

電腦視覺 × AI × Autonomous

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- 國立聯合大學 | 電機工程學系 | 副教授
- 昊博國際服務有限公司 | 人工智慧科技顧問
- 慧穩科技股份有限公司 | 技術顧問

研究主軸

結合電腦視覺與人工智慧技術，應用在機器人平台上，解決真實世界遇到的問題

研究領域

- 電腦視覺
- 人工智慧與深度學習
- 智慧型機器人
- AI-自動光學檢測

經歷

- 助理教授 • 國立聯合大學 • 2016 – 2020
- 專案經理 • 中強光電 • 2015 – 2016
- 高級工程師 • 聚晶半導體 • 2014 – 2015
- 研究員 • 工業技術研究院 • 2010 – 2014

學歷

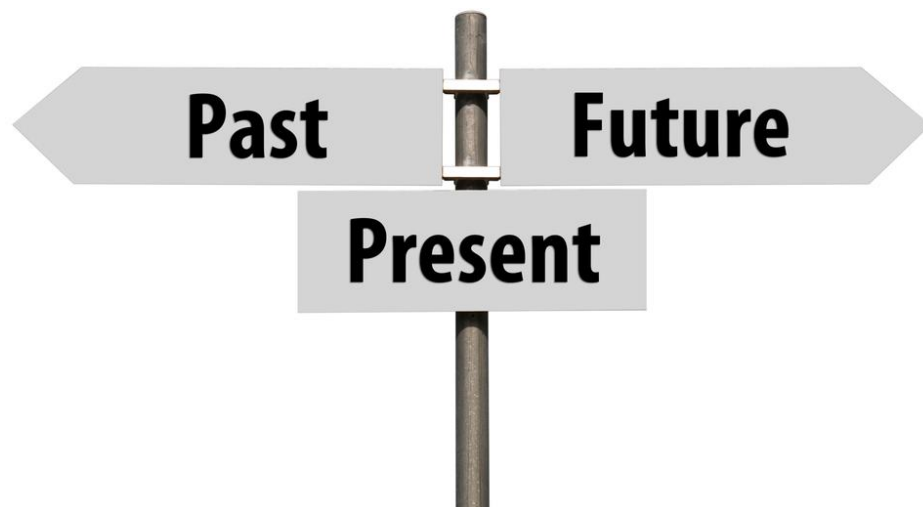
- 博士 • 國立中央大學 • 2005 – 2009
- 碩士 • 國立中央大學 • 2003 – 2005
- 學士 • 國立成功大學 • 1998 – 2002

“Learning deeply in computer vision”

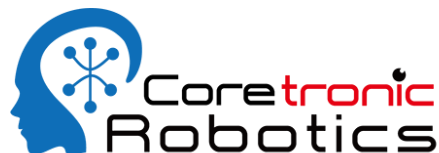
“Computer vision with intelligence on robots”

for solving real-world problems

for social contributions



- 菜逼八、菜逼八、菜逼八
- 過去的經驗與興趣使然



中光電智能機器人股份有限公司



安全可靠

餘冗設計及安全機制
工業等級及耐候性驗證



全自主飛行

自動起飛、執行任務、精準降落及自動充電
簡單控制介面且全天候待命



智能化

即時影像串流及辨識追蹤
人工智慧端點運算及資訊分析

From: <https://www.coretronic-robotics.com/tw/index>



2025年達477億美元

Study Period: 2017-2025

Base Year: 2019

Fastest Growing Market: Asia Pacific

Largest Market: North America

CAGR: 15.37 %



From: <https://www.mordorintelligence.com/industry-reports/drones-market>

■ CHT

- 災害救援
- 場域巡檢
- 設施檢驗



From:

<https://www.cht.com.tw/home/campaign/5genterprise/CHT-Smart-Aircraft-Drone-Inspection.html>

- 不夠聰明
- 大多需仰賴純熟的飛行手
- 特定場域、場合需事先申請，須具備相關飛行操作證照

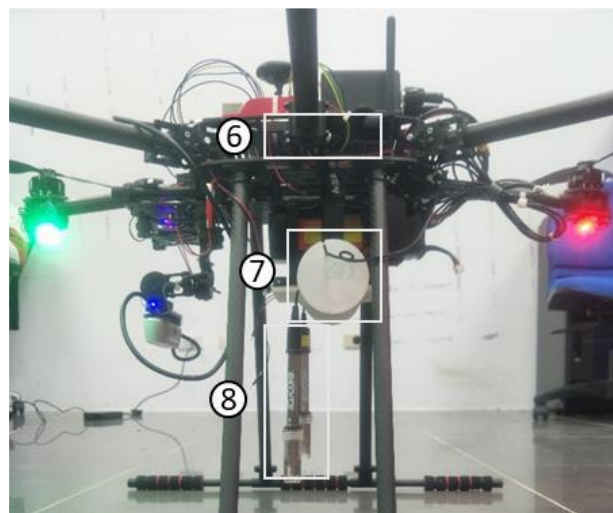
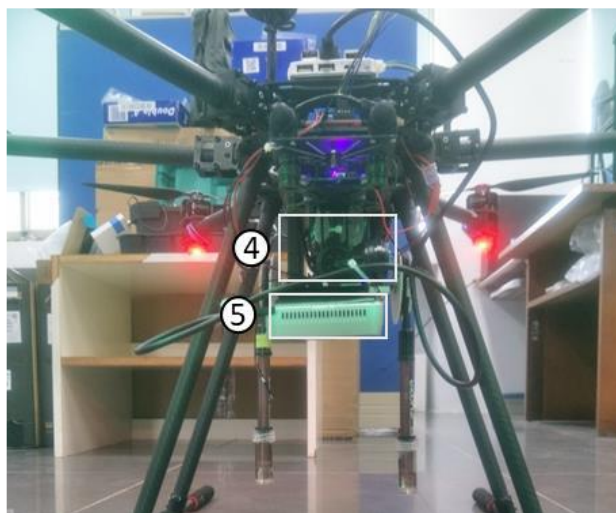
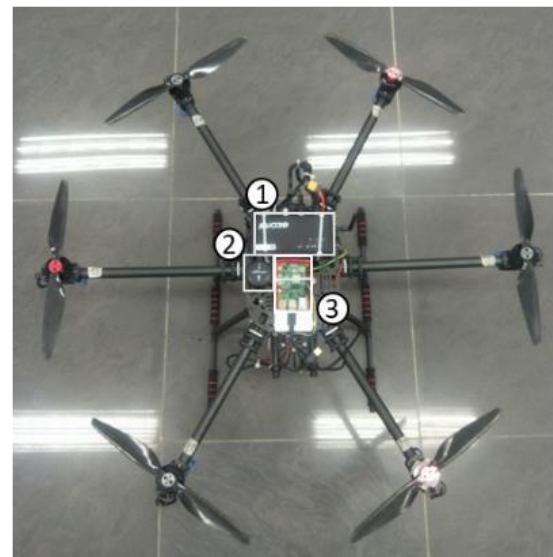


From: <https://money.udn.com/money/story/10860/4745462>

- 結合AI與感測，讓無人機可以自主飛行
- 萬事起頭難...
 - 壹之型：避障
 - 貳之型：精準降落
 - 叁之型：巡航時，執行特定任務

■ 一脫拉庫

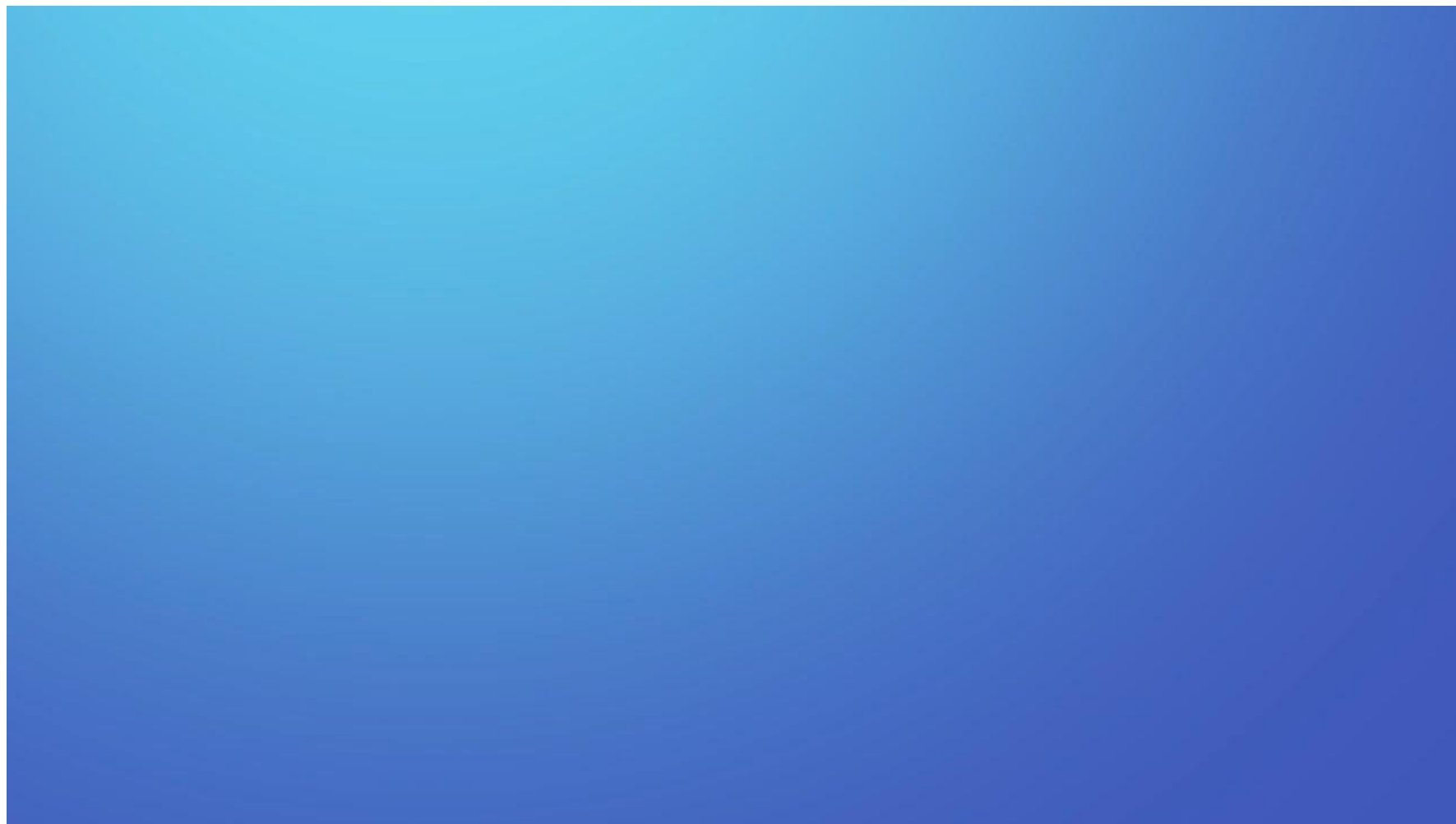
- 橋梁檢測用
- 建物表面裂縫追蹤
- 結合AI，僅利用單眼視覺避障
- 無人機警衛
- 無人機廠區巡察用
- 水質檢測用
- 競賽型
- 連撿垃圾都有



