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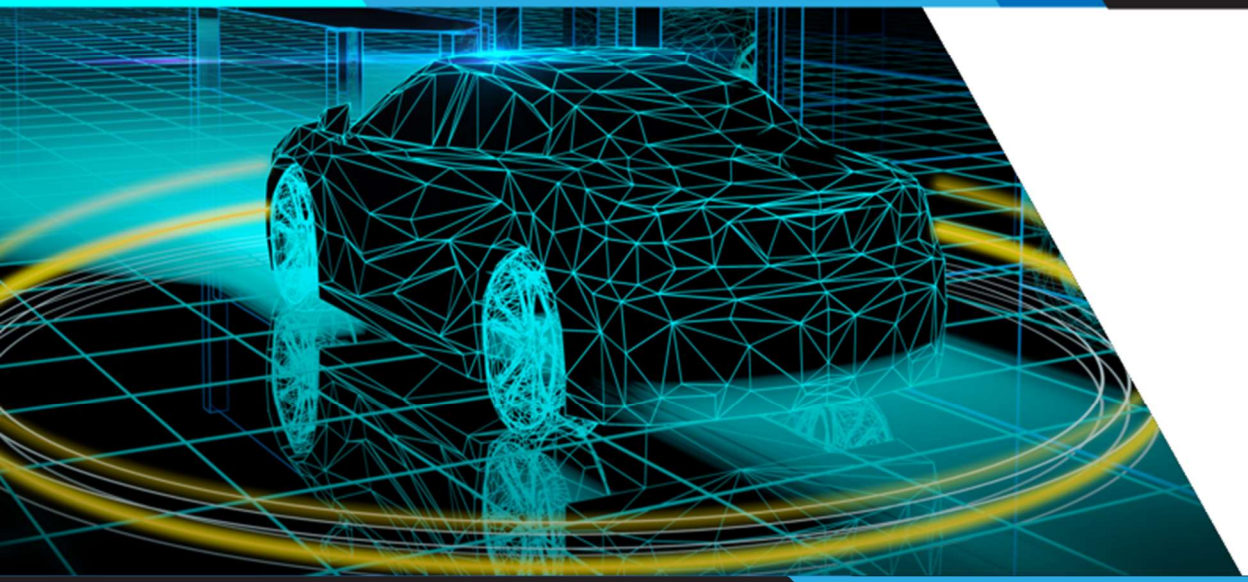
driving easier and safer

Auto-valet-parking: A special use-case of self-driving



Steven Chuang

2023/2/13

oToBrite Electronics, Inc.
歐特明電子股份有限公司

Agenda

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- What is AVP(auto-valet-parking):
  - The requirements and scenario
  - Current products of AVP market(XP, Bosch, etc.)
  - Introduction to oToBrite and oToBrite's AVP
- Related techniques
  - Detection
  - Localization
  - Control and strategy planning
- Our road map
  - Current status
  - Future
- Some experimental results

The Current Products about Self-Driving

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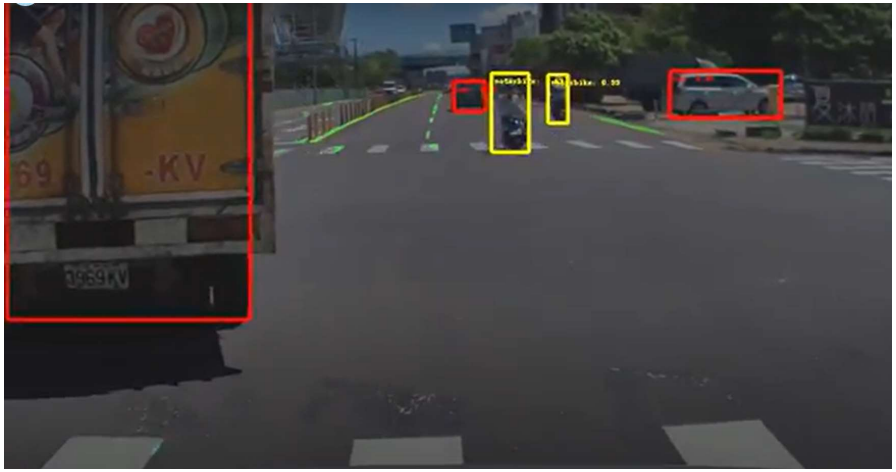
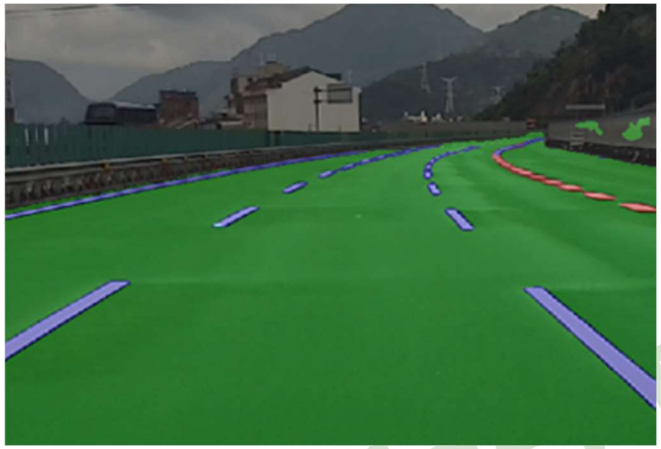
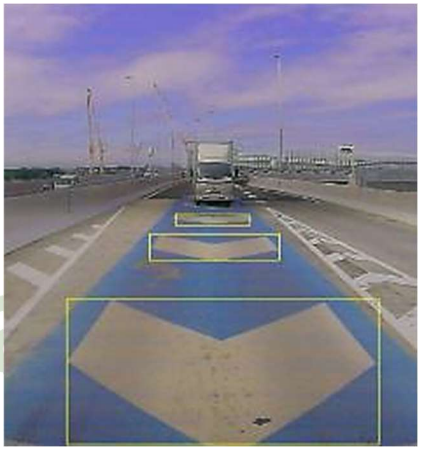


