

小鴨城 (Duckietown) 一個基於 Raspberry Pi 和 ROS 的開源無人小車專案介紹

台灣樹莓派 <sosorry@raspberrypi.com.tw>
2018/06/02 @PyCon2018

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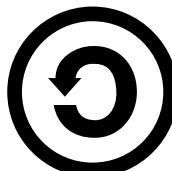
姓名標示 — 非商業性 — 相同方式分享



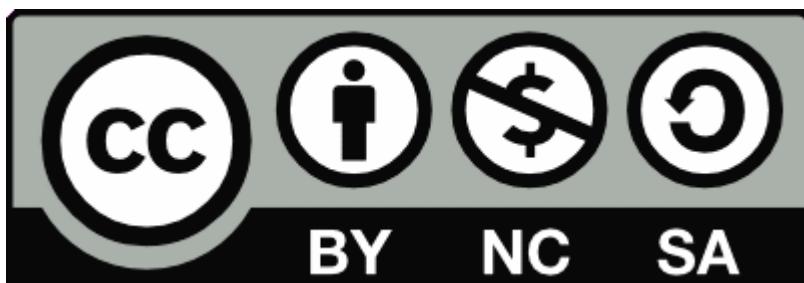
姓名標示 — 你必須給予 適當表彰、提供指向本授權條款的連結，以及 指出（本作品的原始版本）是否已被變更。你可以任何合理方式為前述表彰，但不得以任何方式暗示授權人為你或你的使用方式背書。