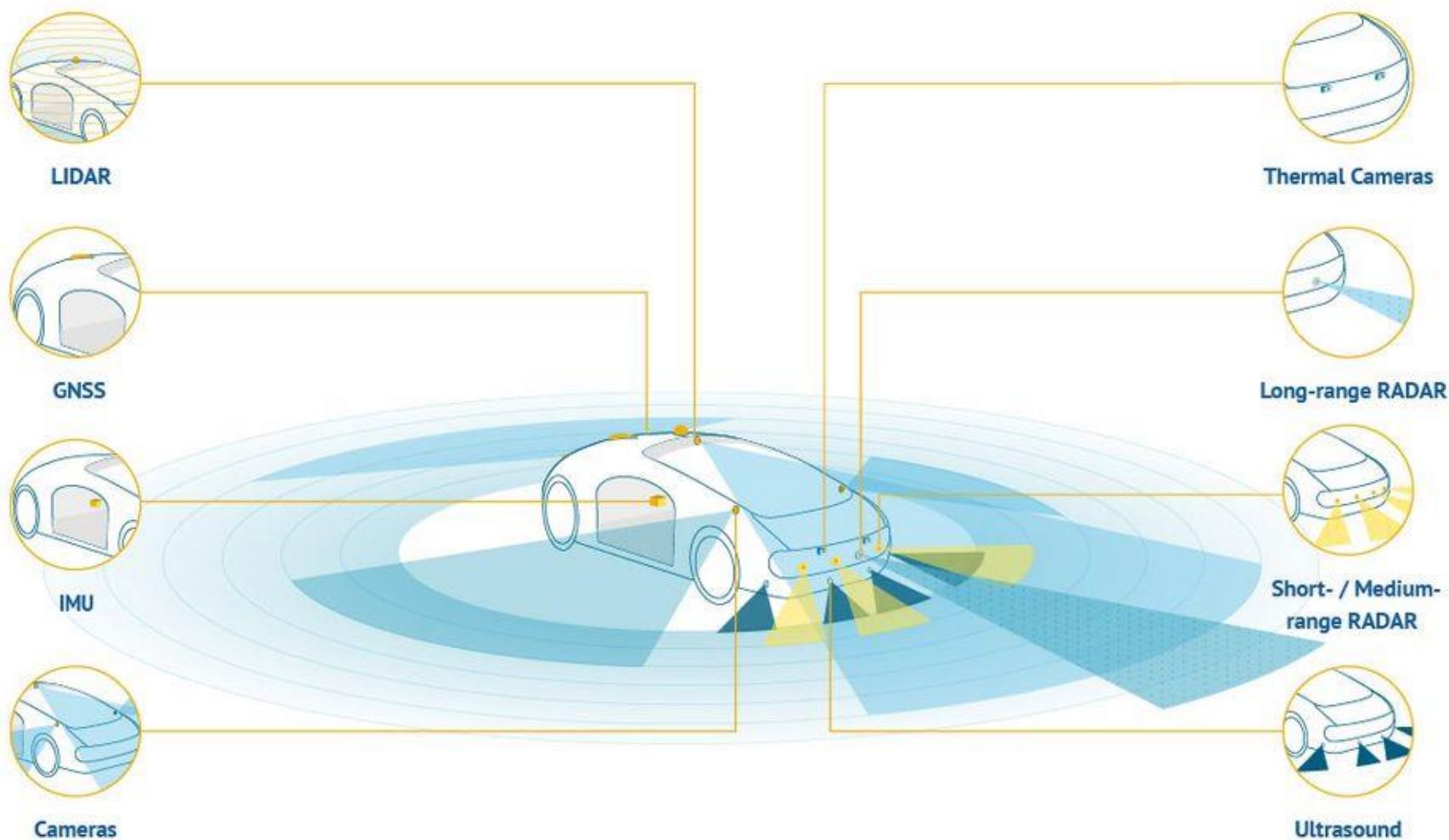
- 結合AI與感測，讓無人車可以自主移動
- 萬事起頭難...
 - 壹之型：避障
 - 貳之型：精準定位
 - 叁之型：巡航時，執行特定任務

等級0	等級1	等級2	等級3	等級4	等級5
X	1D	2D	車子具有可靠的眼睛(感測能力)	車子具有腦力(判斷決策)，能應付幾乎所有的路況	人可以睡覺或不在車上
X	不用腳	不用腳 不用手	不用腳 不用手 不用眼	不用腳 不用手 不用眼 不用腦	不用腳 不用手 不用眼 不用腦 不用人

