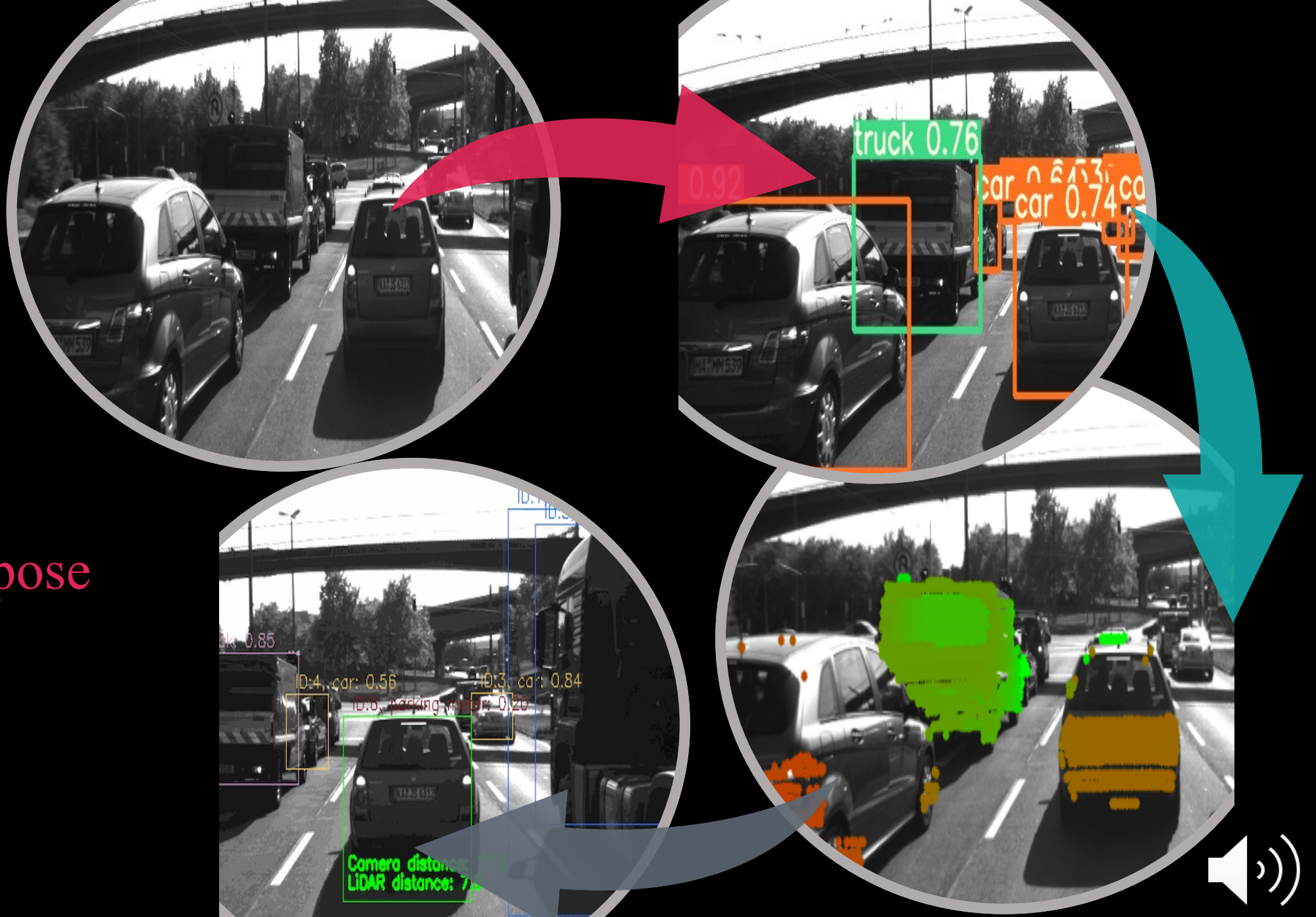
camera and LiDAR calibration
testing on real car
analyzing performance
Q W E
A S D
My problems with actual car
TOP
SIDE
FRONT