Front collision warning

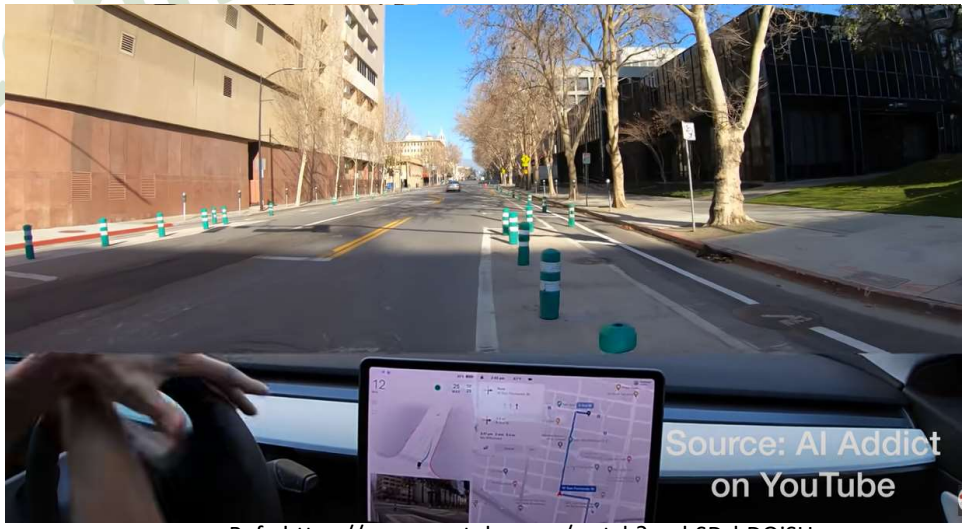


Lane departure warning



Road sign detection

Ref.: https://cdn.images.express.co.uk/img/dynamic/24/590x/uber-self-driving-car-video-accident-crash-Arizona-935431.jpg



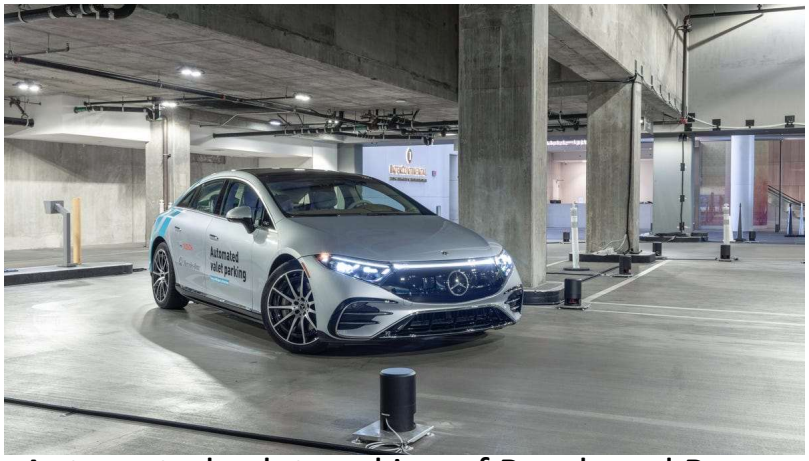
Ref.: https://www.youtube.com/watch?v=sbSDsbDQjSU

The Requirements for Auto-Valet-Parking (AVP)

- The condition of parking garages:
  - Low speed
  - Narrow environment
- High accuracy requirement for detection, localization, and control
- TESLA, XP, etc. provide their products

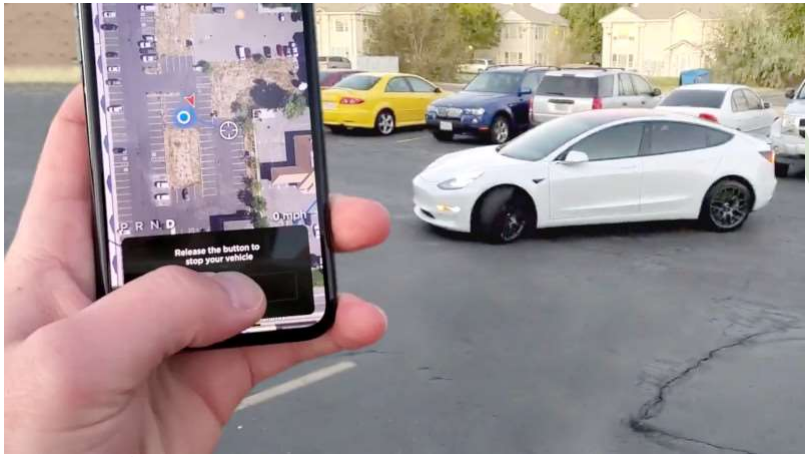
Ref.: https://mp.ofweek.com/Upload/News/Img/member49731/202301/wx_article__fde0d11fd5d10b46e6390409642e980e.jpg

Current Products of AVP Market



Automated valet parking of Bosch and Benz

Ref.: https://www.cnet.com/a/img/resize/42cf268072f6e3b456bbf3b4354a06a1f1e3732b/hub/2022/03/19/27c29d9a-6f30-4c5a-a0c3-cb828cd7bbf5/mercedes-benz-eqs-intelligent-park-pilot-113.jpg?auto=webp&fit=crop&height=675&width=1200



TESLA's smart summon

ref.: https://hackaday.com/wp-content/uploads/2019/10/smartsummon-title800.jpg?w=800

Xpeng's auto parking system and AVP

ref.: https://mms.businesswire.com/media/20210616005851/en/885709/4/%E8%BD%A6%E8%BE%86%E6%B3%8A%E5%85%A5.jpg?download=1

ref.: https://cdn.pingwest.com/portal/2021/06/09/S25Yp7sb18eeie_xa3sTEFmR9T68BPz3.jpg?x-oss-process=style/article-body