非商業性 — 你不得將本素材進行商業目的之使用。



相同方式分享 — 若你重混、轉換本素材，或依本素材建立新素材，你必須依本素材的授權條款來散布你的貢獻物。



about 台灣樹莓派

- Raspberry Pi 官方經銷商
- 專注於 Raspberry Pi 應用與推廣
- 舉辦社群聚會 / 工作坊 / 讀書會 / 黑客松

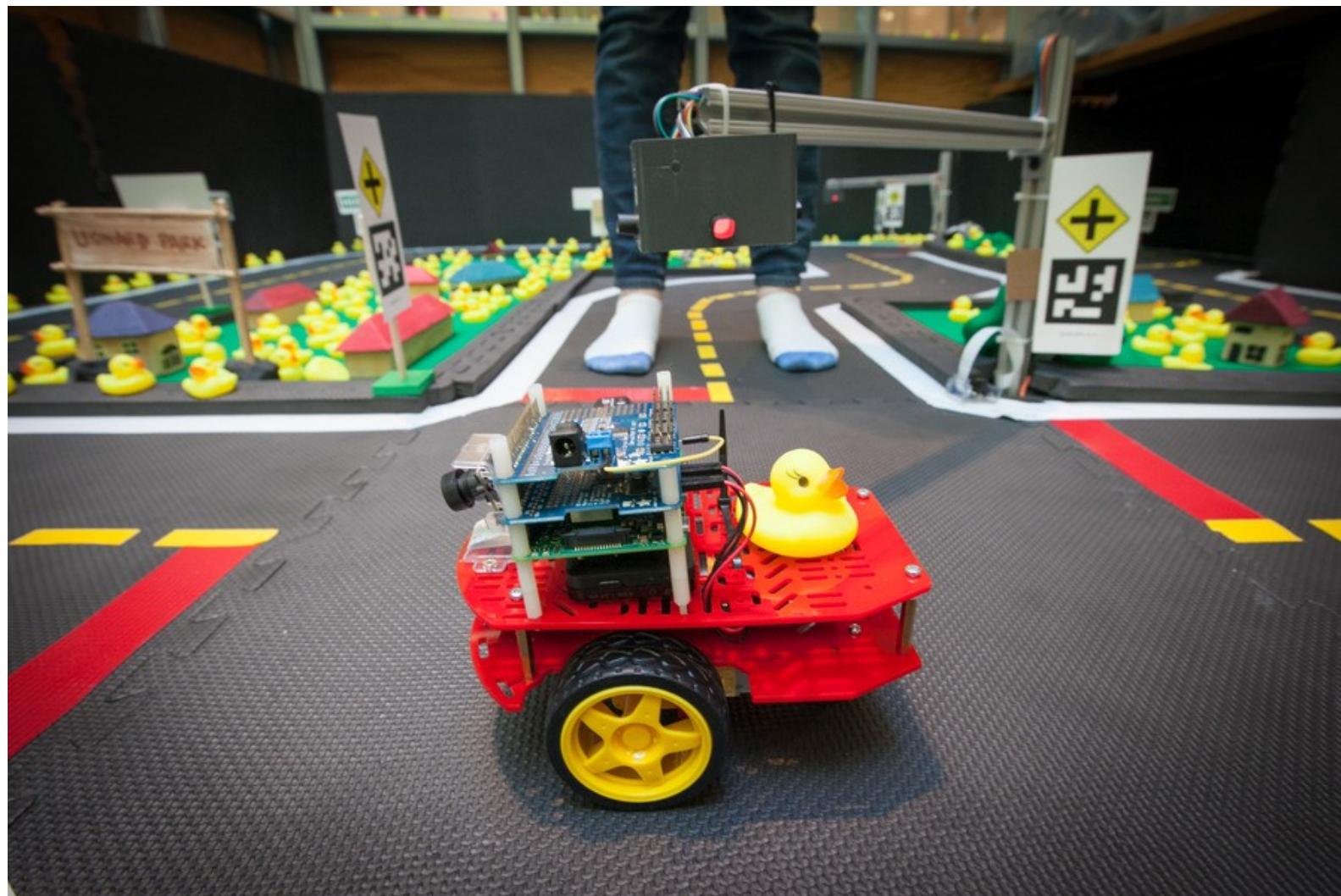


本次主題

- 什麼是 Duckietown?
- 所需硬體和環境
- 使用電腦視覺作為自駕車的輸入
- 用機率計算車道相對估計與控制
- 學習資源
- DEMO

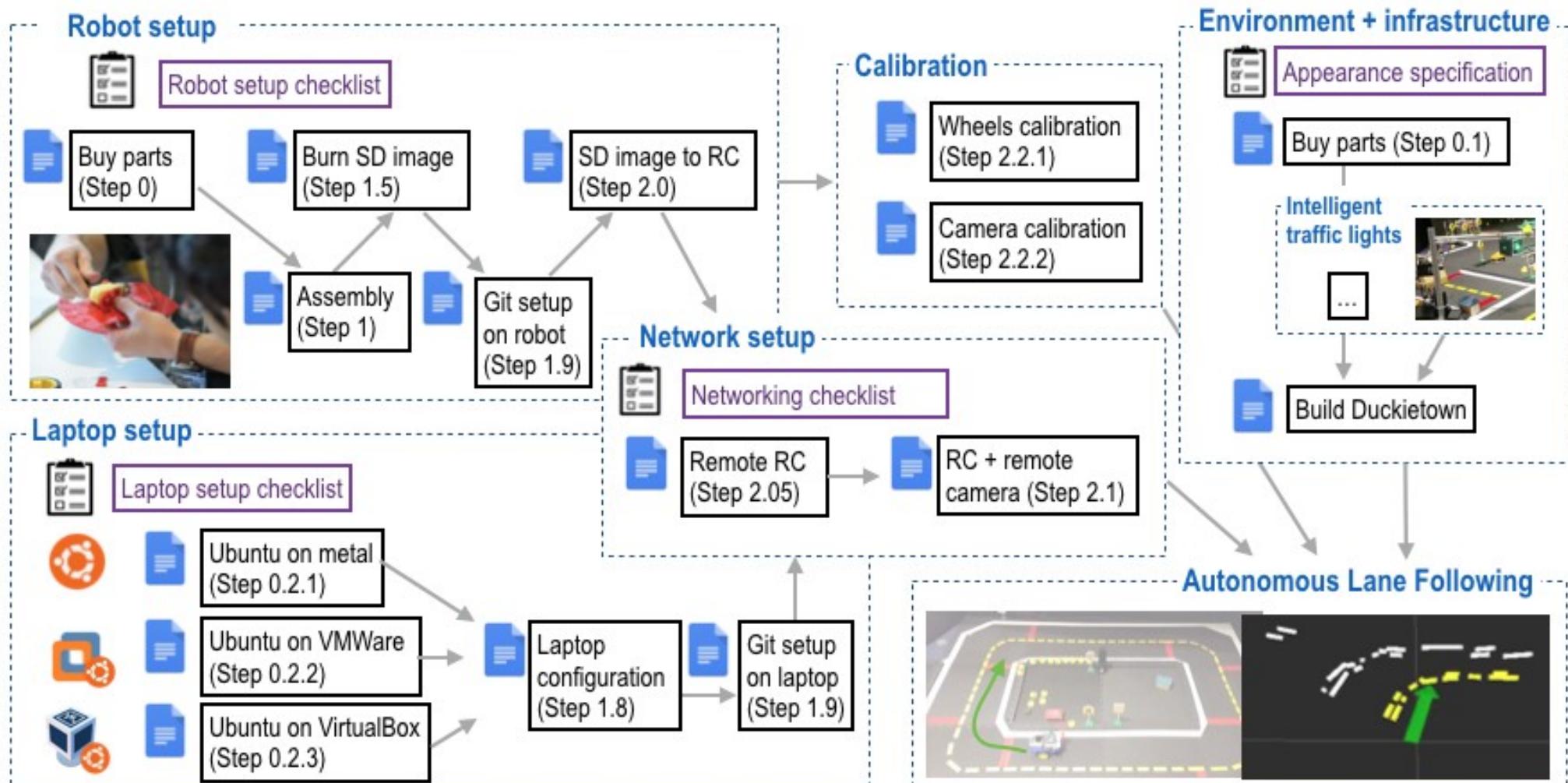
什麼是 Duckietown?