What I propose



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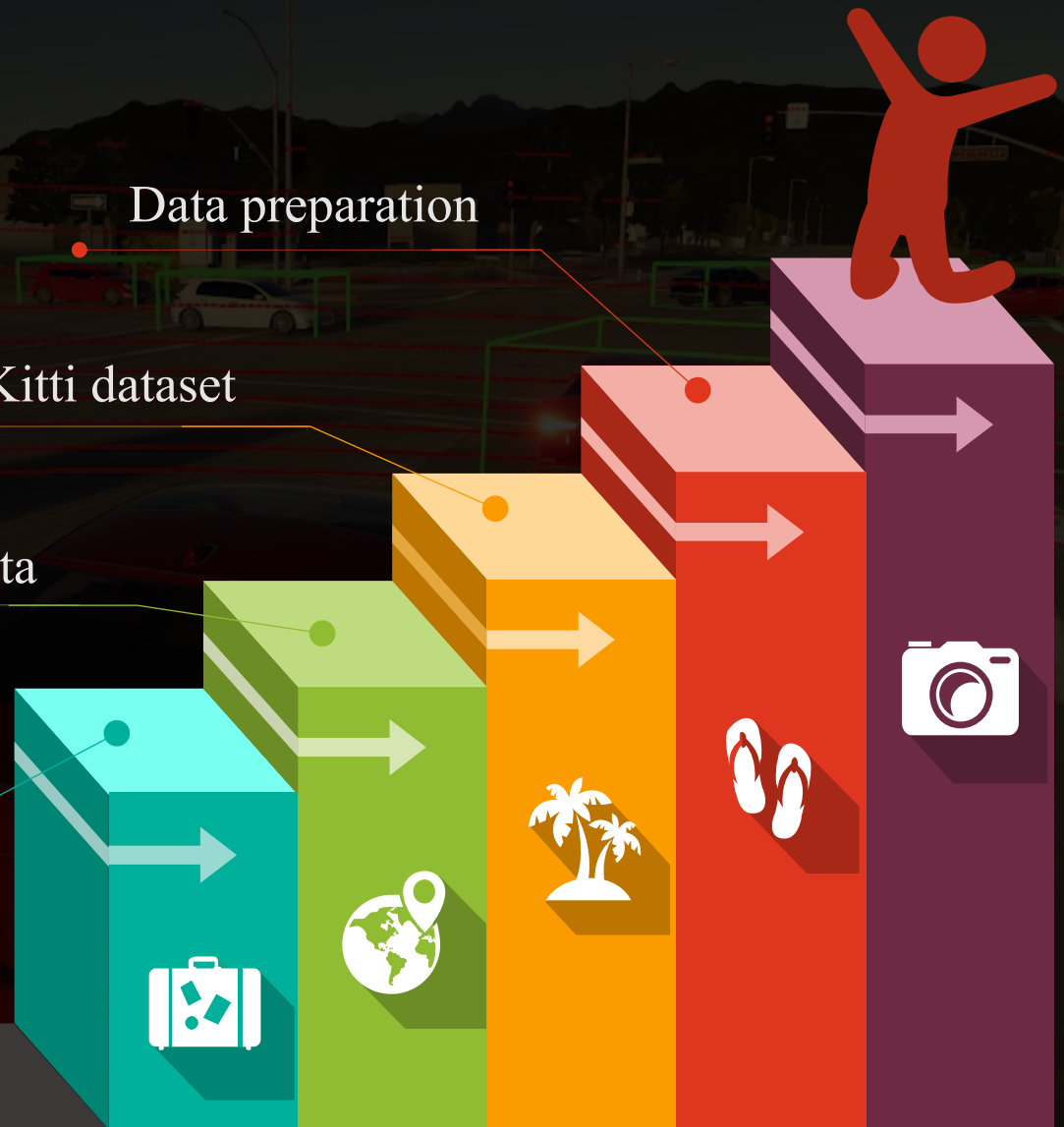
How I do it

Data preparation

Test Fusion on Kitti dataset

Test YOLOv3 on real cone data

Test YOLOv3 on COCO dataset



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What is YOLOv3

*YOLOv3 is a family of **deep learning models** designed for real-time object detection that identifies specific objects in videos, live feeds, or images.*