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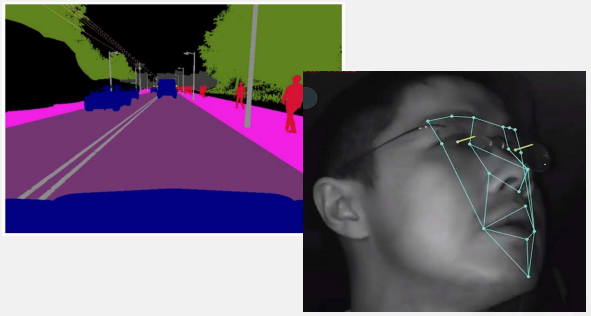
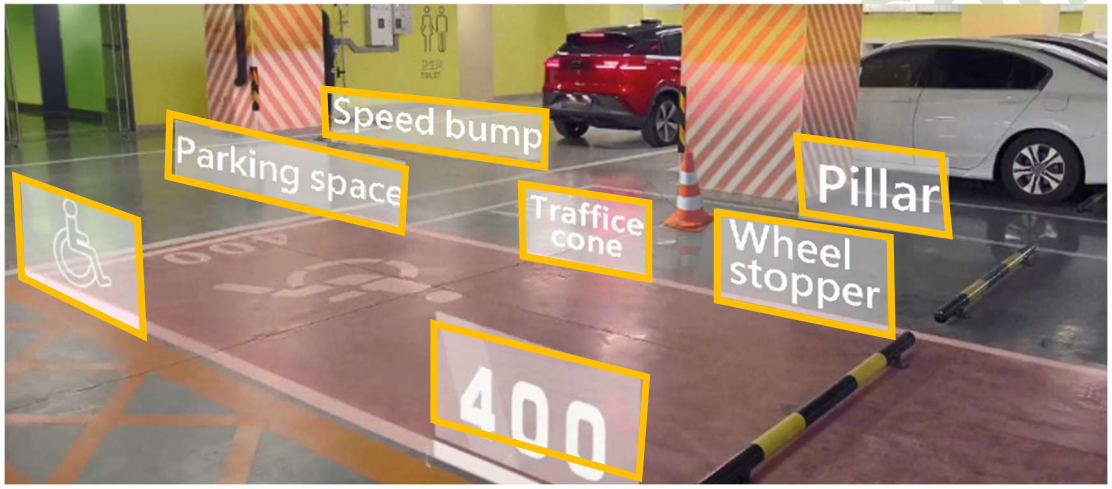
Camera modules

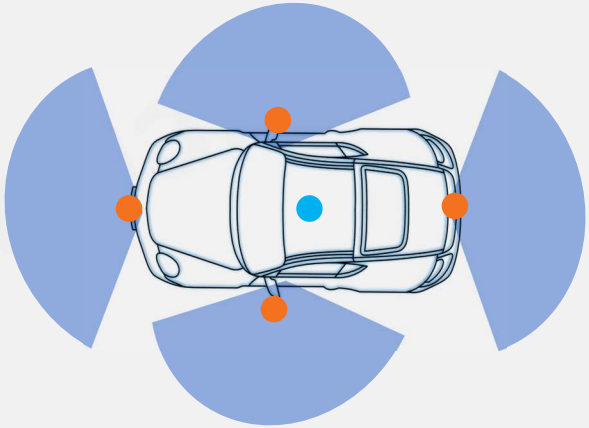
- **For vehicles**
  - For harsh environment
  - 1~8M pixels
  - 30° ~ 180°
- **For others**
  - AR/VR
  - AIOT

Visual AI IP





ADAS



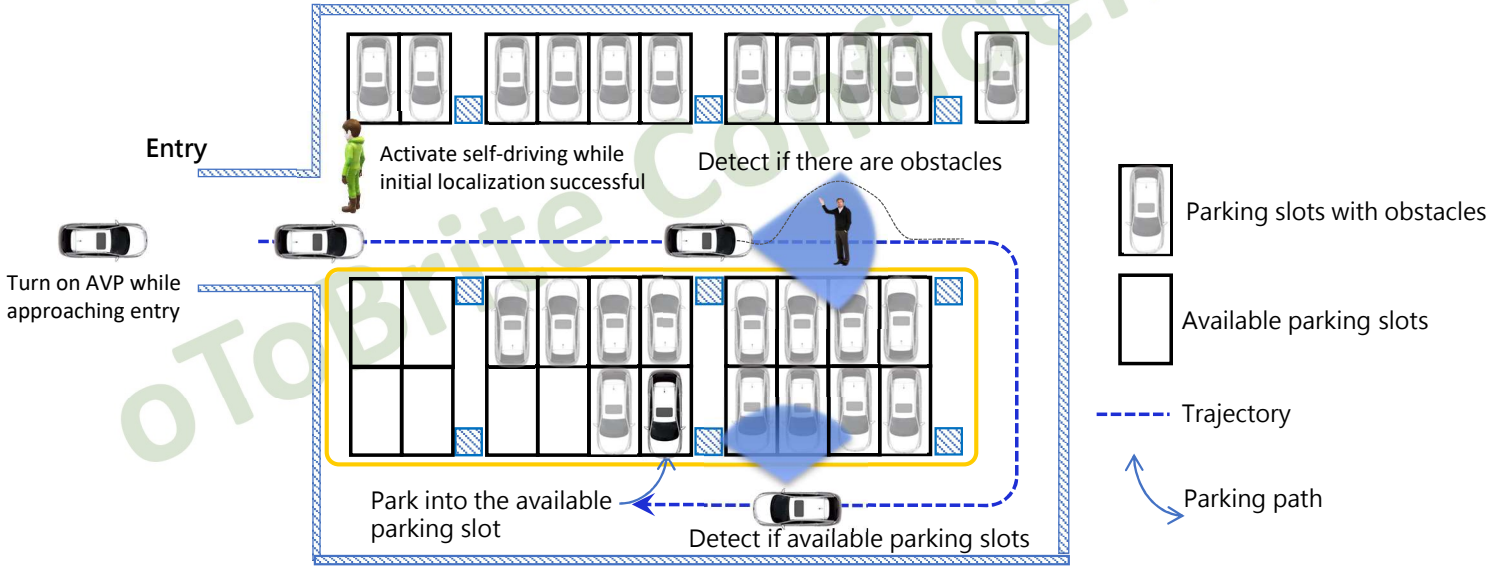
AI **Visual AI model**

Edge computing unit (ECU)