Duckietown Project - From MIT



<http://duckietown.org/>

一個開源的電腦視覺自駕車學習專案



History

- 2016 麻省理工大學
 - > Duckietown class



- 2016 國立交通大學
 - > Autonomous Vehicle

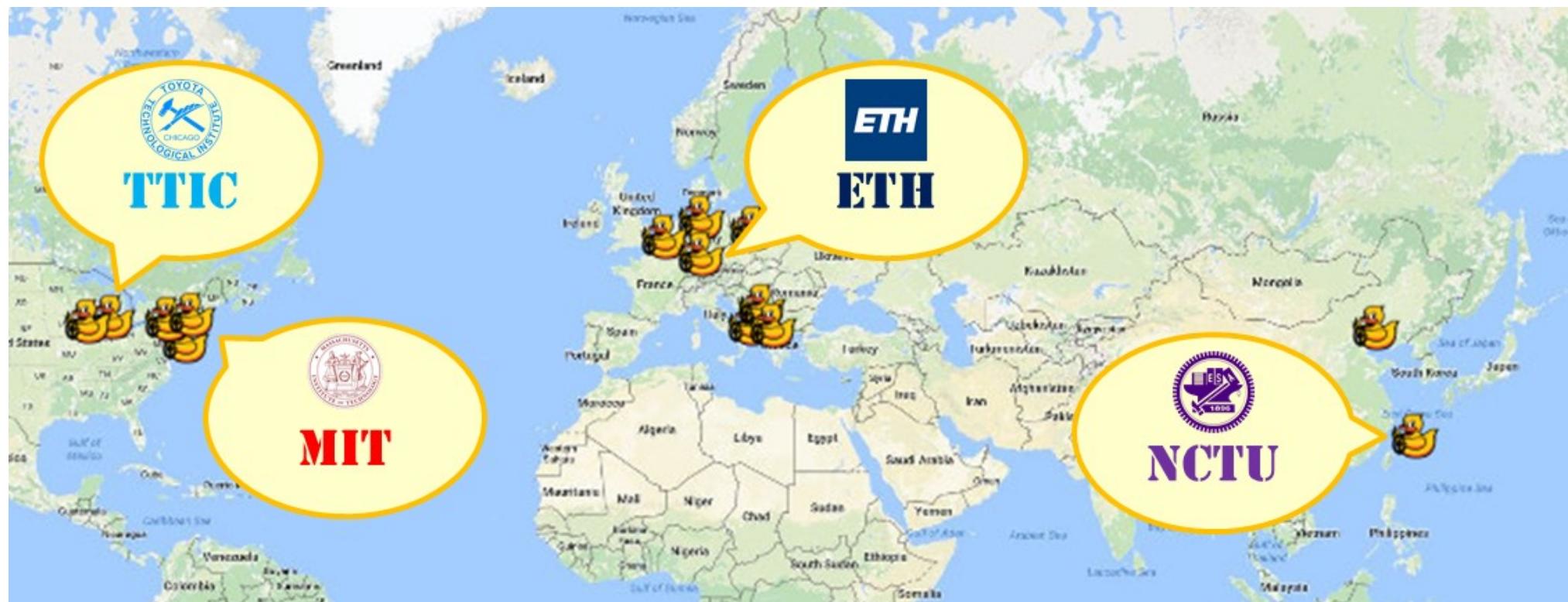


- 2017 蘇黎世聯邦理工學院
 - > Autonomous Mobility on Demand



<http://bit.ly/2L8P53a>

誰在用 Duckietown 專案？



我們可從專案中學到

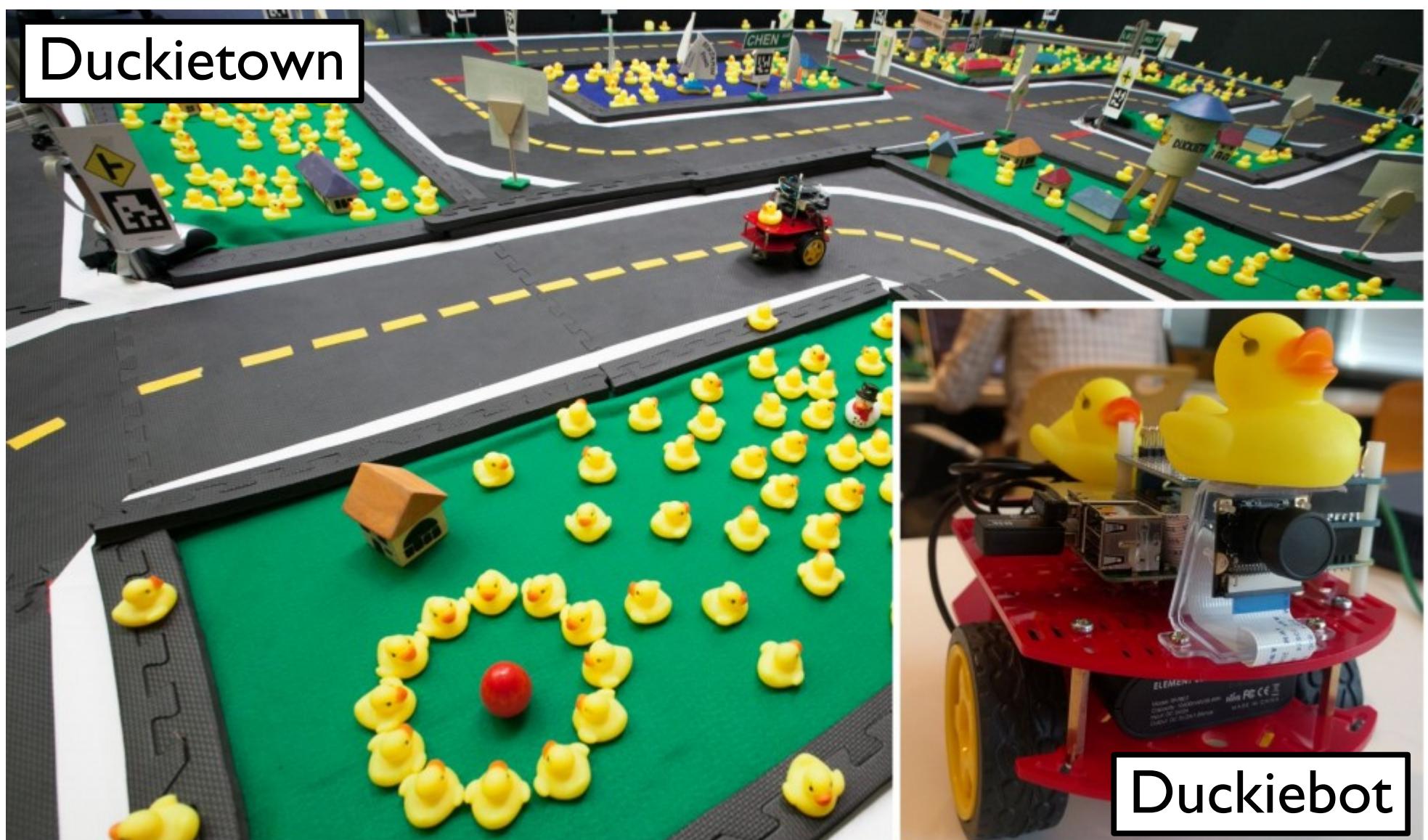
- 感測器校正，設定與感知
- 計算機視覺
- 物體辨識
- 非線性估計
- 全域定位
- 分散式協調