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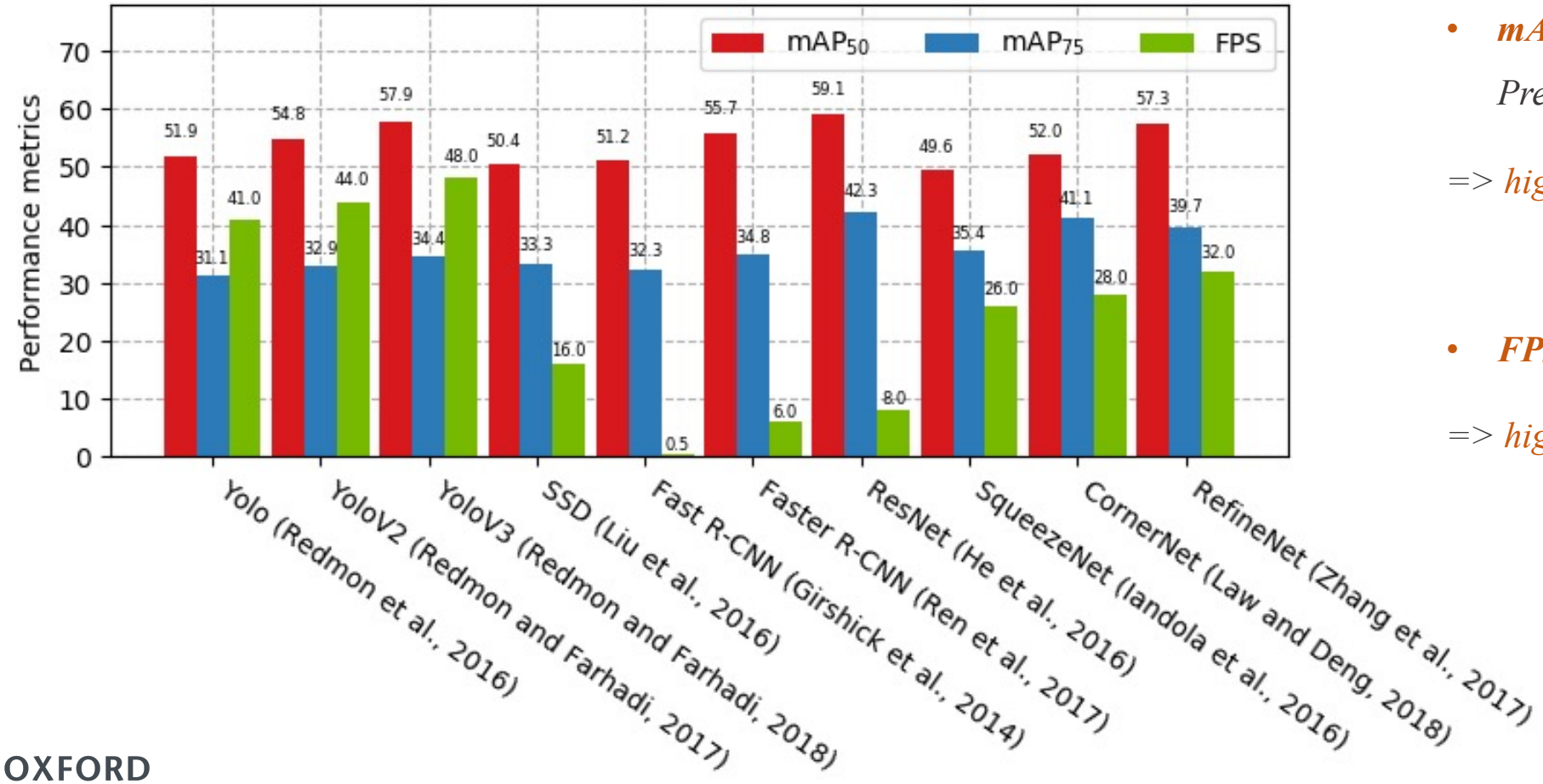
Why YOLOv3



- ***mAP***: *Mean Average Precision*

=> *higher is better*

- ***FPS:*** *Frames Per Second*

=> *higher is better*

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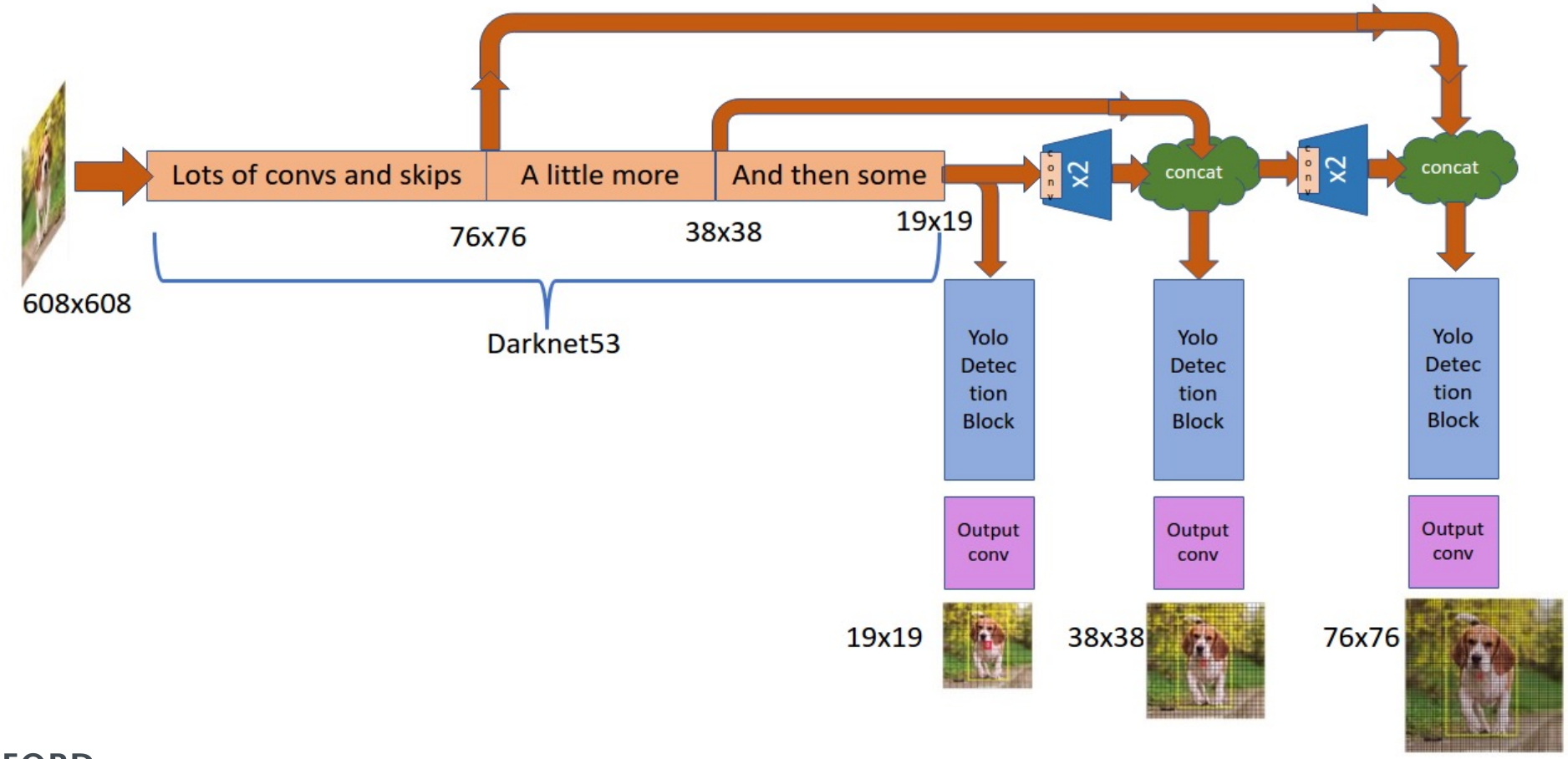
Source: A survey of deep learning techniques for autonomous driving