Camera modules

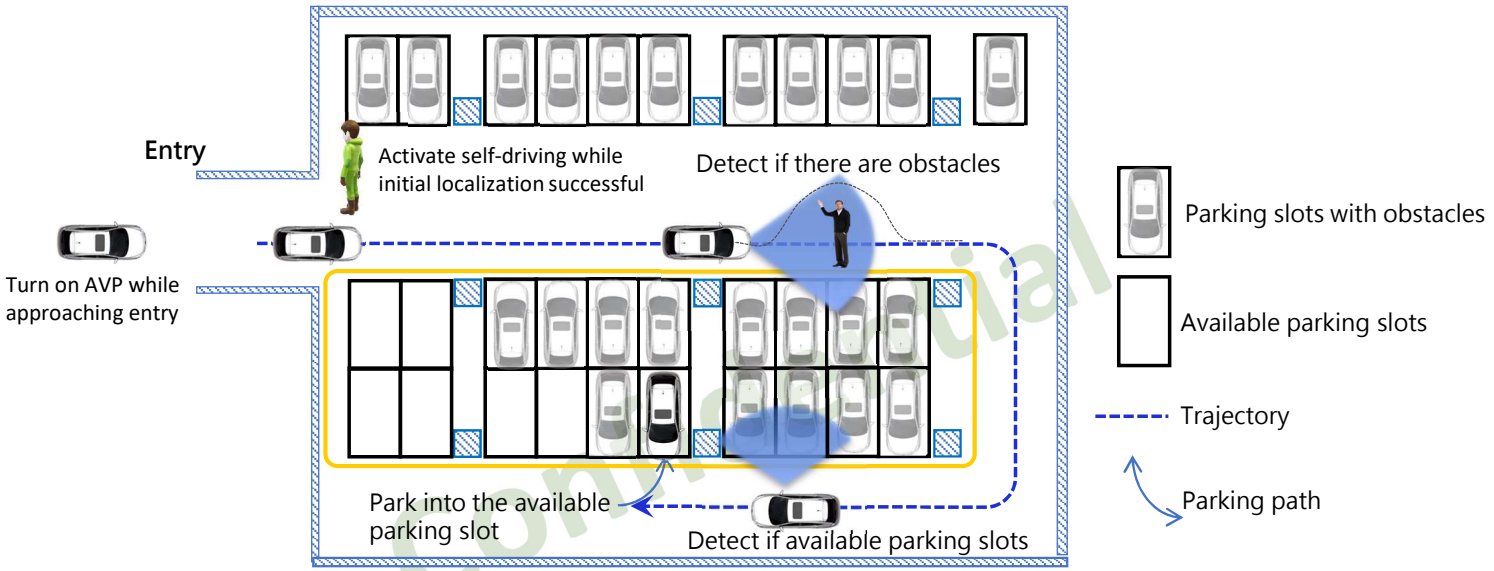
oToBrite's AVP

- With the sensors and ECU on the vehicles
- Without the specific infrastructure of garages
- Based on oToBrite defined maps built by users



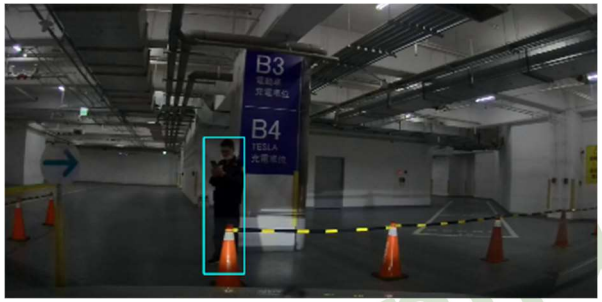
Related Techniques

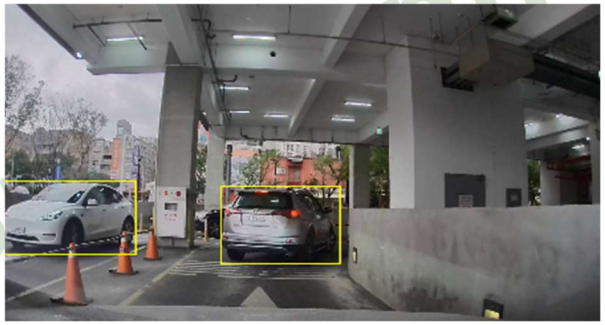
- Localization
- Detection
- Control and strategy planning

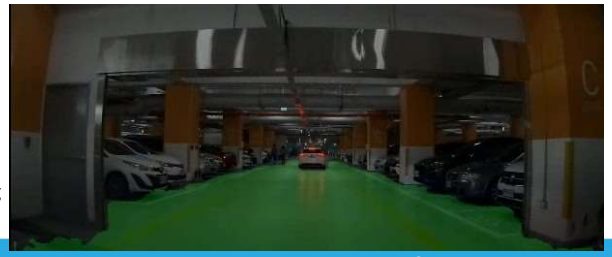


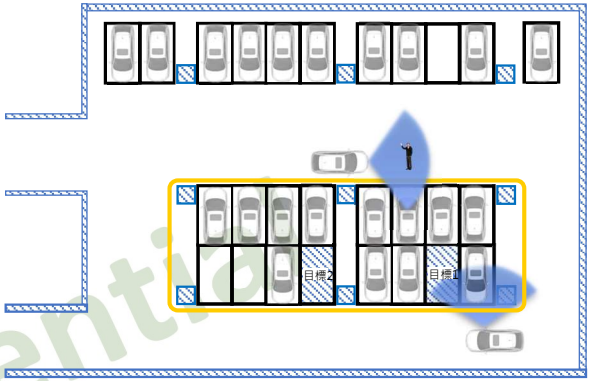
Detection

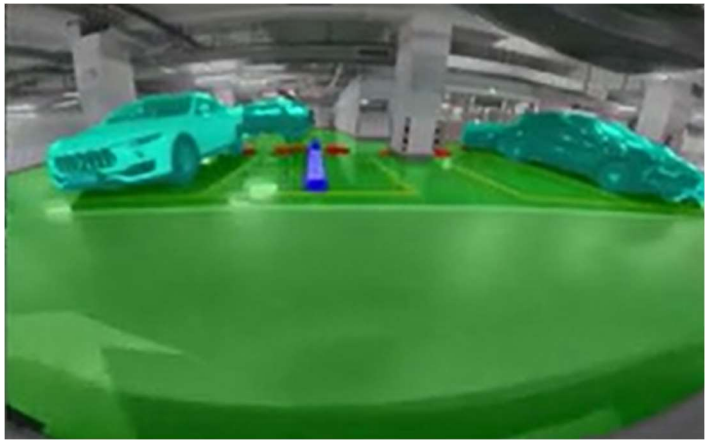
- Detection is essential
- Detecting obstacles, lanes, traffic sights
- Sensing source:
  - Visual features
  - Distance detections
    - Sonar
    - RADAR
    - LiDAR