並實際操作

- 架設 Duckiebot 平台和 Duckietown 環境
- 機器人體系 (ROS) 建立
- 功能模組的實現與擴充
- 單系統機器人車道跟隨 (lane following)
- 單系統機器人定位 (localization), 規劃 (planning) 和導航 (navigation)
- 多系統機器人交換訊息和協調
- 系統層級的資源管理

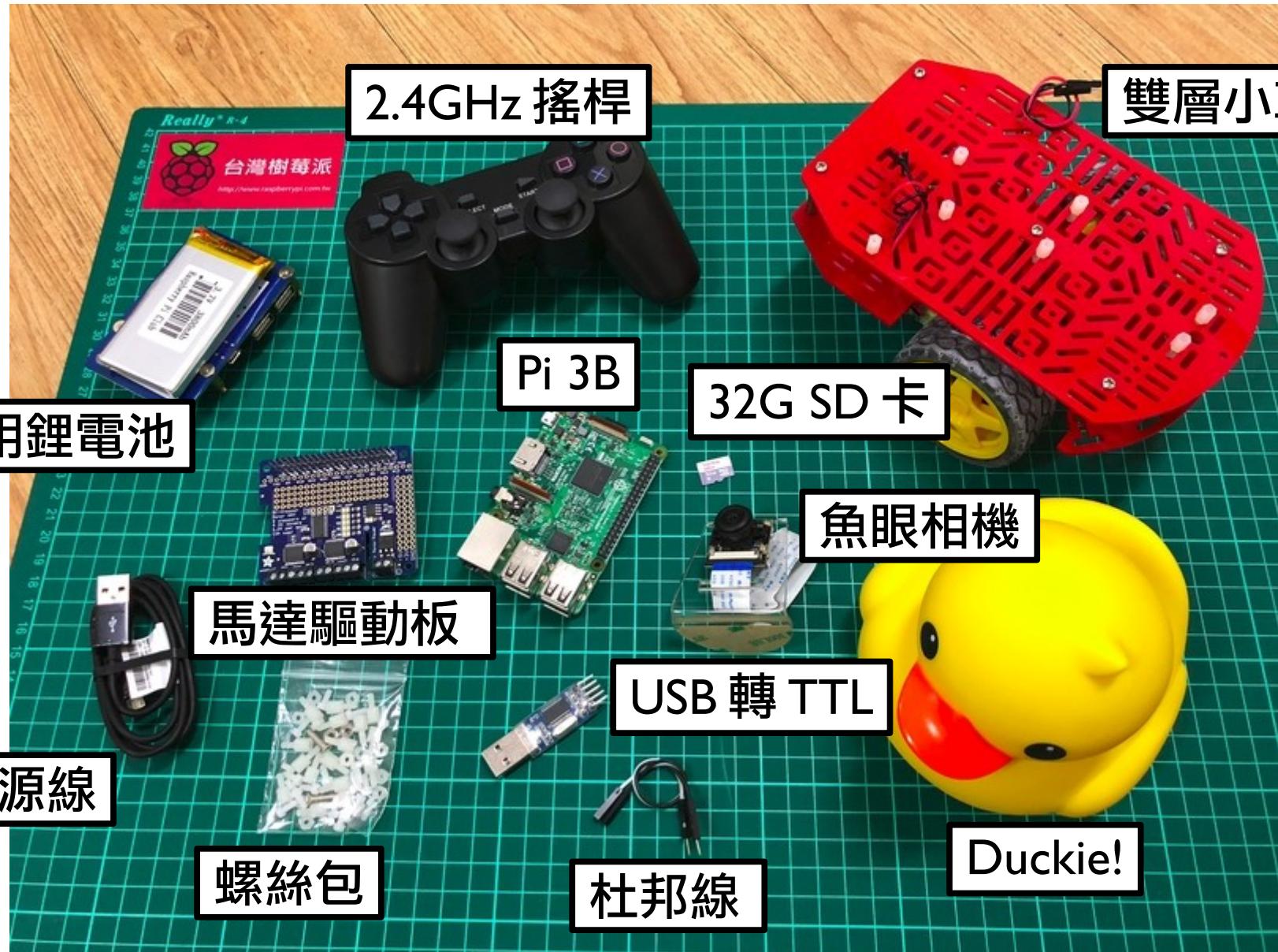
所需硬體和環境

小鴨車 + 小鴨城

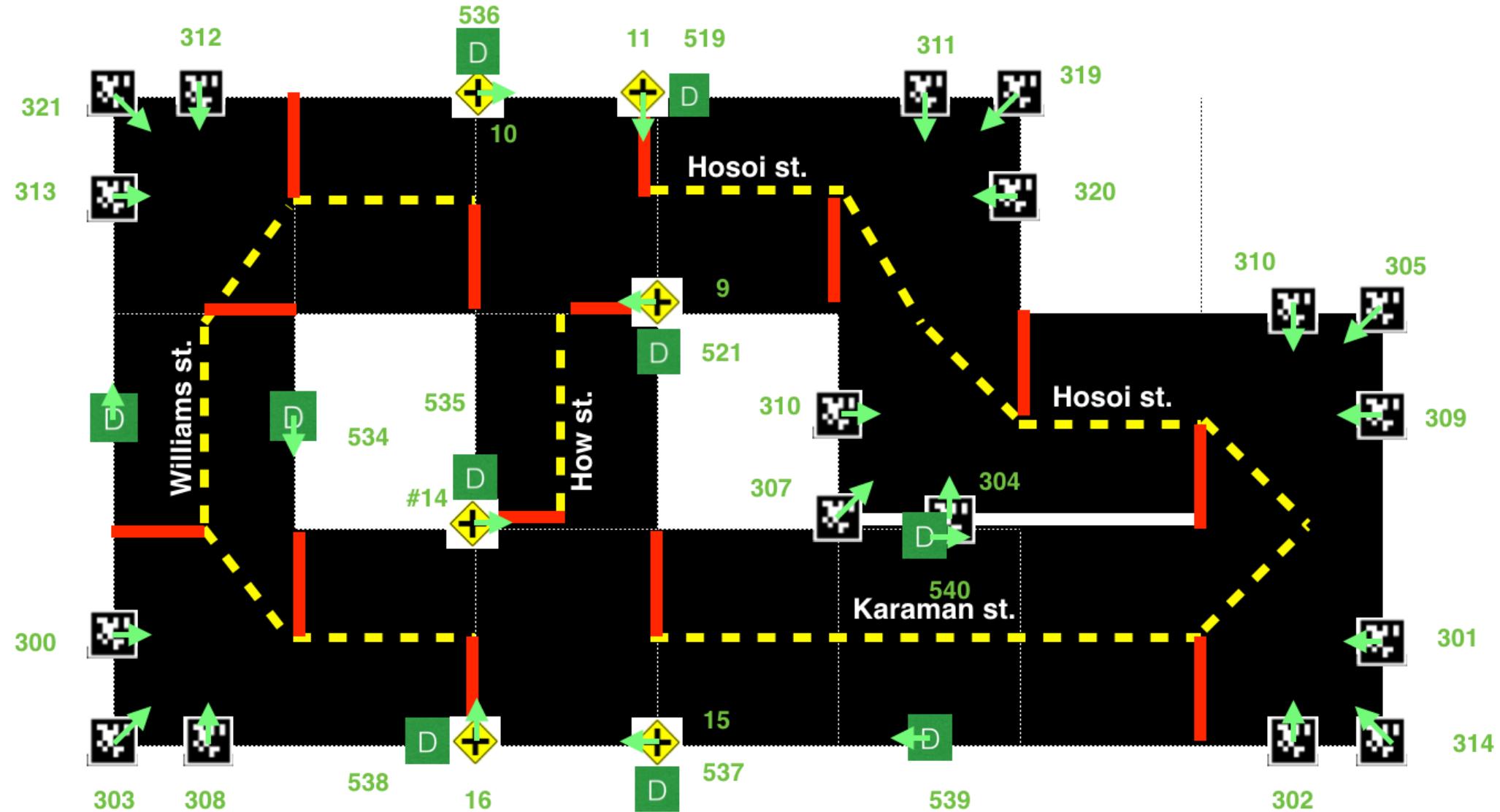


<http://duckietown.nctu.edu.tw/materials/paull-2017-icra-duckietown.pdf>

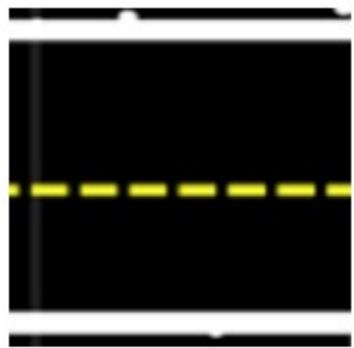