- Sorin et al., 2019

YOLOv3 Architecture



Source: YOLO V3 Explained - Towards Data Science

Uri Almog, 2020

How YOLOv3 works

Bounding-box on KITTI dataset from YOLOv3

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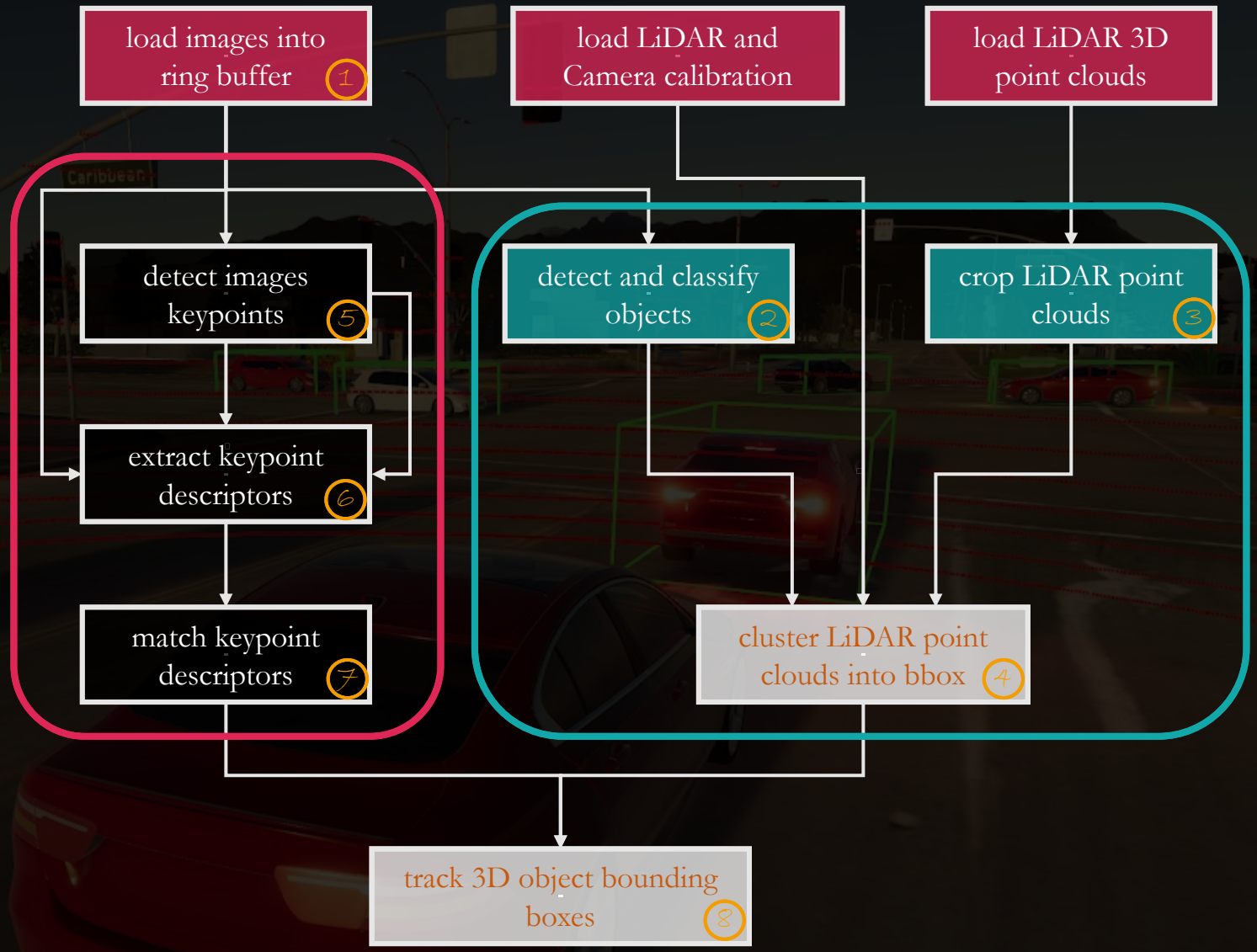
From 2D to 3D