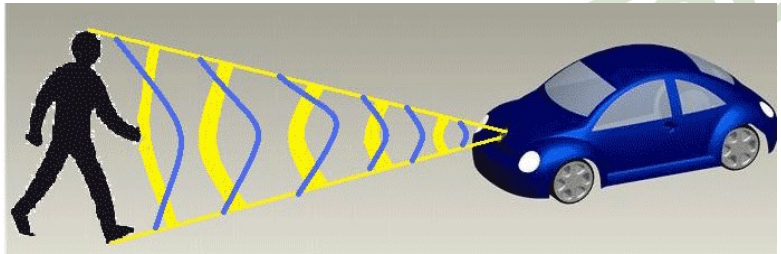








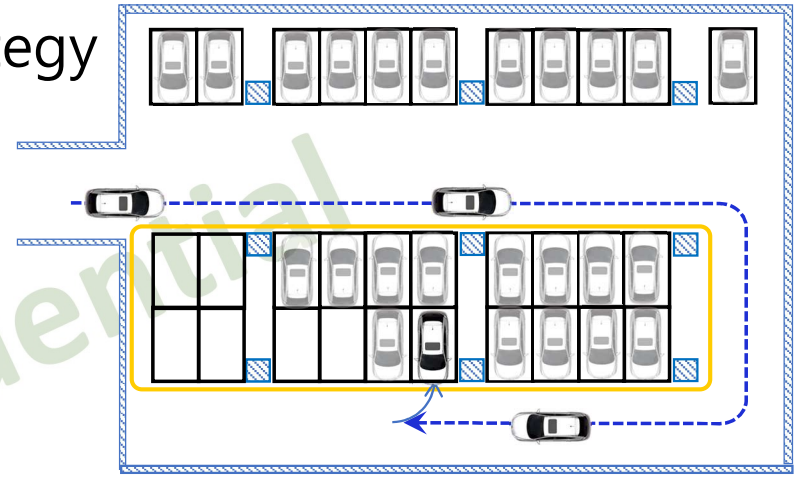


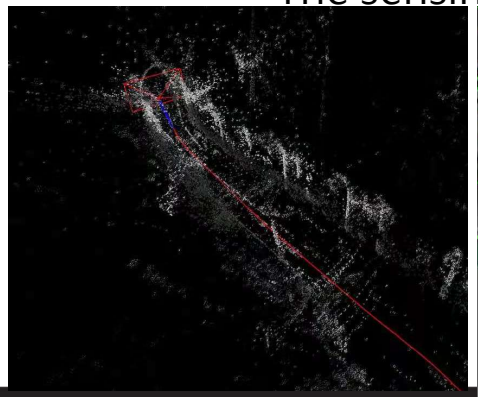


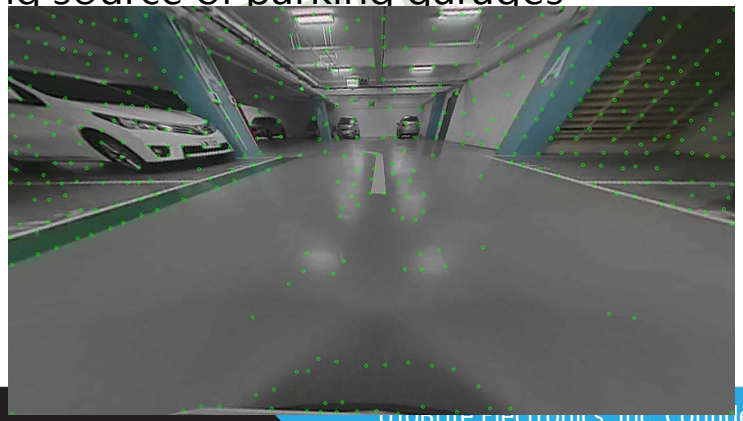
Ref.: https://cecas.clemson.edu/cvel/auto/AuE835_Projects_2011/images/Mayyas_CAR-8.png

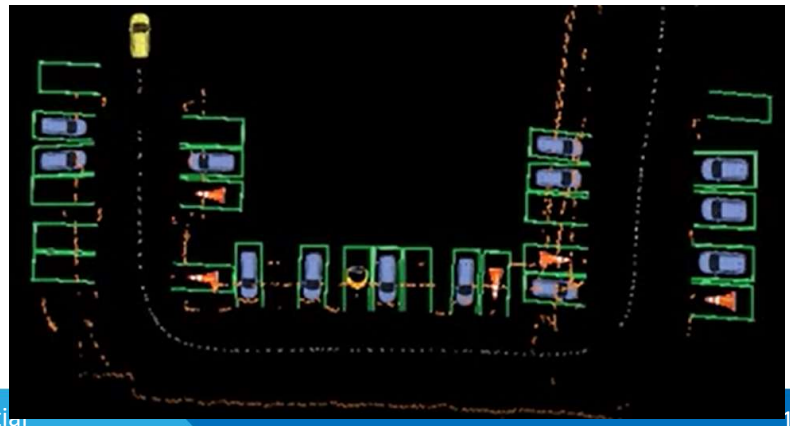
Localization

- Localization is also essential
- Providing current position for control and strategy
- It can leverage:
  - Information from the detection
    - Visual features
    - Distance detections for point clouds
  - Additional signal source
    - Inertial measurement unit (IMU)
    - GPS/RTK
    - The sensing source of parking garages