Duckiebot 所需零件



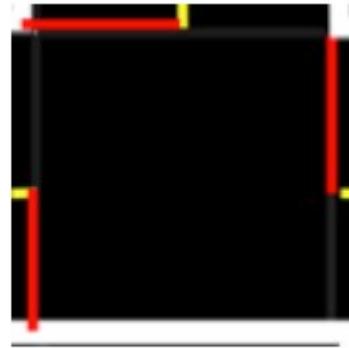
Duckietown 環境建立



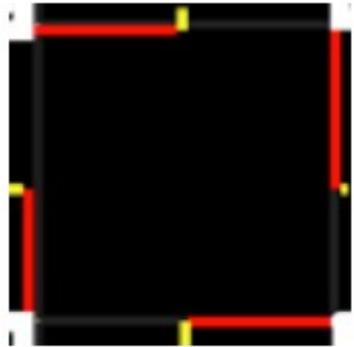
道路定義與信號定義



(a) straight



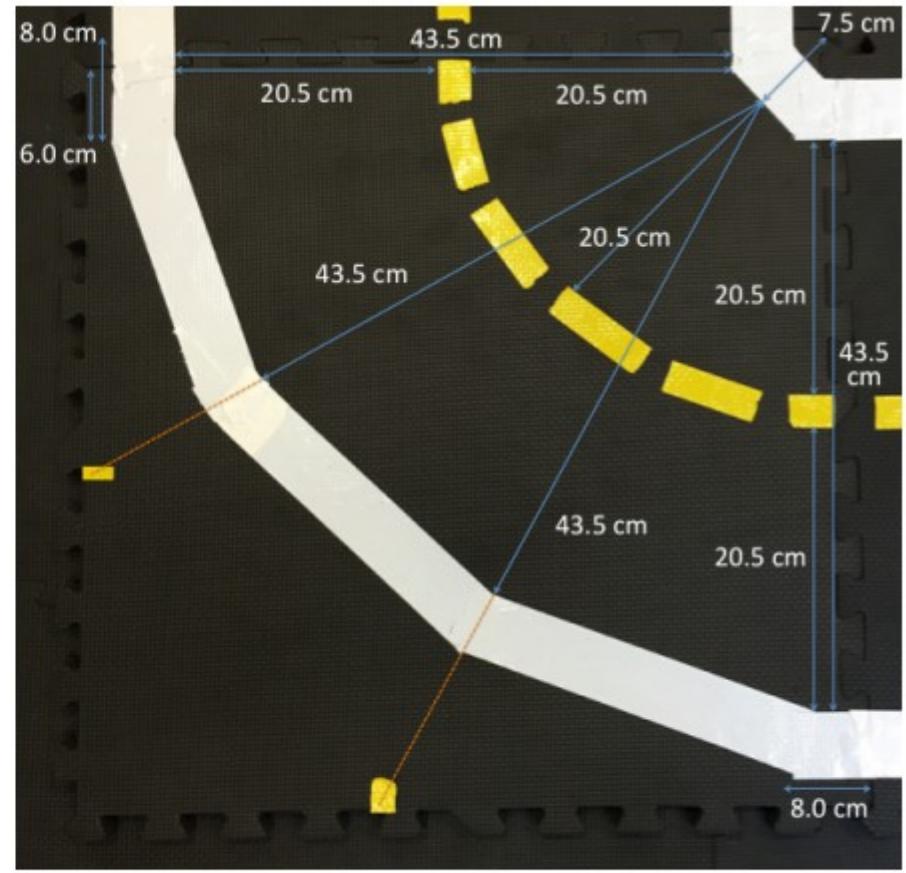
(b) 3-way