Bounding-box



Source: FSND 3D Object Tracking, Udacity

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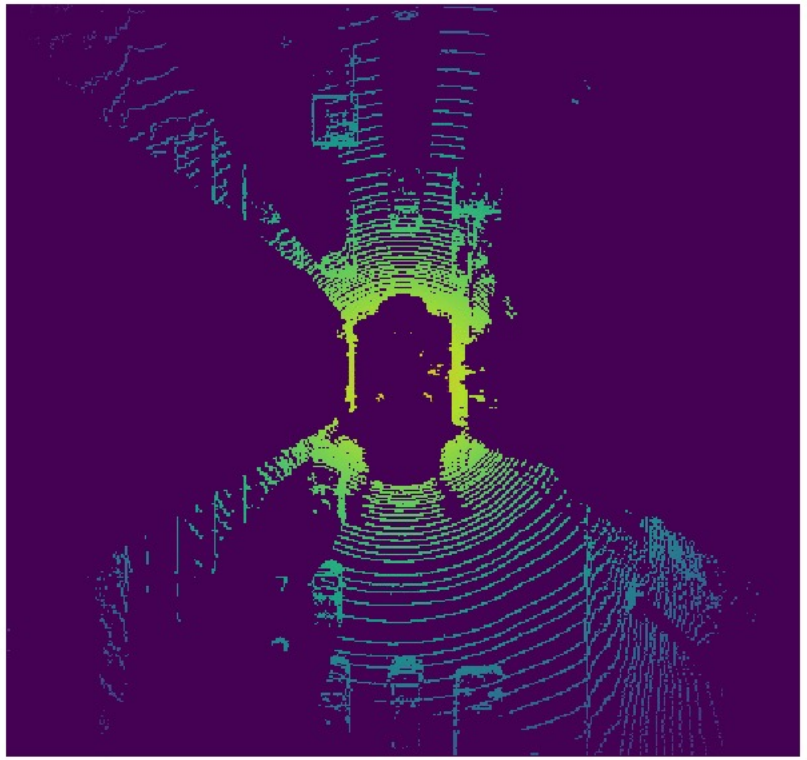
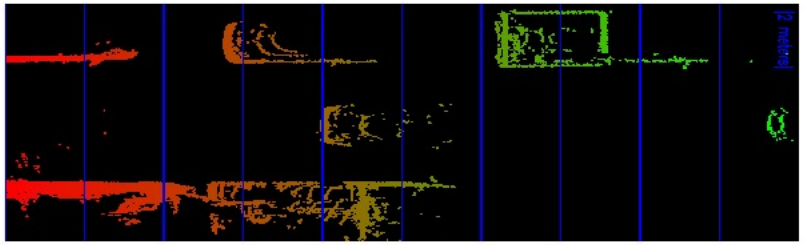
Cluster points

on objects

Top-View of LiDAR data (KITTI)