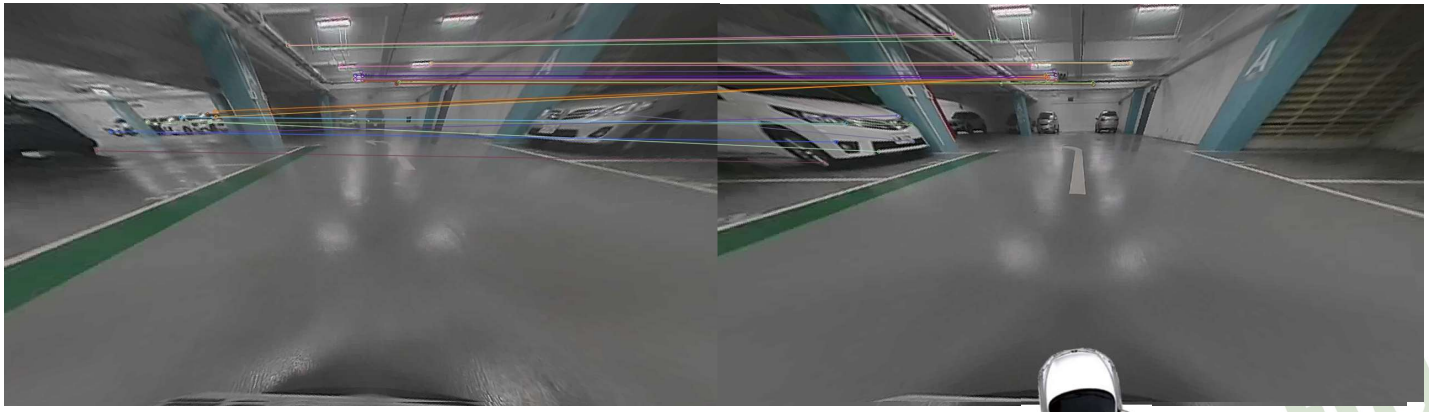


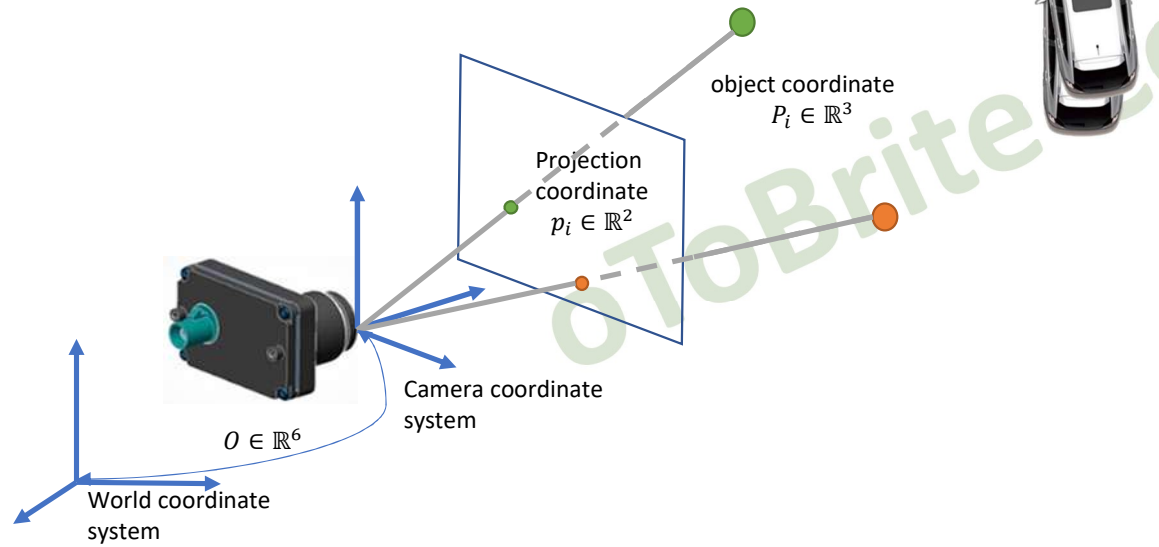






Localization(Visual SLAM)





Feature Detection

↓

Feature Matching

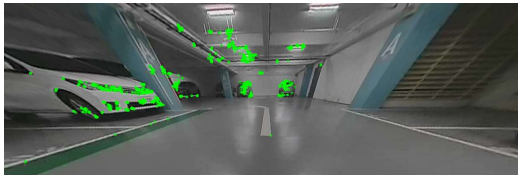
↓

Epipolar geometry and 3D construction

↓

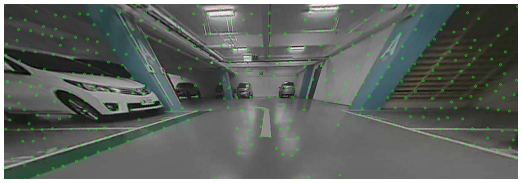
Relation of rotation and translation (x, y, yaw)

Model Based Visual SLAM

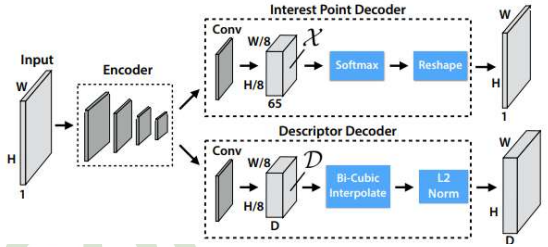


CV features
ORB
SIFT,
etc.

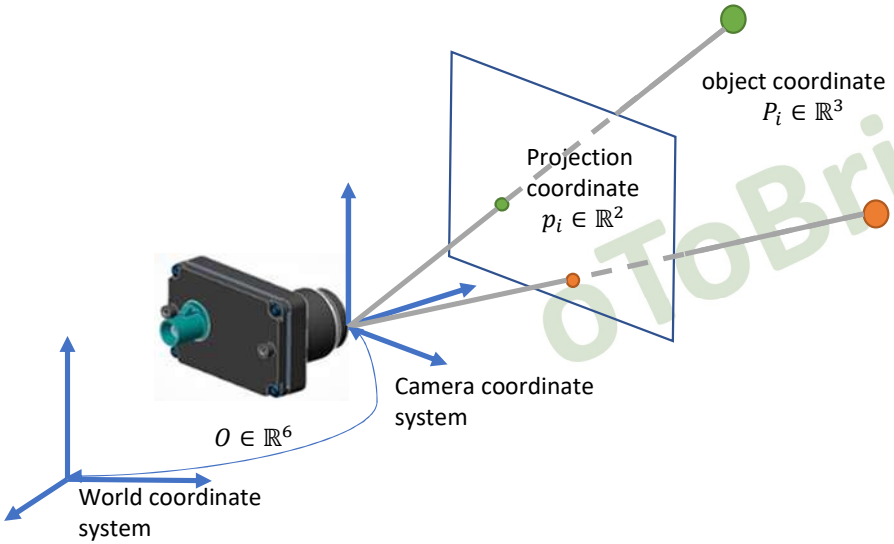
vs.