(c) 4-way

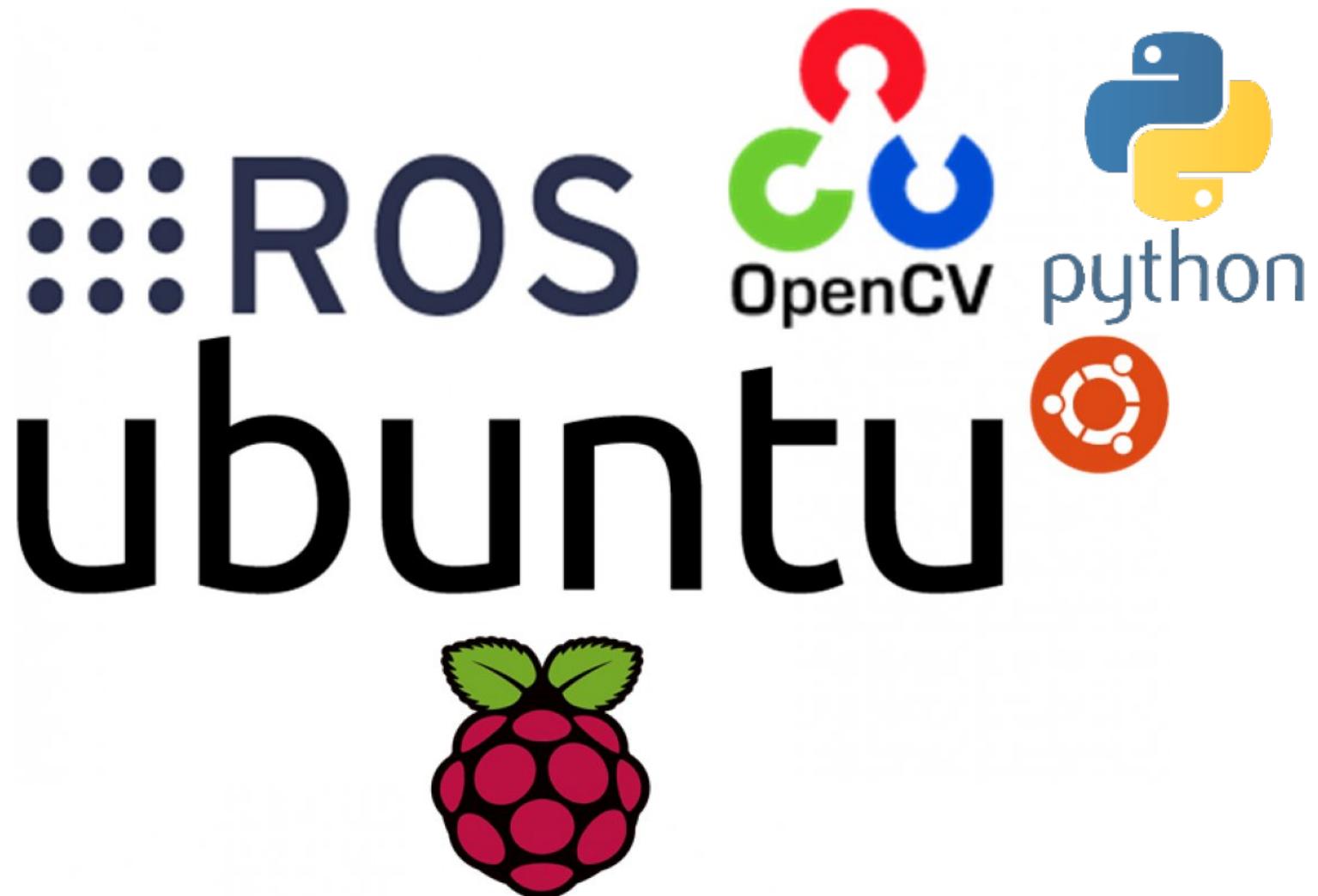


(d) empty



(e) turn

Duckiebot 系統堆疊



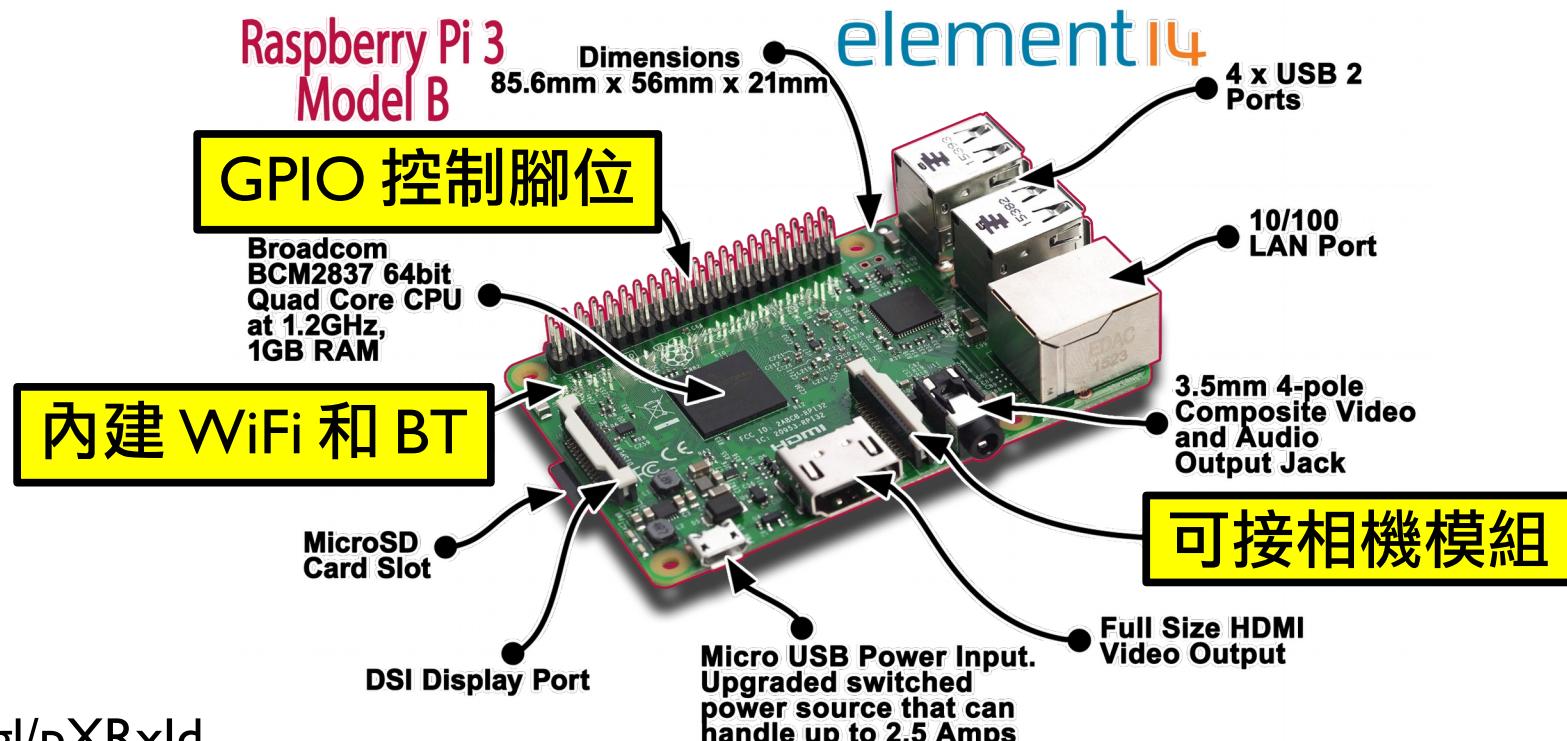
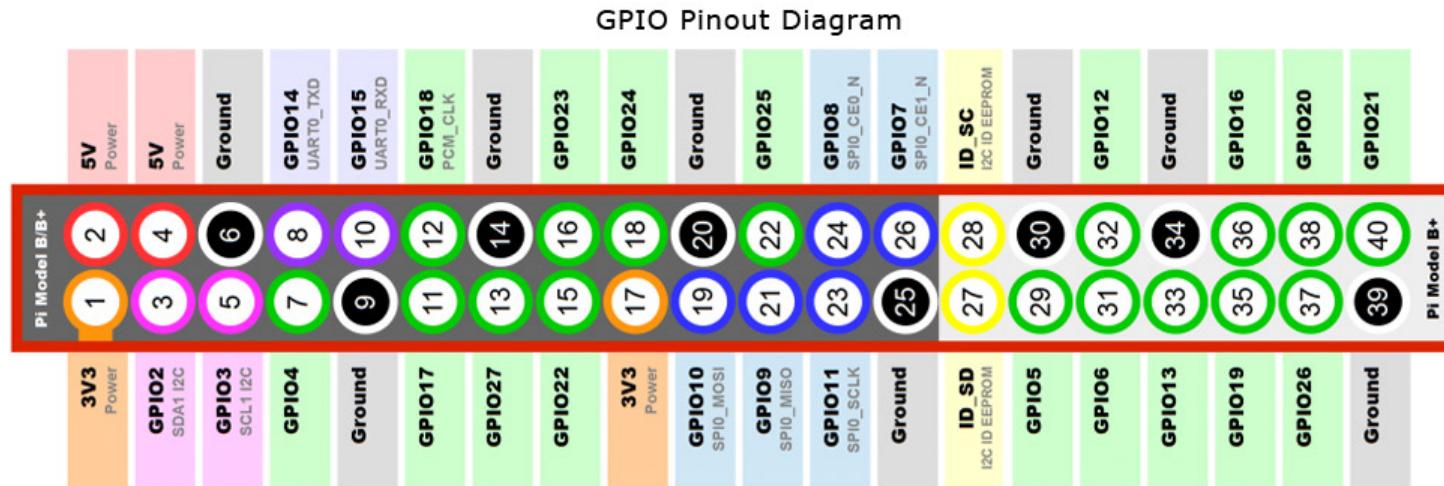
Raspberry Pi 是什麼？