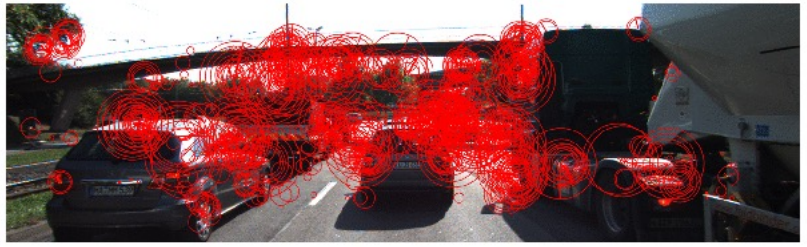


Top-View of filtered LiDAR data

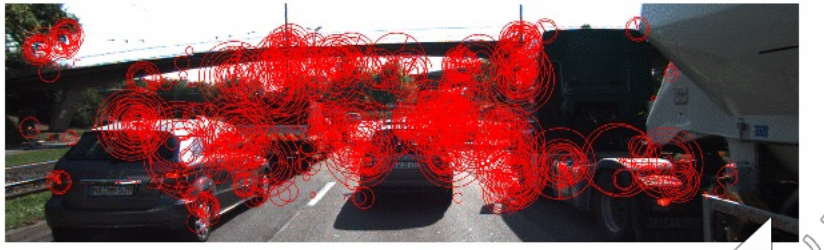


LiDAR fusion

Good Keypoints Last Frame



Good Keypoints Current Frame



Testing with KITTI dataset

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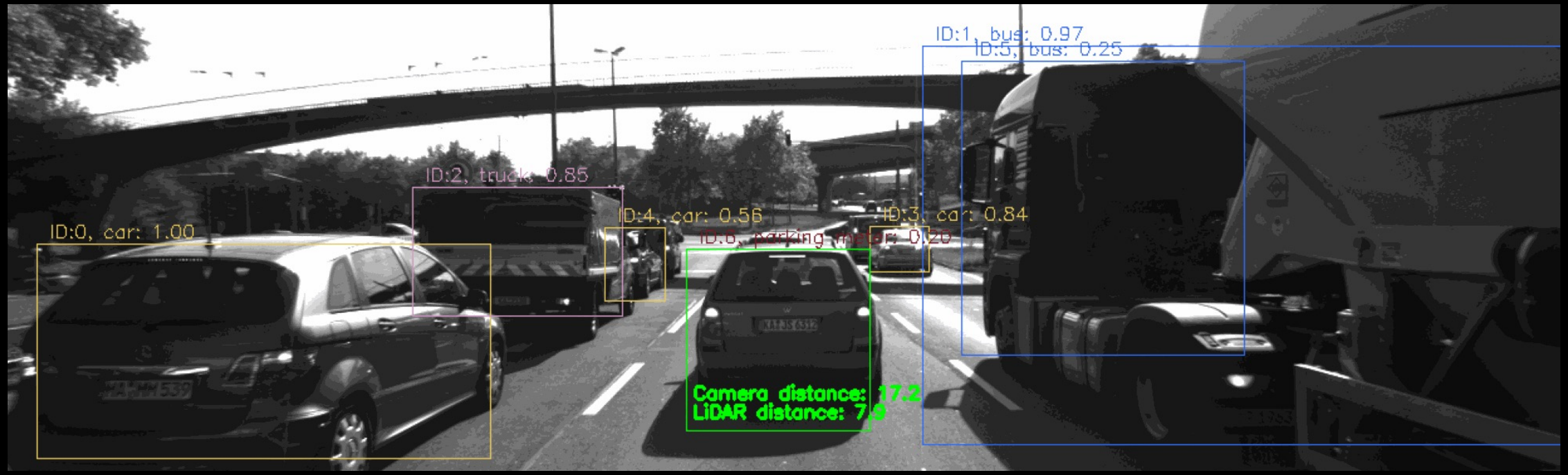
Mean distance



Testing with KITTI dataset

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Preparing custom data

YOLOv3

Create dataset.yaml
- *directory*
- *number of classes*
- *class names*

Create labels .txt file
class x_center y_center width height

Organize directories
- *dataset/images/im0.jpg*
- *dataset/labels/im0.txt*

Fusion

Import .weight file
trained file .weight from YOLOv3

Data folder
- *point cloud .bin format*
- *image folder*

Calibration folder
- *calib_cam_to_cam.txt*
- *calib_imu_to_velo.txt*
- *calib_cam_to_velo.txt*

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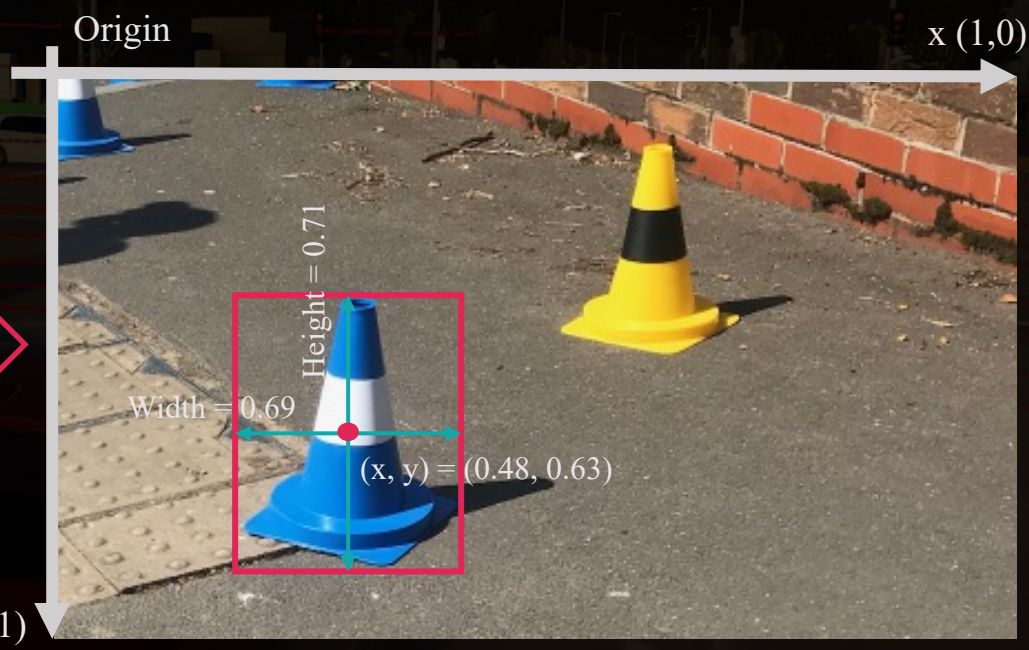
Annotation