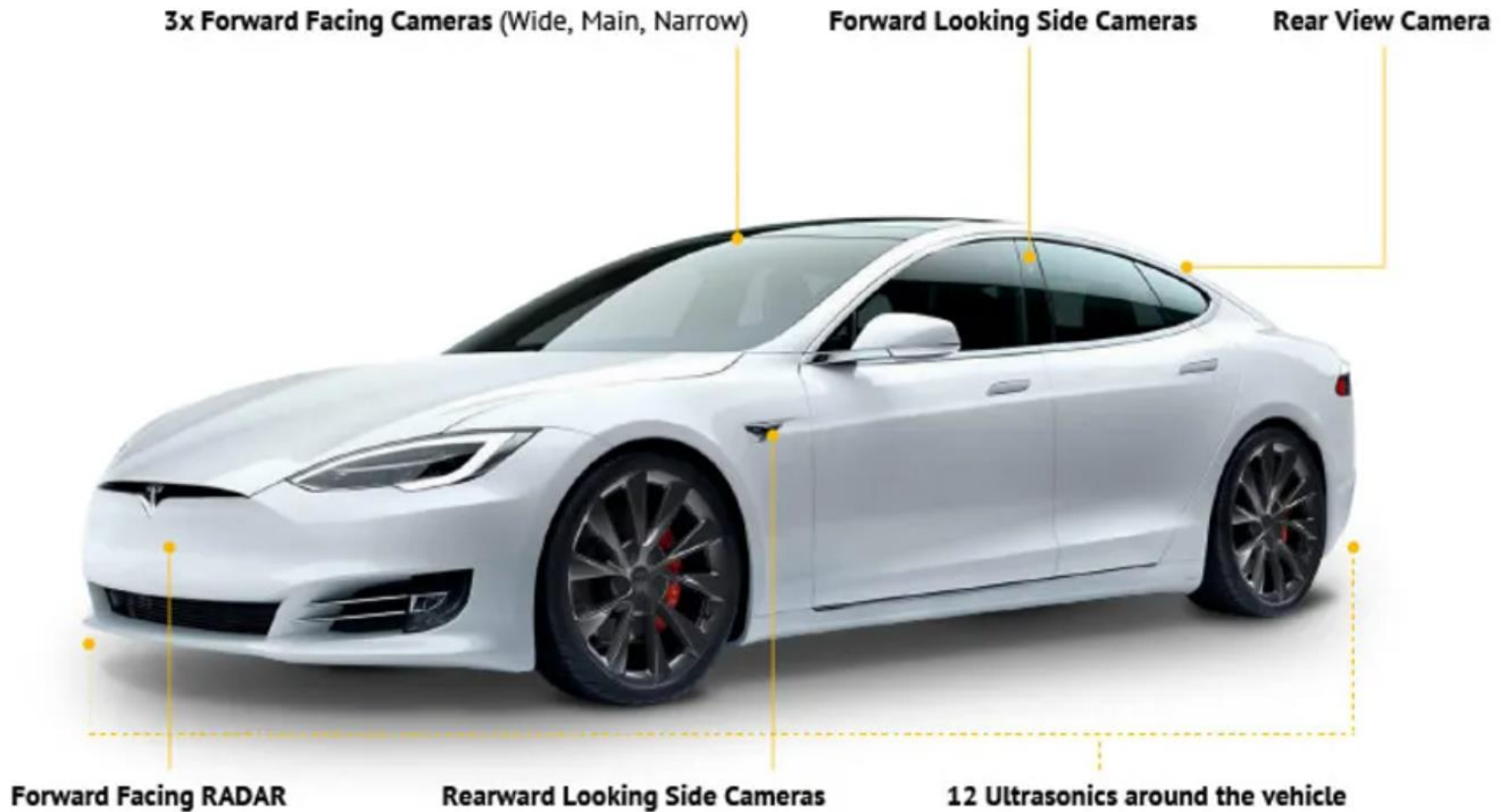
我自己的分類



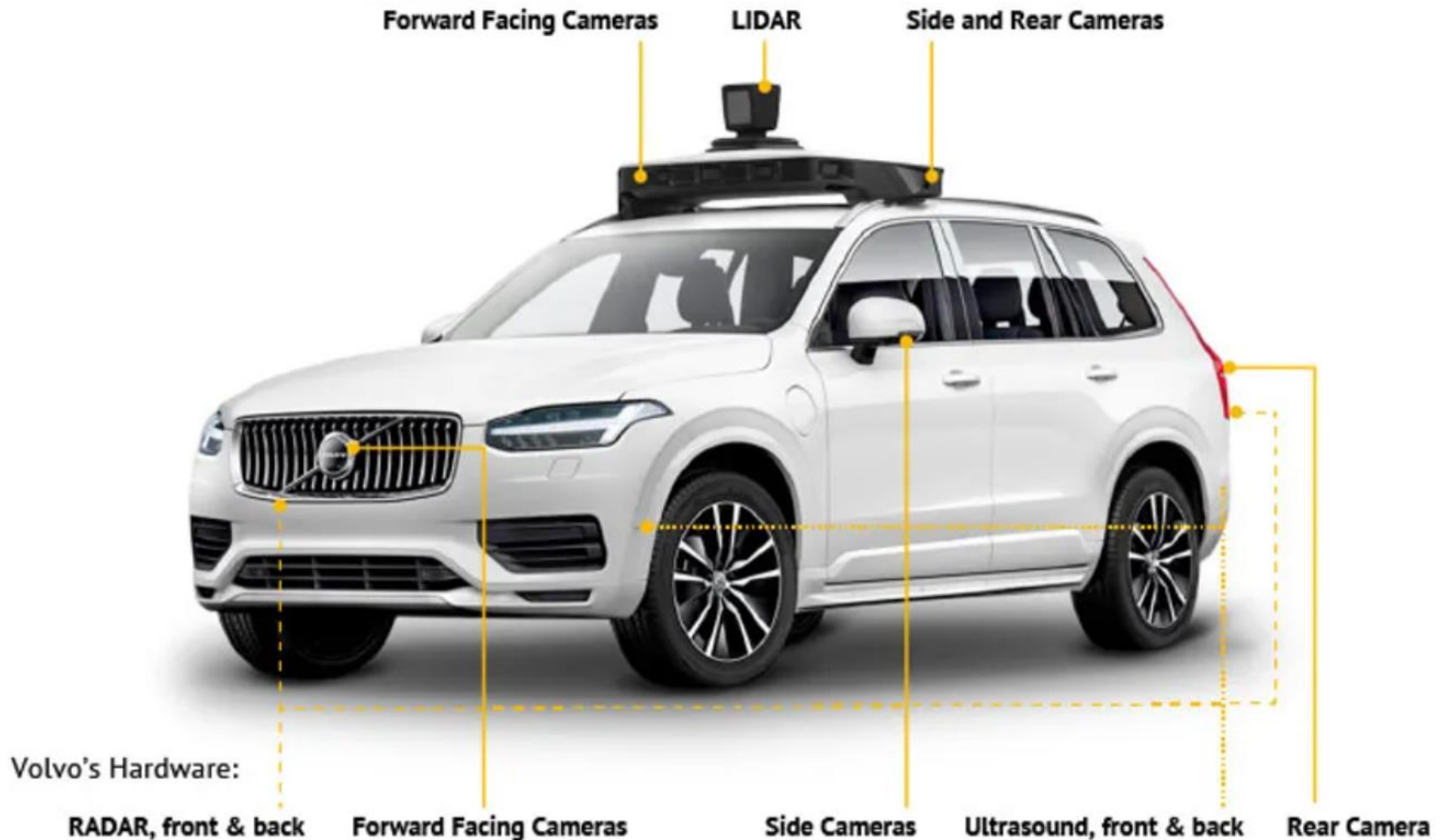
From: https://www.youtube.com/watch?v=L9HE_HrW0Ac



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>

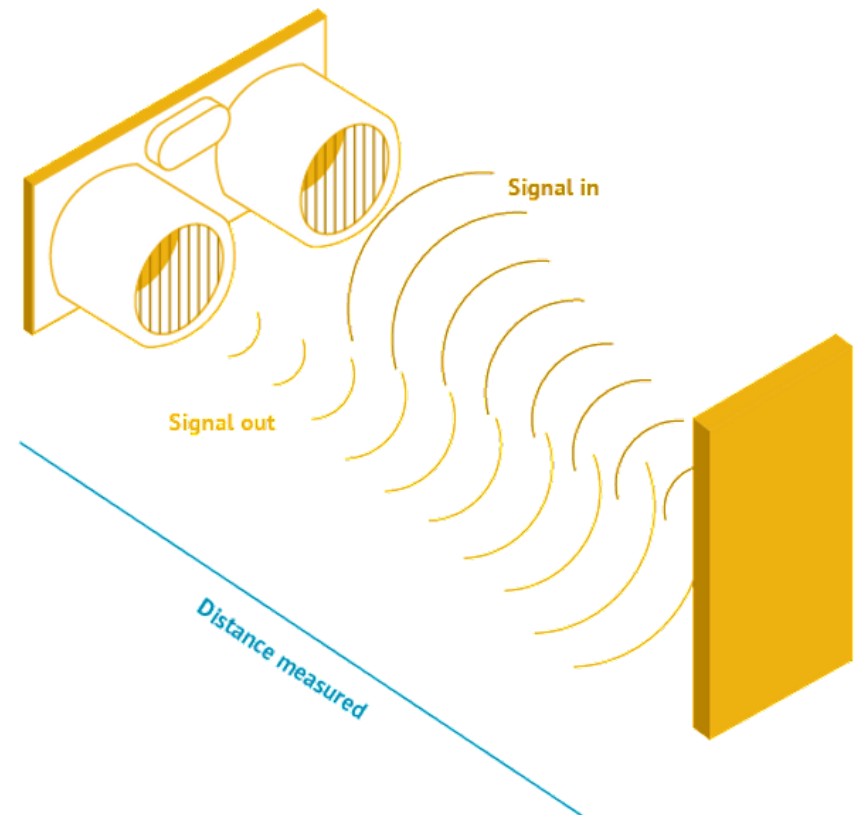
Sensor	Measurement distance (m)	Cost (\$)	Data rate (Mbps)
Camera	0-250	4-200	500-3500
Ultrasonic	0.02-10	30-400	< 0.01
RADAR	0.2-300	30-400	0.1-15
LiDAR	Up to 250	1,000-75,000	20-100

■ Technical factors

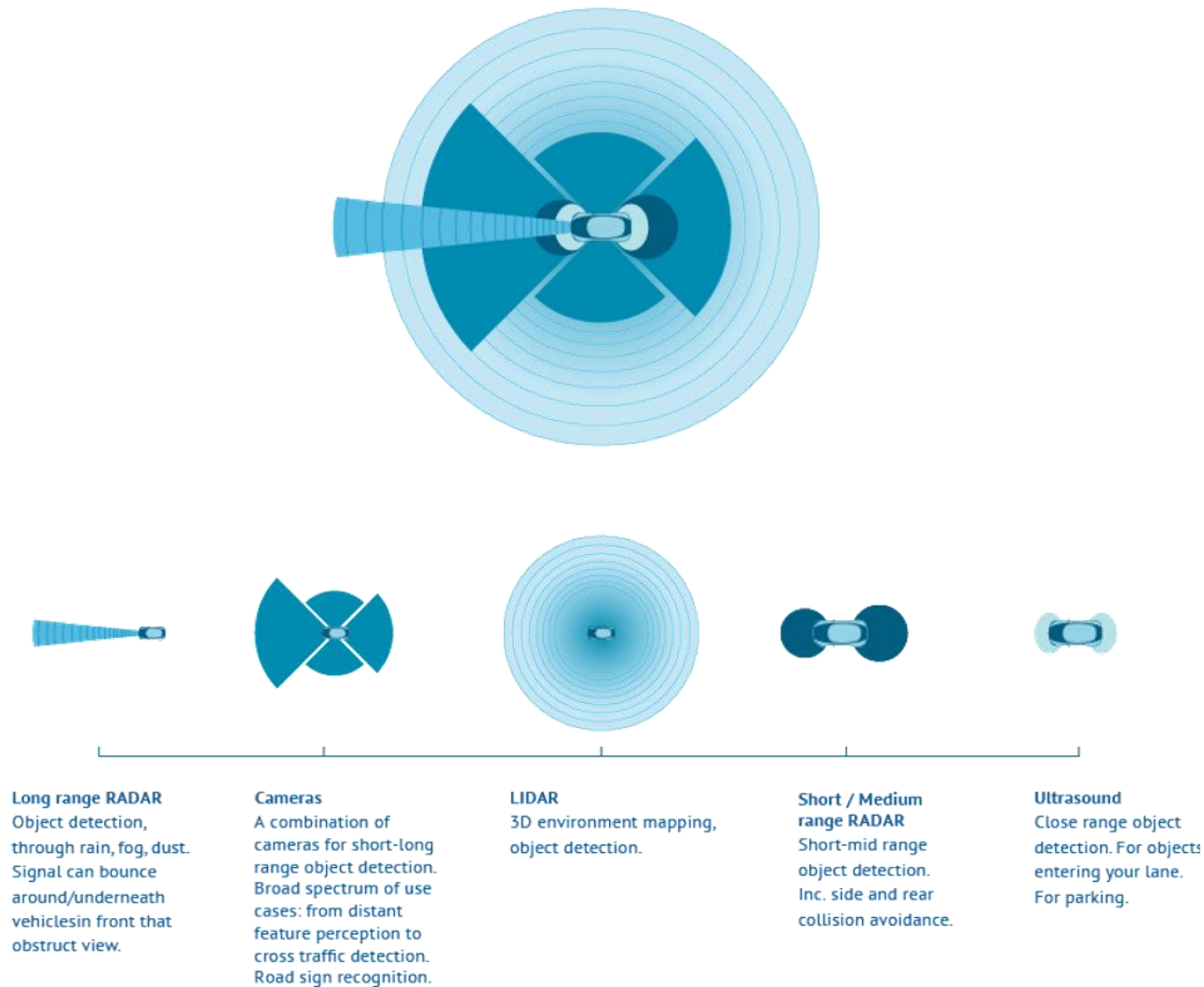
- Scanning range, refresh rate
- Resolution
- Field of view
- Objects distinguish
- Accuracy, reliability
- Cost, size, weight
- Data size

From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>

- Active sensors have a signal transmission source and rely on the principle of time-of-flight (ToF) to sense the environment. (飛時測距)
 - Ultrasonic 超音波
 - RADAR (**RA**dio **D**etection **A**nd **R**anging) 雷達
 - LiDAR (**Li**ght **D**etection **A**nd **R**anging) 光達