Model based:
Superpoint,
Unsuperpoint,
GCN,
R2D2,
etc.



Ref.: SuperPoint: Self-Supervised Interest Point Detection and Description



Feature Detection

↓

Feature Matching

↓

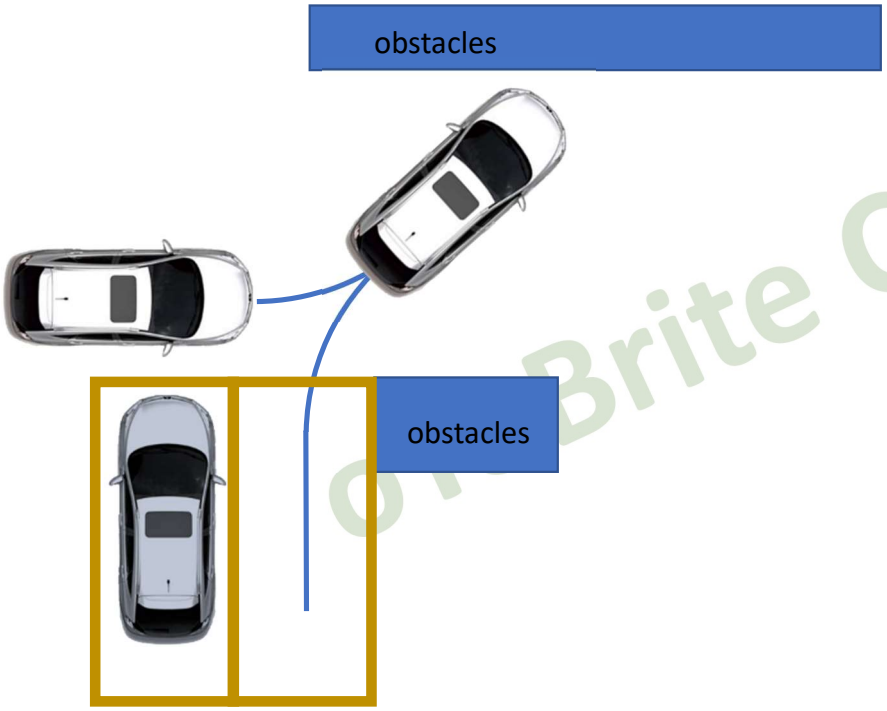
Reprojection and 3D construction

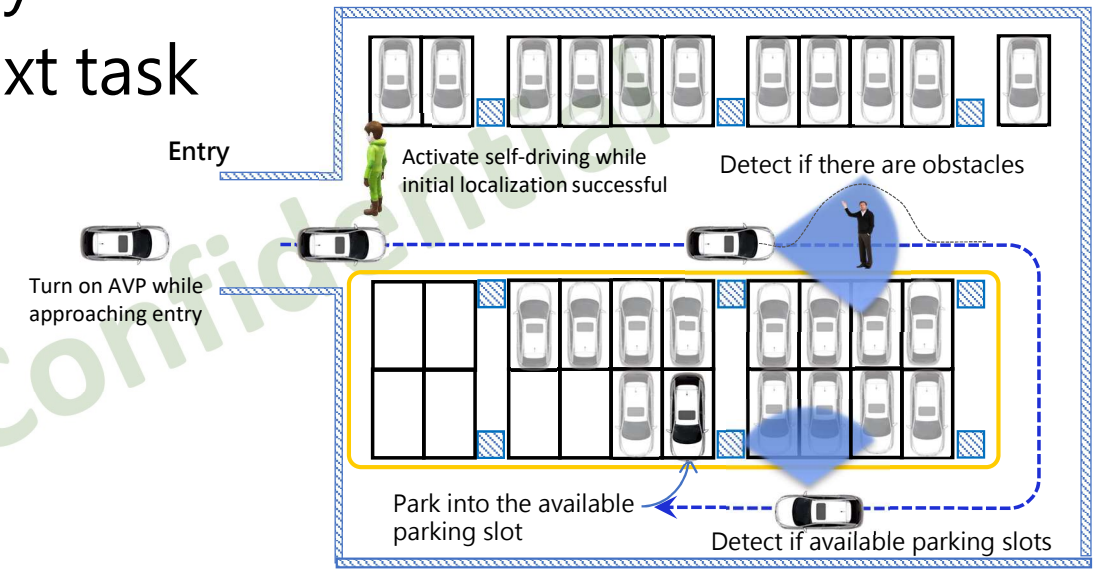
↓

Relation of rotation and translation (x, y, yaw)

Control and Strategy Planning

- Based on detection and localization
- Planning an efficient trajectory
- Determine the current and next task