.json label format

[[left, top], [right, bottom]]



.txt label format

0 x y Width Height

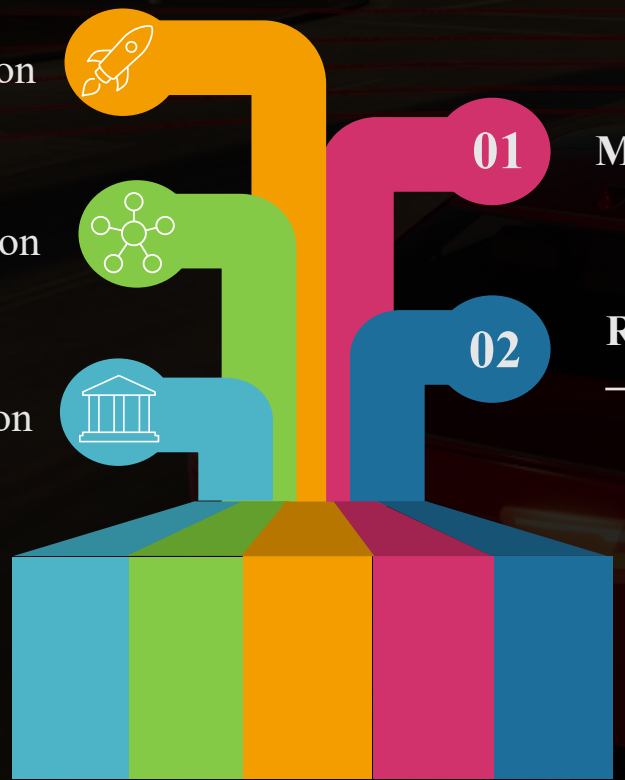
Calibration

The transformation matrix in the form of orientation and relative positions between the two sensors is the precursor to fusing data from these two sensors. Lidar camera calibration helps in estimating the transformation matrix between 3-D lidar and a camera mounted on the autonomous vehicle.

Camera-to-camera calibration

Velodyne-to-camera registration

GPS/IMU-to-Velodyne registration



01 **Matlab calibrator apps**

02 **Raw data development kit**
– The KITTI Vision Benchmark Suite

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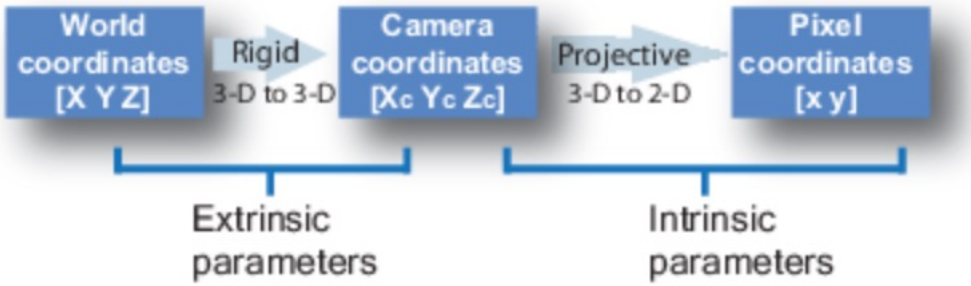
How camera LiDAR calibration works