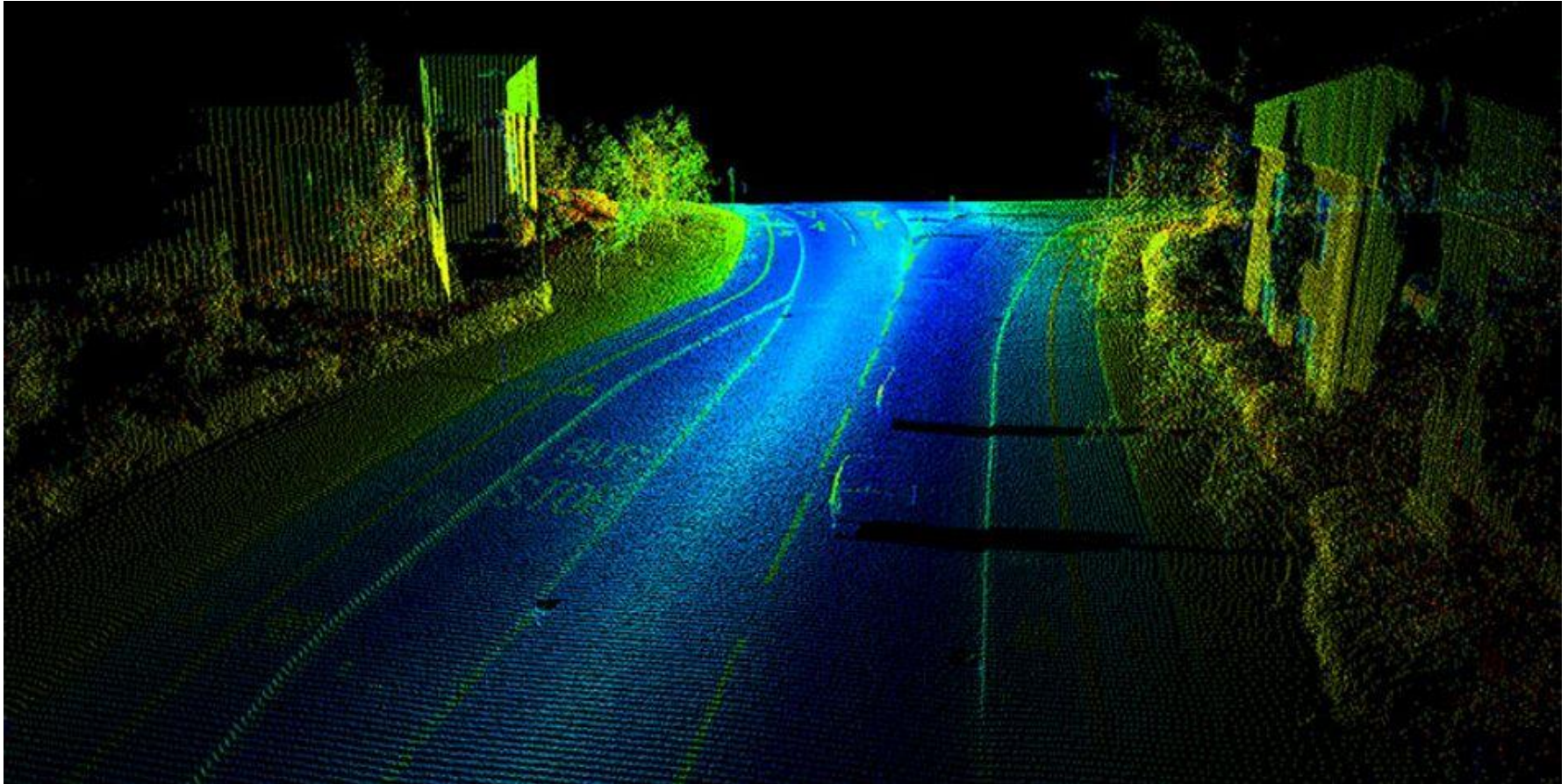


From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>

- Providing 3D point cloud of the environment



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>

- 解析度高
- 兩個相機可建構立體視覺
- 製程成熟，價格低廉
- 人容易理解

“Once you solve cameras for vision, autonomy is solved; if you don't solve vision, it's not solved ... You can absolutely be superhuman with just cameras.”

By Elon Musk, 2017.

- 電腦視覺？影像處理？
 - 電腦利用高階的分析能力，從影像或影片中理解事物，取得有用的資訊
 - 尋求一個適當的方式，讓電腦的眼睛跟人的眼睛一樣厲害



Information

Q: What kind of scene ?
Q: Where is the cyclist ?
Q: How far is the cyclist ?

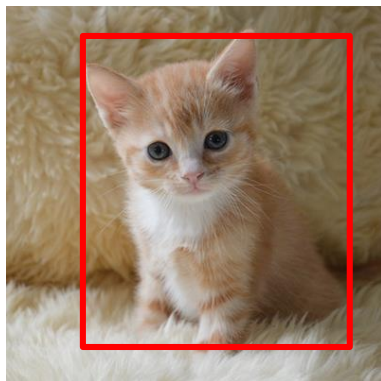


From: <https://blog.tripbaa.com/tw-taoyuan-hutou-mountain-park/>

Classification



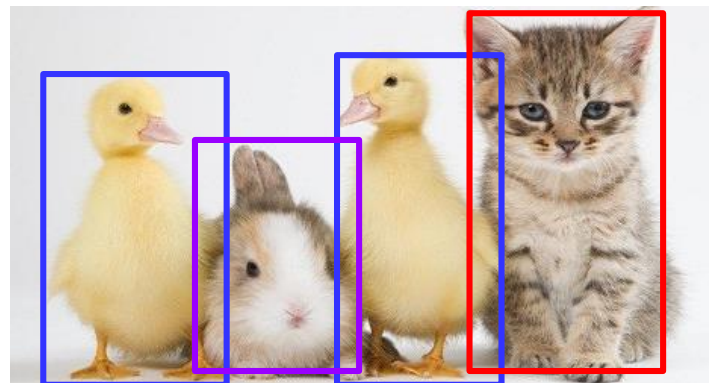
“Cat”



“Cat”

Detection Localization

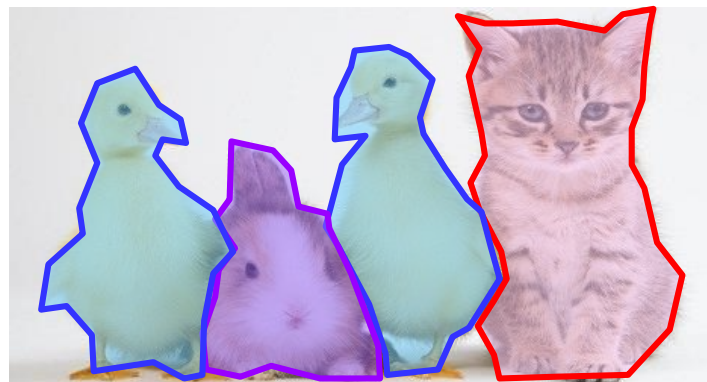
Detection, recognition



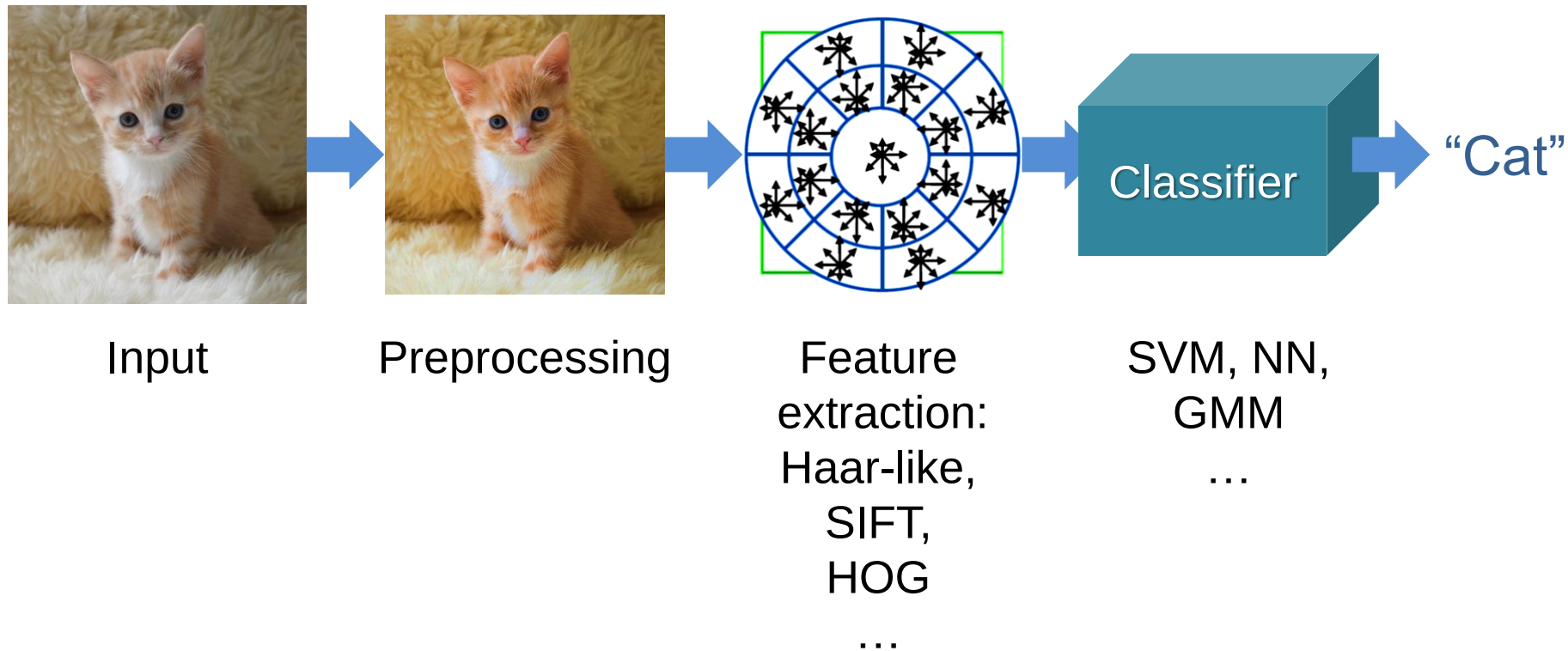
“Cat”

“Duck”

“Rabbit”