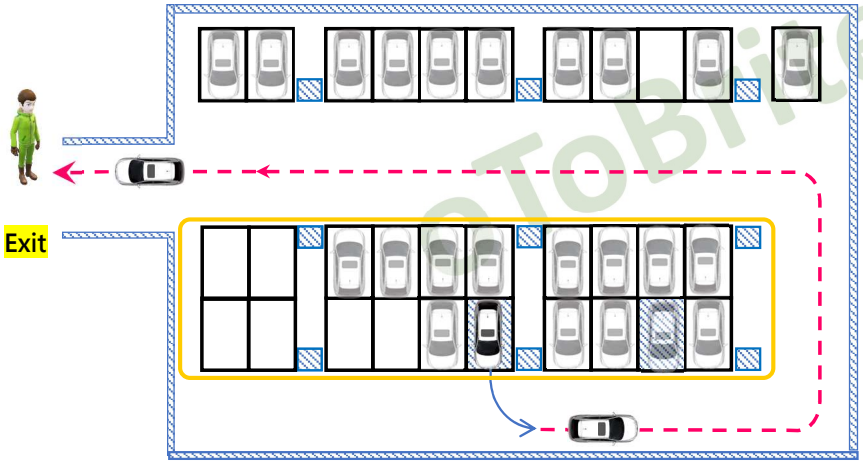


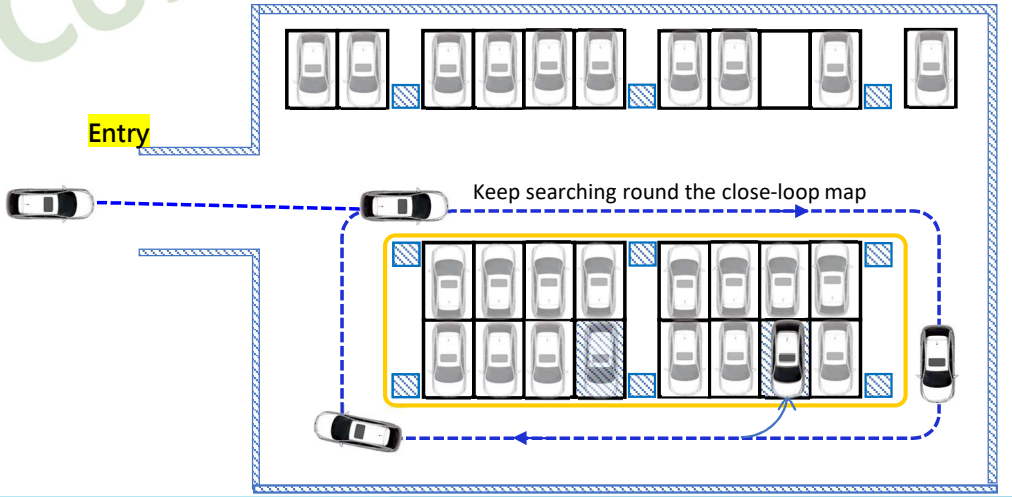


Current oToBrite's AVP Products

- Focusing on detection and localization
- Collaboration with control/integration system partner
- Productions of
  - ECU system
  - IP license of libraries

- Support summon for park-out, long-distance, and closed-loop maps this year





The Roadmap of oToBrite's AVP

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2017
AVM

2019
APA1.0

APA 10m
- Vision + Ultrasonic Fusion

2021
AVP1.0

AVP1.0 100m
- Memorized Automated Valet Parking
- Vision SLAM

2023
AVP2.0

AVP2.0 **1km**
- Long-distance Around-route Automatic Valet Parking

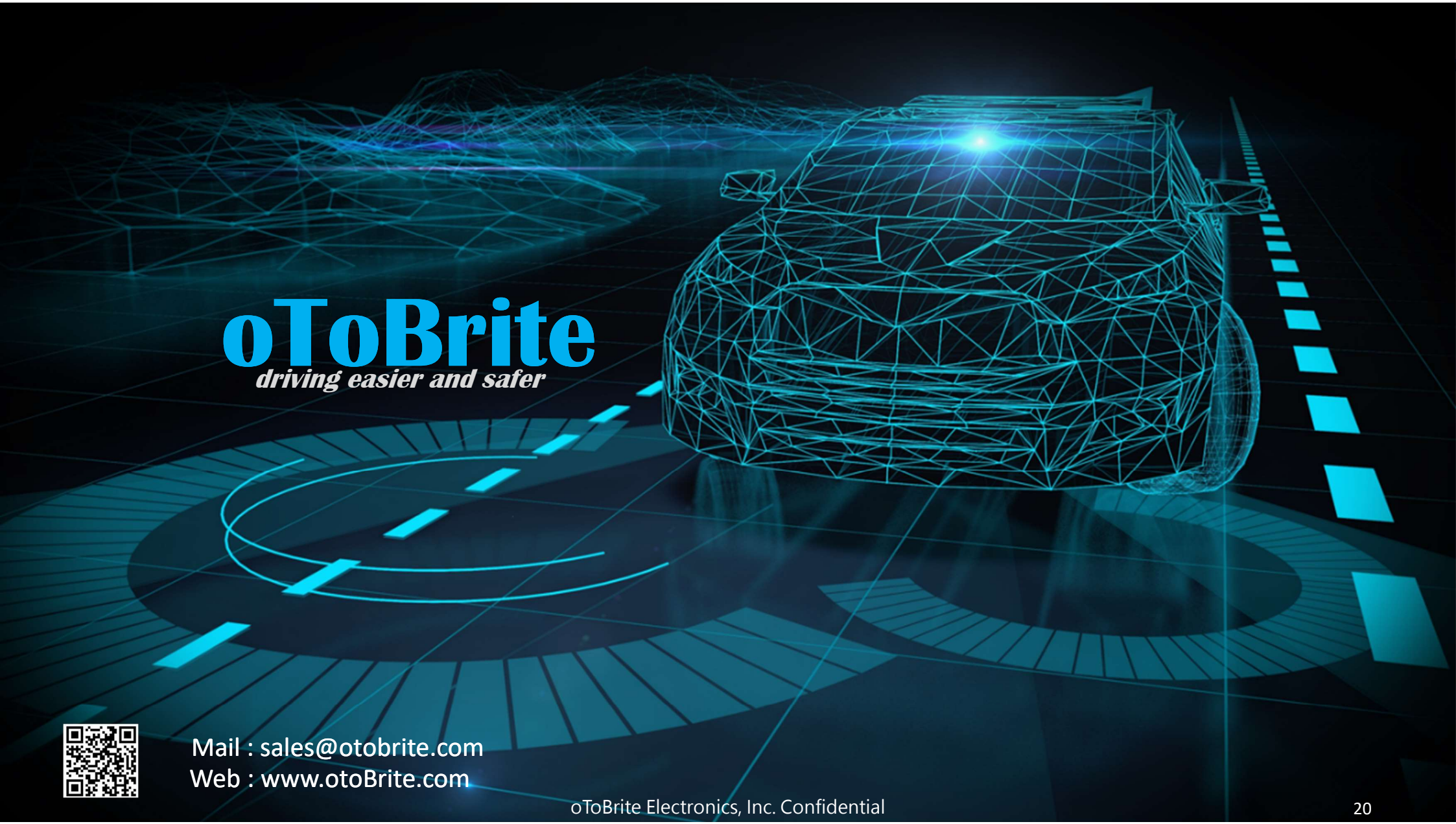
SOP in Q4, 2023

L4 AD

Autonomous tractor

Autonomous port truck

Autonomous haulage



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