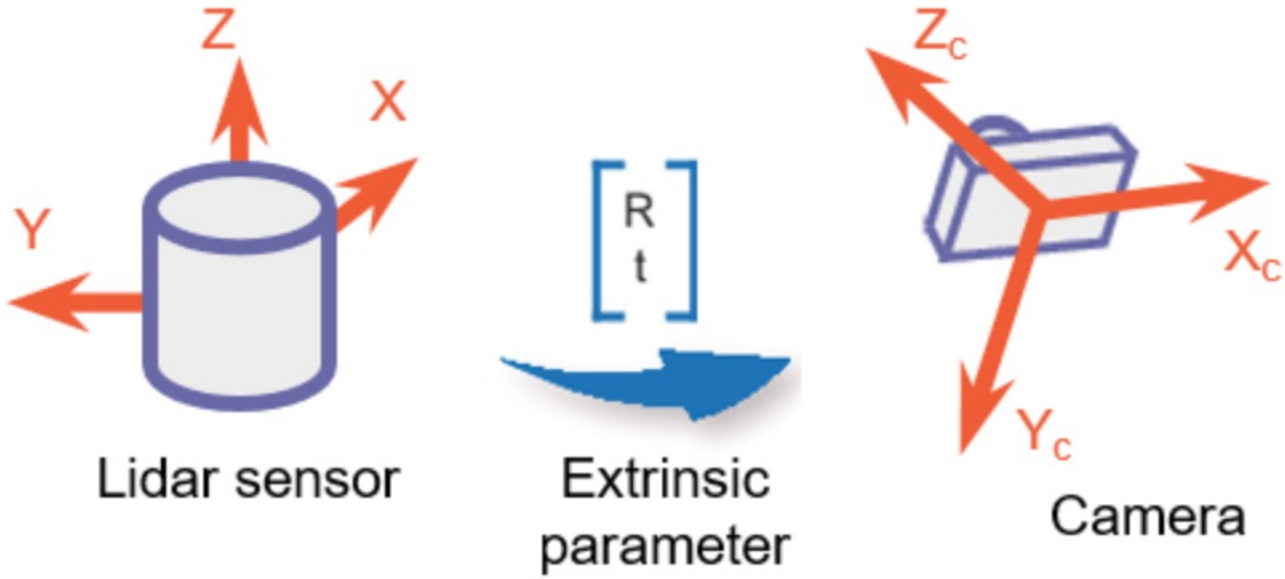
$$[x\ y\ 1] = [X\ Y\ Z\ 1] \begin{bmatrix} R \\ t \end{bmatrix} K$$

Image points · *World points* · *Extrinsics Rotation and translation* · *Intrinsic matrix*

Source: What Is Lidar Camera Calibration?

- Mathworks

*Lidar camera calibration estimates **a rigid transformation matrix** that establishes the correspondences between the points in the 3D lidar plane and the pixels in the image plane*



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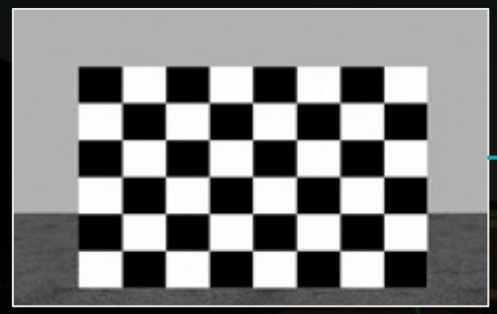
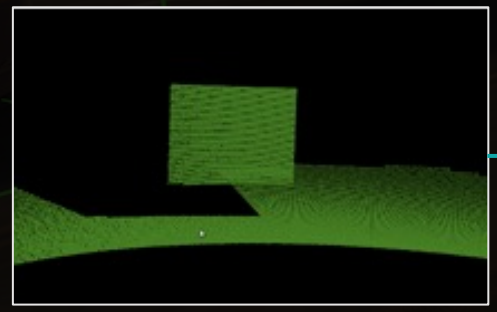
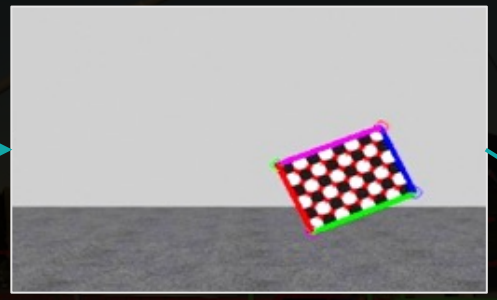
How camera LiDAR calibration works



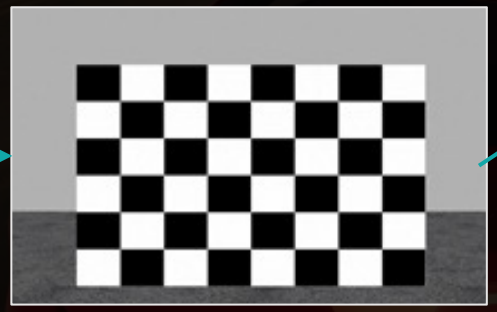
Camera images

Point clouds

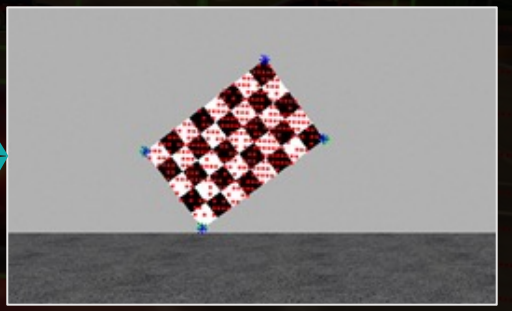




Feature Extraction



Calibration



After Calibration

Source: Camera LiDAR calibration - Matlab

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