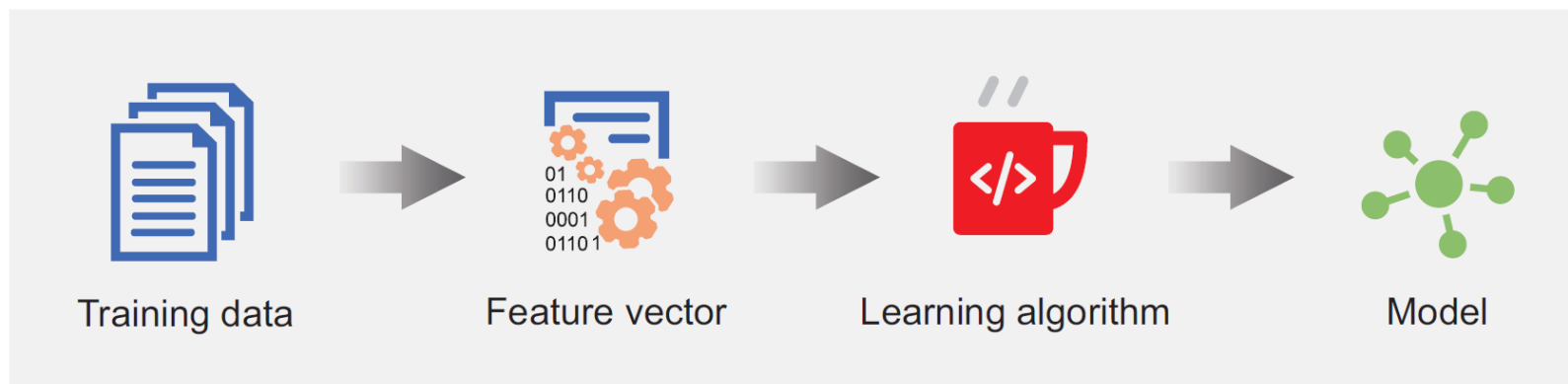


Segmentation

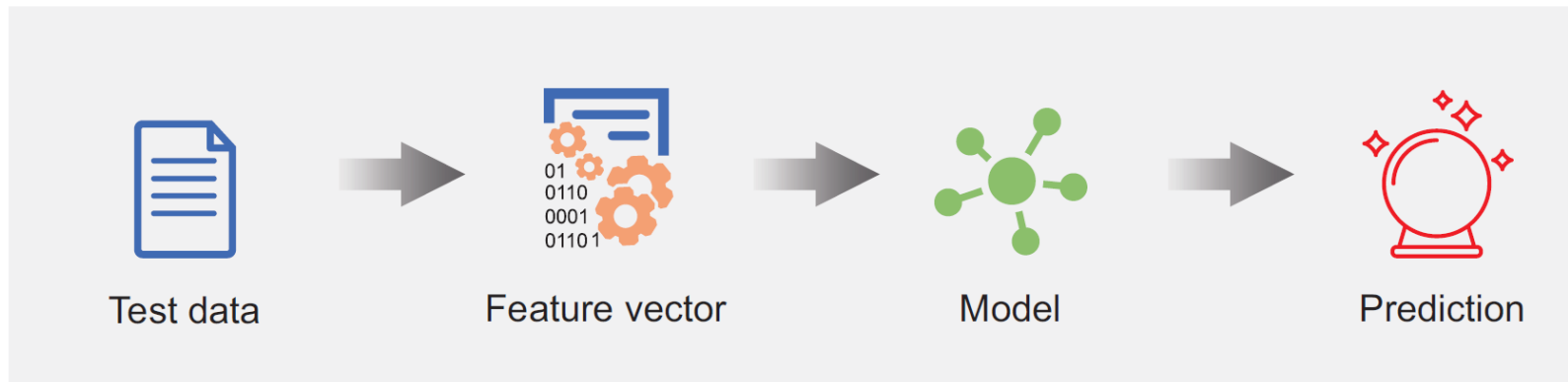


- Traditional methods are always done by a CV expert.
- Hand-crafted features are domain-specific.

■ Learning

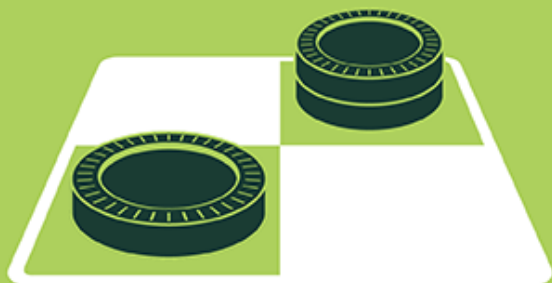


■ Inferencing / predicting, and then making decision



ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



MACHINE LEARNING

Machine learning begins to flourish.



DEEP LEARNING

Deep learning breakthroughs drive AI boom.



From: <https://blogs.nvidia.com.tw/2016/07/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/>



- End-to-end learning concept of image classification

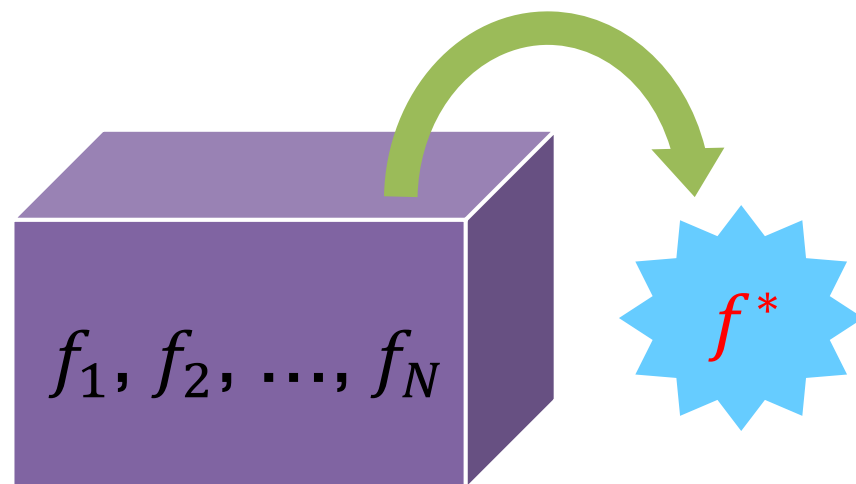
$$f\left(\text{Image of Kitten}\right) = \text{"Cat"}$$

$$f_1(\text{img}_1) = \text{"Cat"}$$

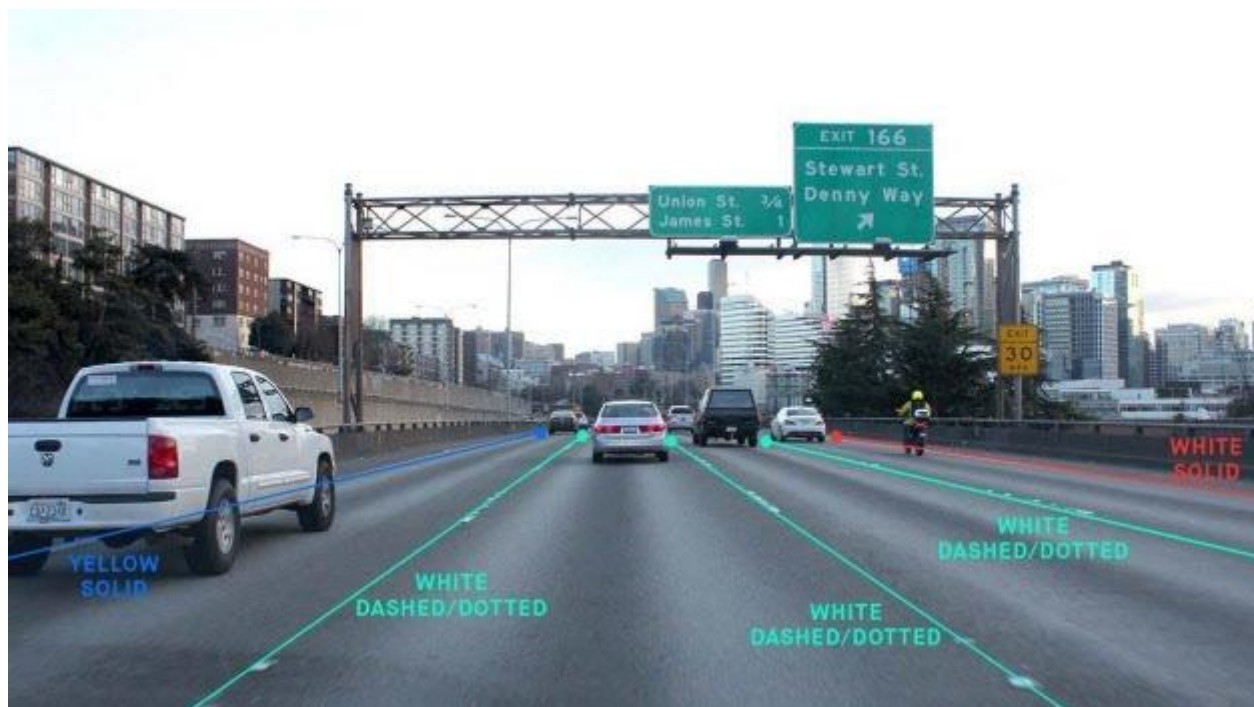
$$f_2(\text{img}_2) = \text{"Cat"}$$

$$f_1(\text{img}_3) = \text{"Monkey"}$$

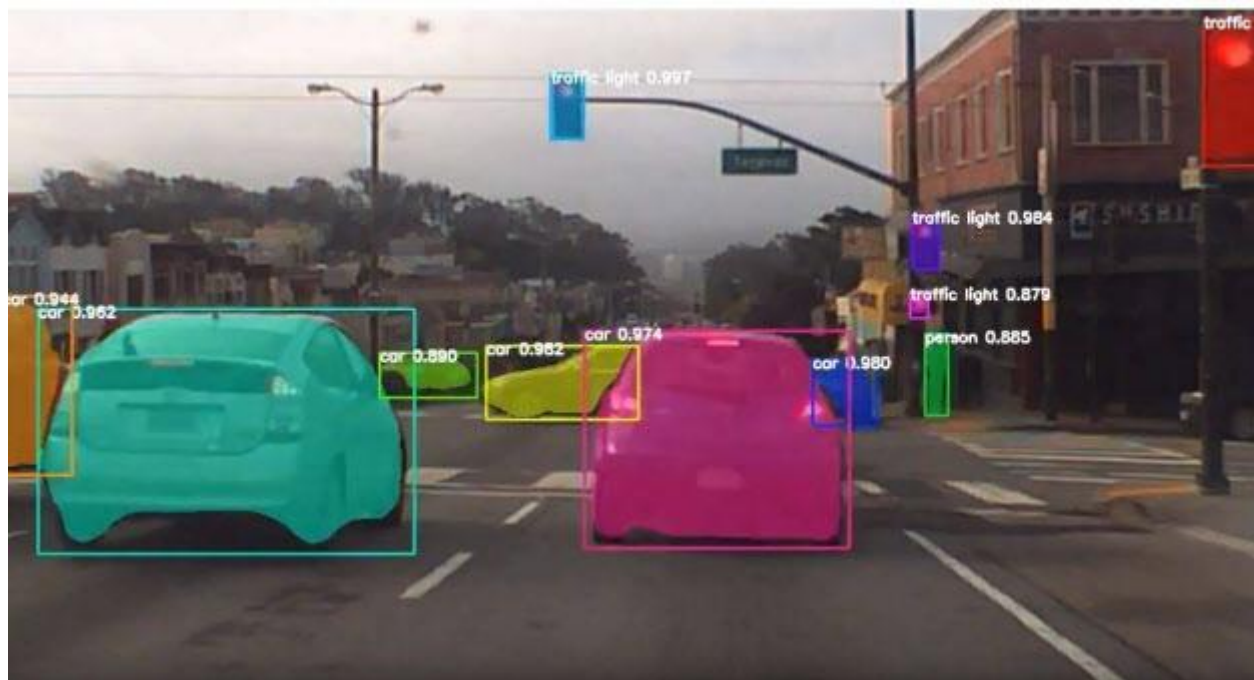
$$f_1(\text{img}_4) = \text{"Rabbit"}$$



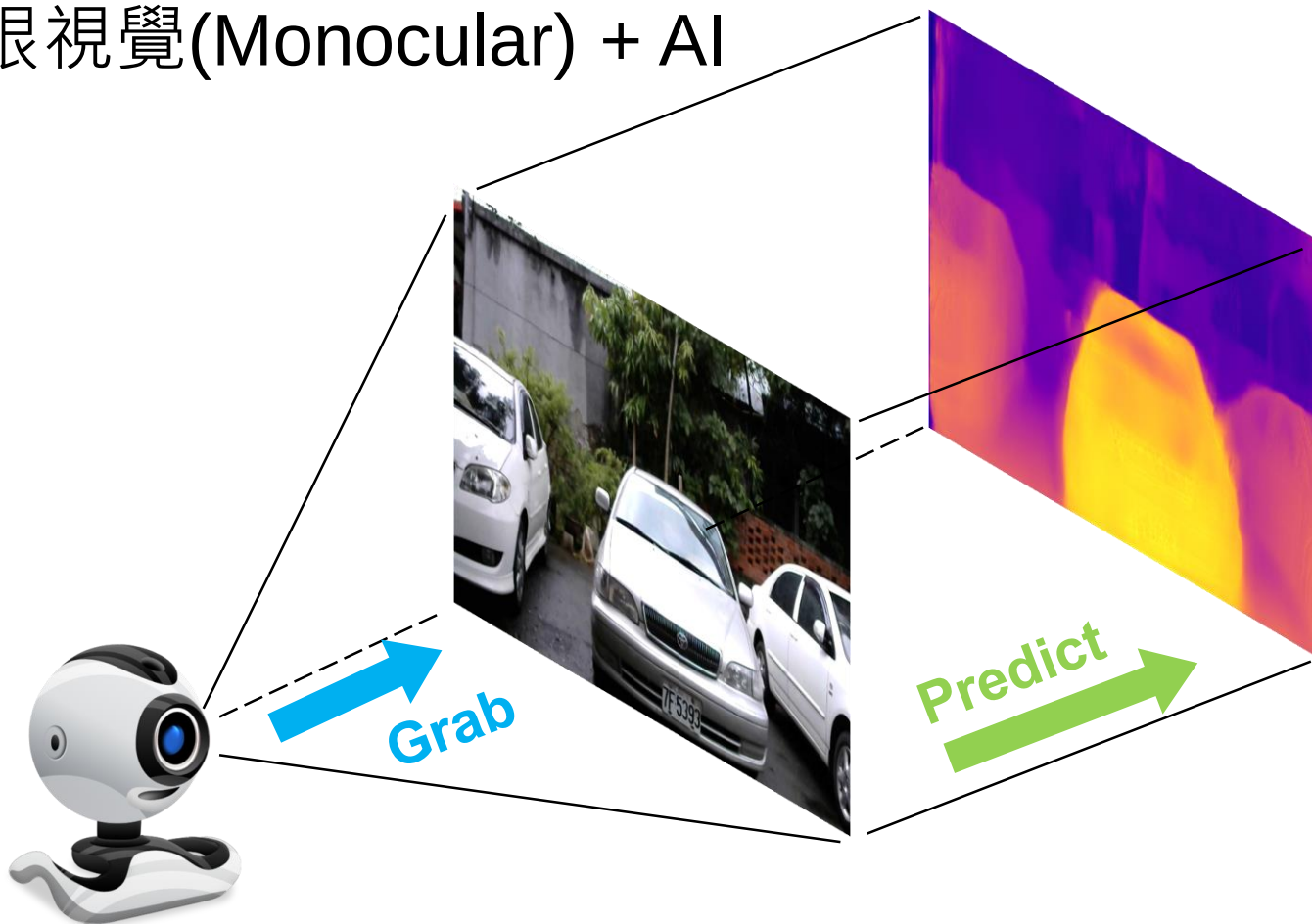
- 車道偵測
- 號誌辨識
- 物件偵測 (行人、機車、汽車...)
- 物件追蹤、軌跡預測



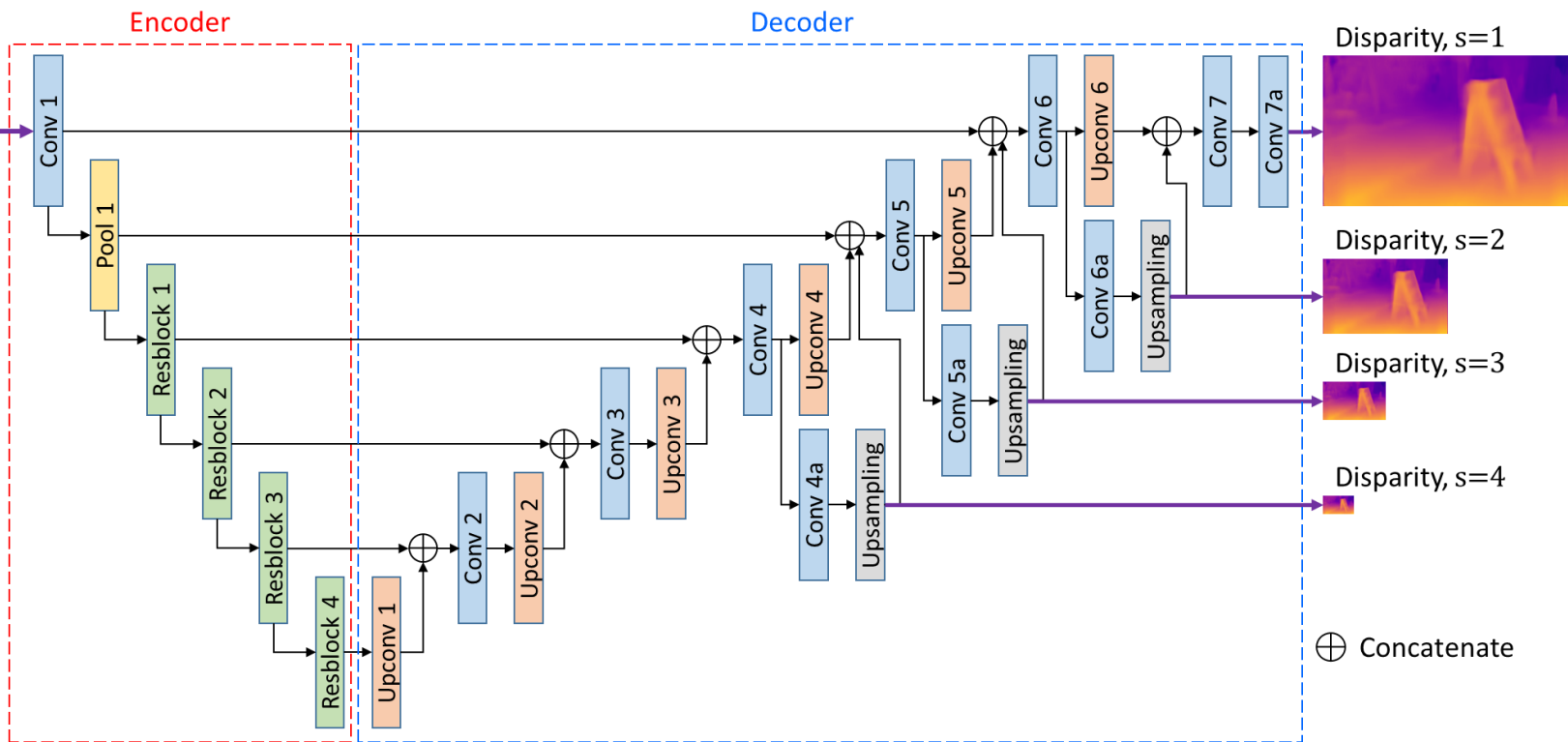
- 車道偵測
- 號誌辨識
- 物件偵測 (行人、機車、汽車...)
- 物件追蹤、軌跡預測



- 雙眼視覺(Binocular)
- 單眼視覺(Monocular) + AI

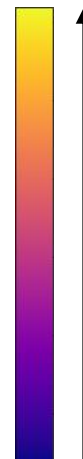


Goal: Predict a depth map from a color image



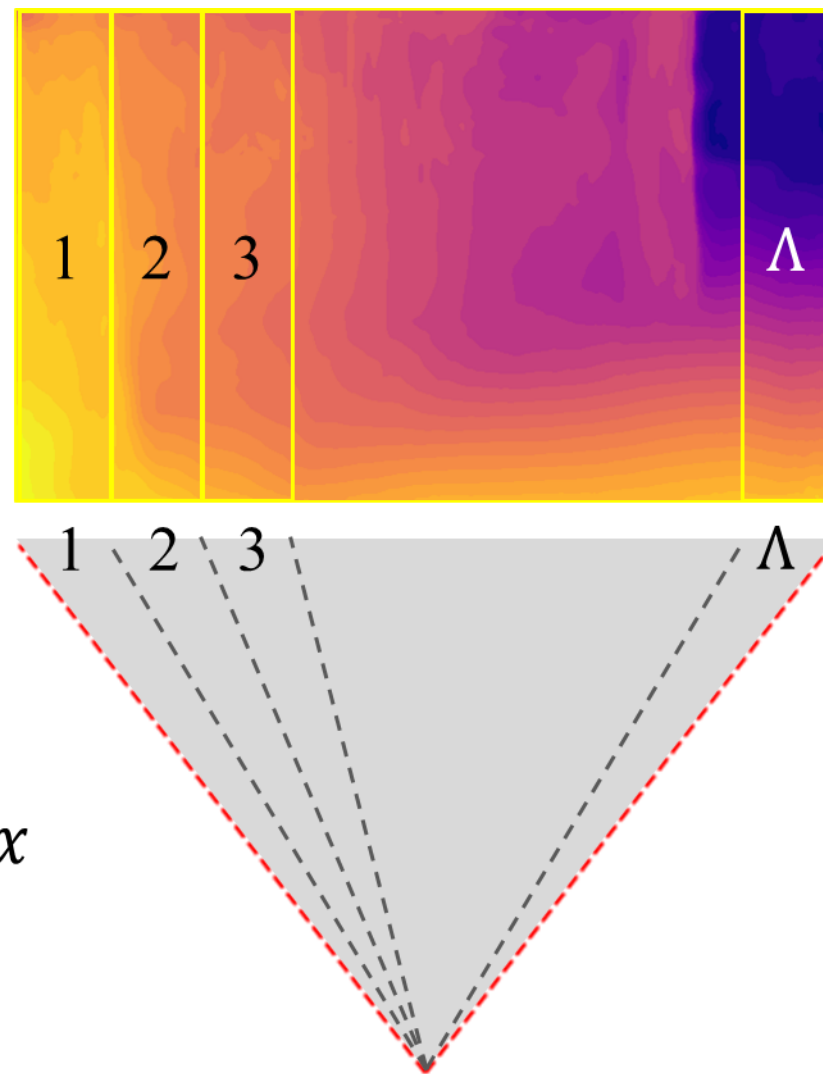
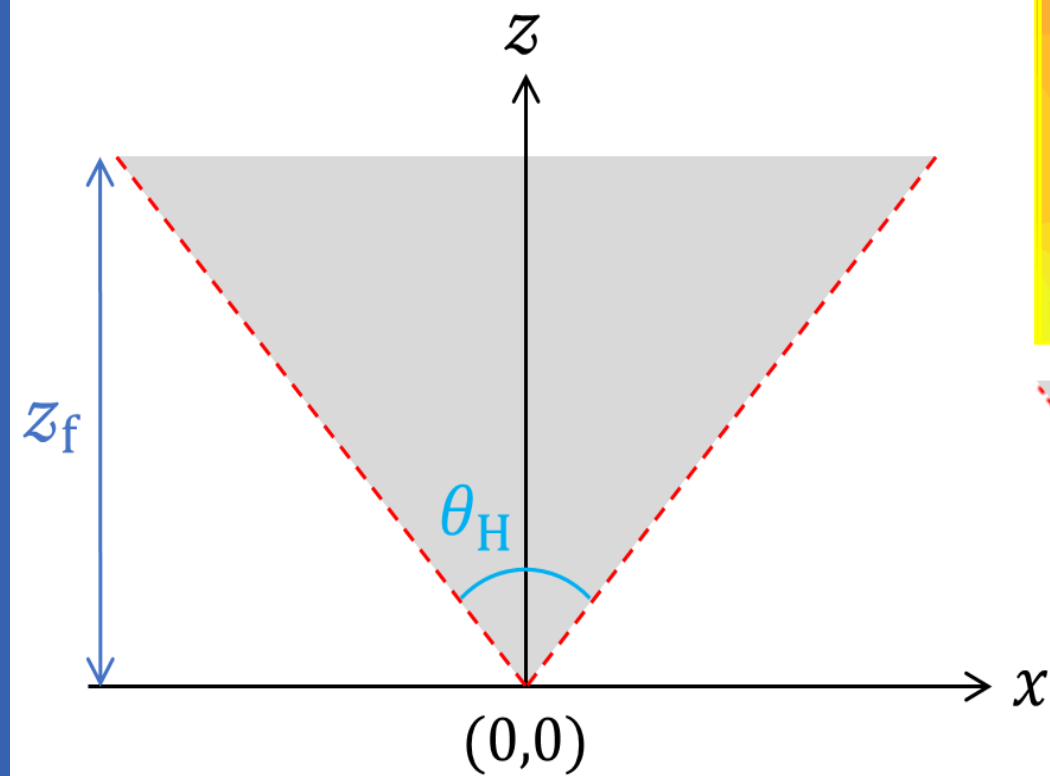


Large



Small



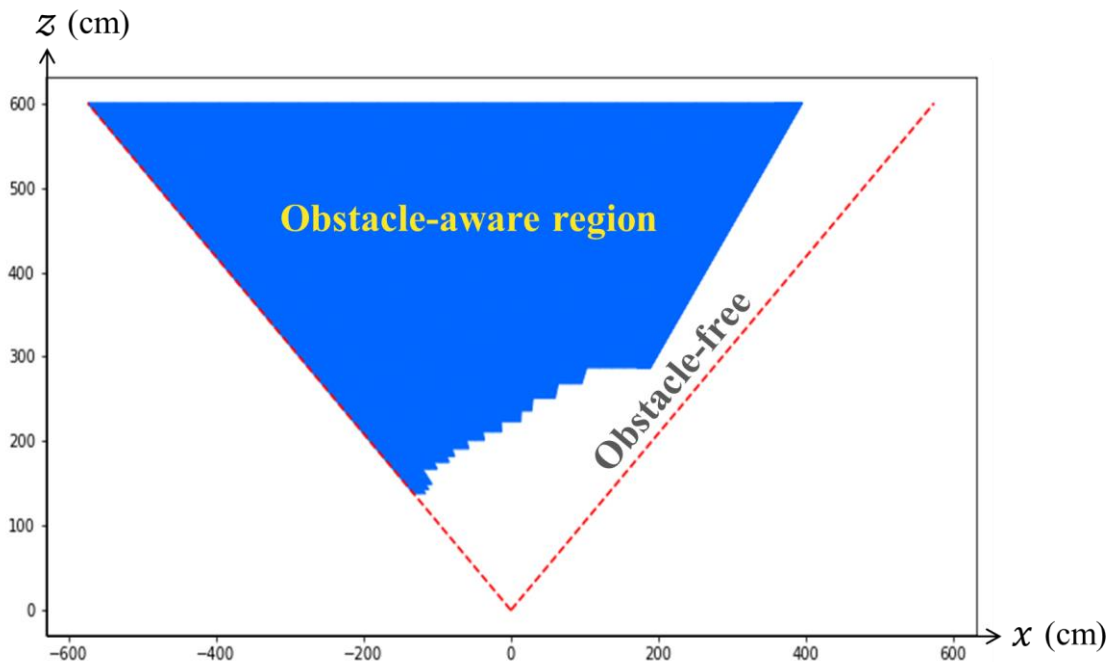


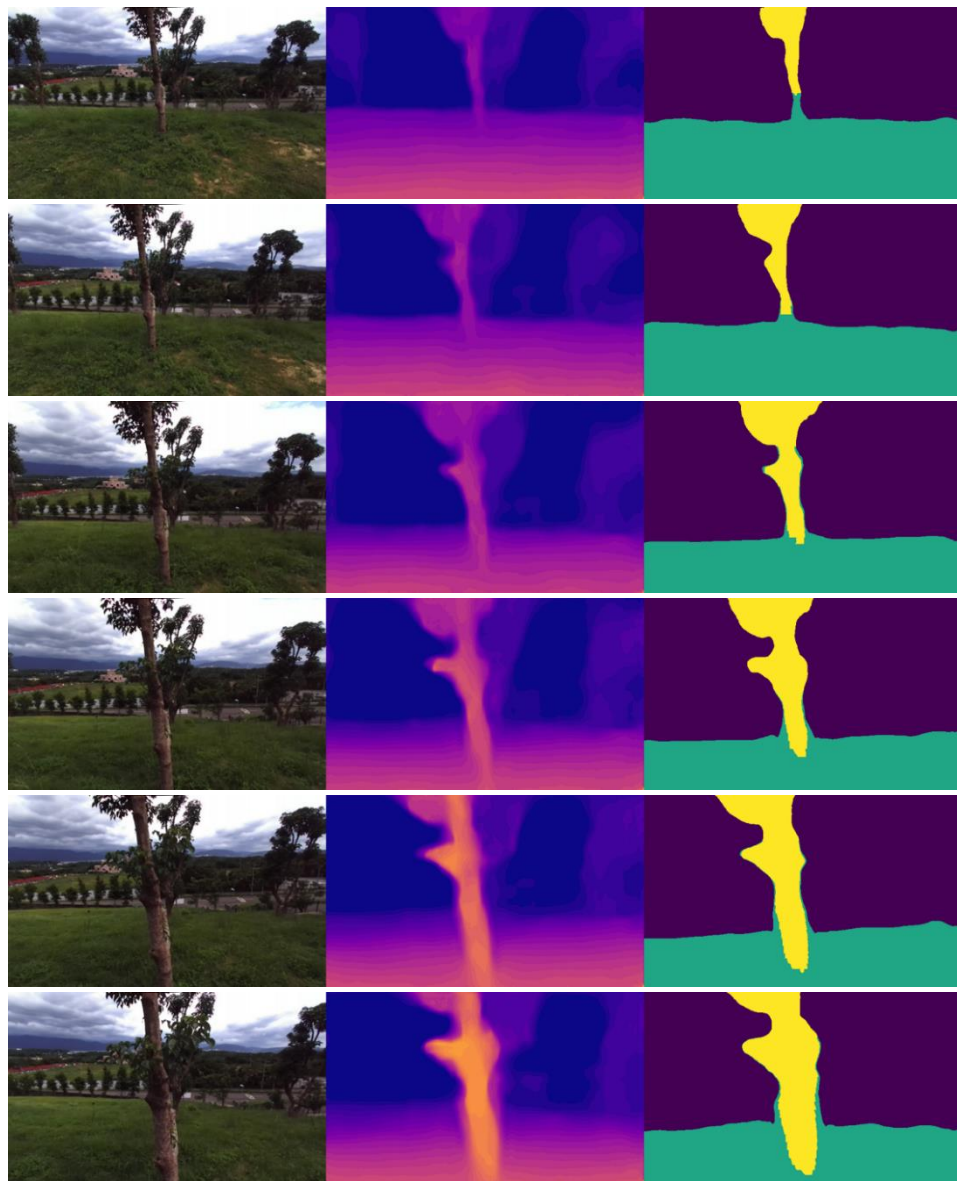


← What a robot sees.

What our robot understands.

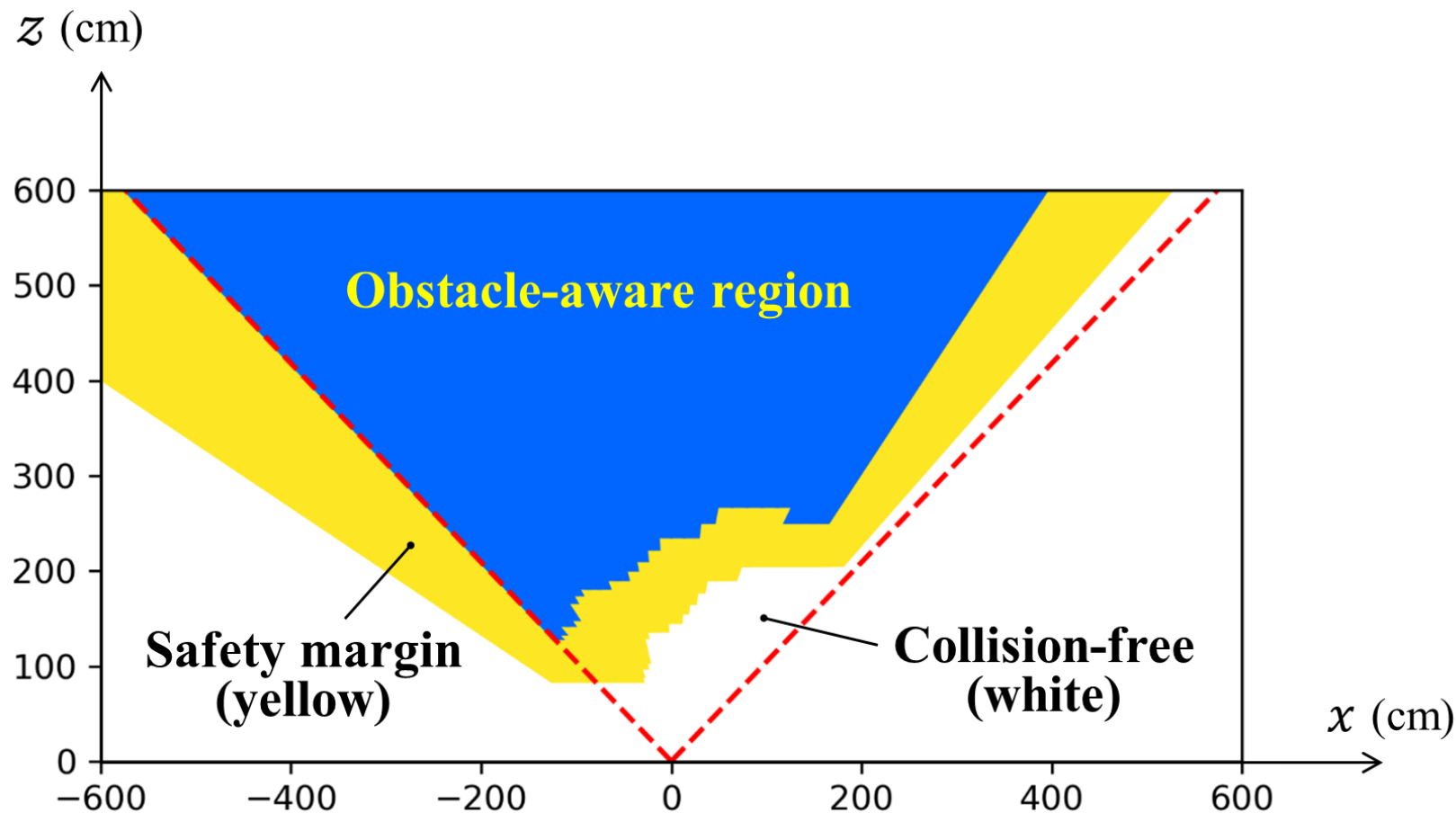
Enough for guiding a robot?

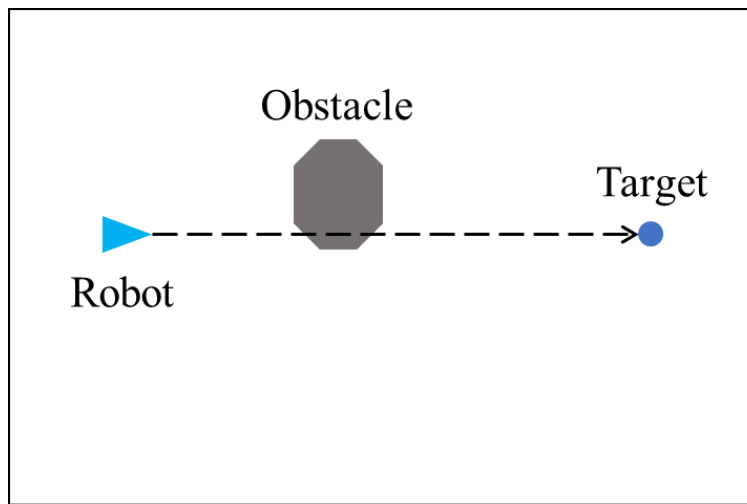




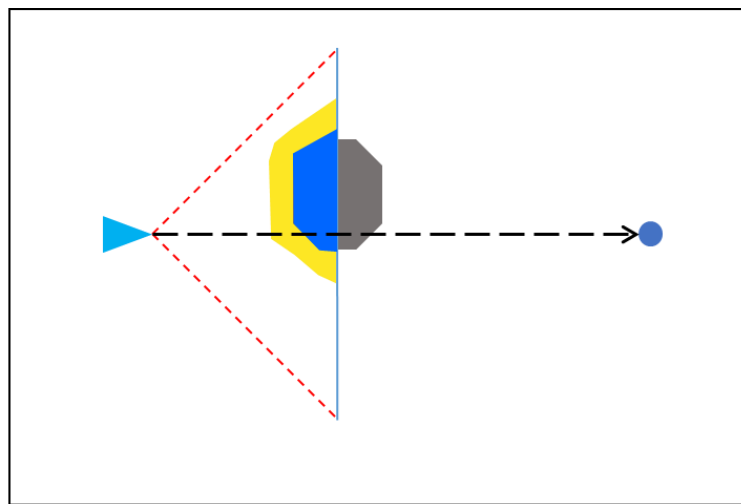
Average relative error
3%-9.2%

Construct the collision-free region

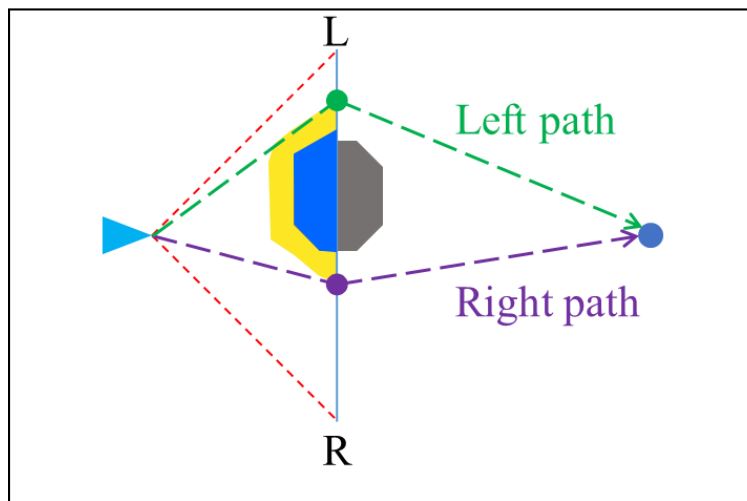




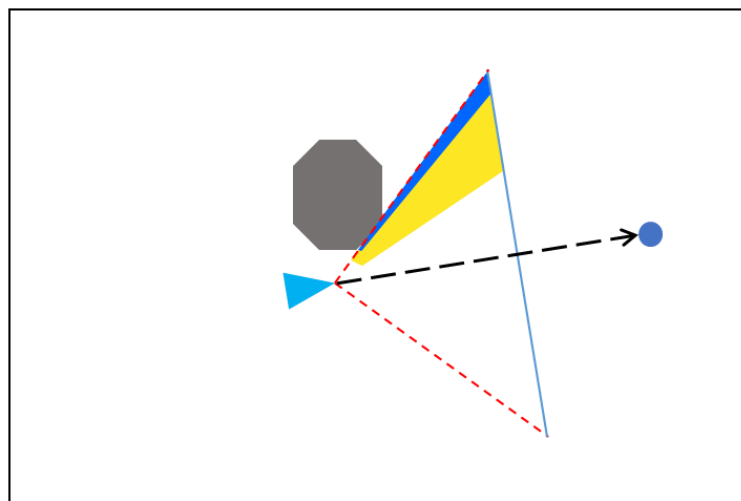
(a)



(b)



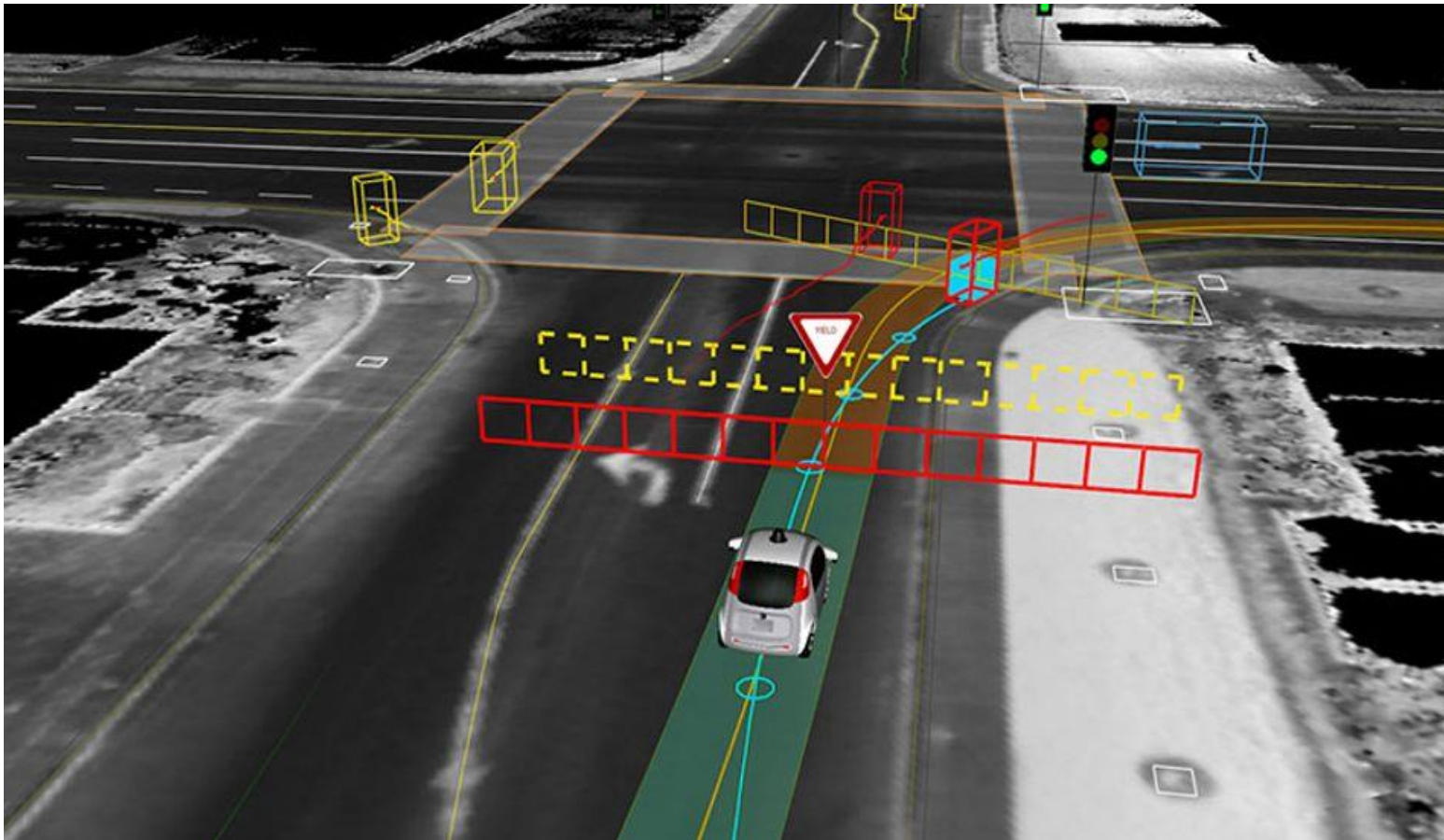
(c)



(d)

**Monocular depth estimation
and collision avoidance
on a multiroror drone**

- Autonomous



From: <https://www.wevolver.com/article/2020.autonomous.vehicle.technology.report>

- 感測融合
- 人工智慧 + 電腦視覺
- 當感測器都已成熟，未來的機會在於誰提供更強大即時的運算能力

IoAT + CPS

Thank you.