- 信用卡大小般的電腦



<http://www.flickr.com/photos/fotero/7697063016/>

Raspberry Pi3 硬體規格與特色





FreeBSD®



gentoo linux™



KODI



webOS



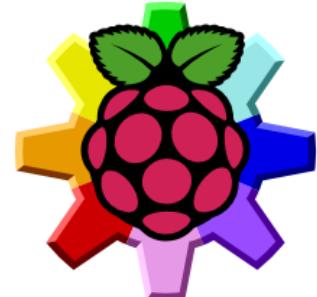
http://en.wikipedia.org/wiki/Raspberry_Pi

OpenWrt
Wireless Freedom



archlinux

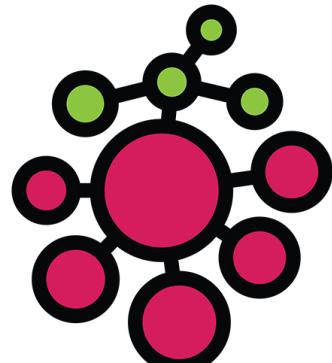
ubuntu MATE



RISC OS Pi



Firefox OS



一個機器人需要多少感測器？



測距、加(角)速度、電子羅盤、陀螺儀等

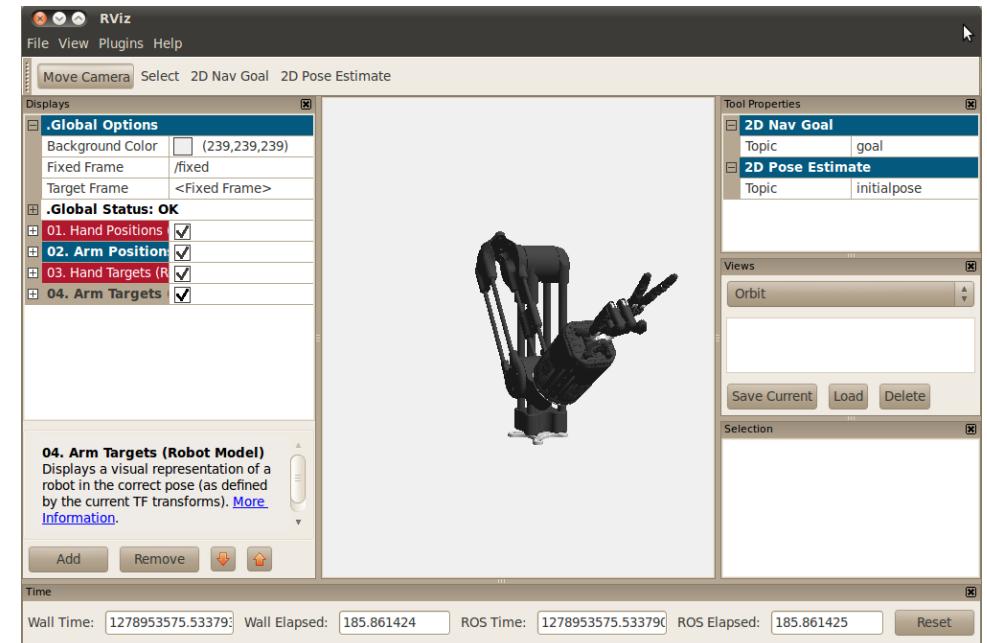
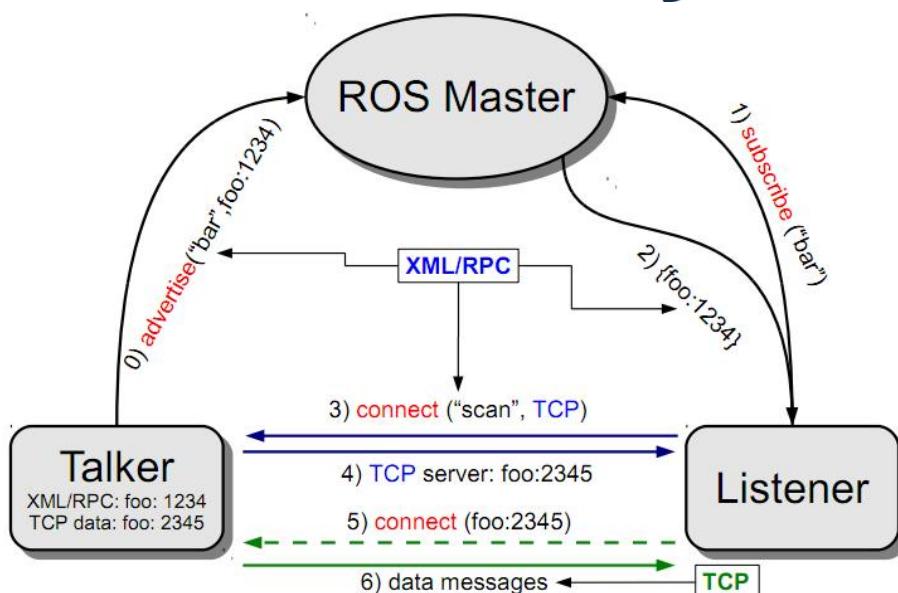


<http://site.robotclub.com.my/main/3150/index.asp?pageid=71406>

ROS

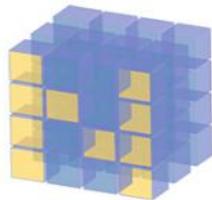
- 專為機器人軟體開發所設計的系統架構
- ROS= 訊息管道 + 組態工具 + 機器人功能 + 生態系統
- Python, C++, Lisp

 ROS.org



Python

- 提供基礎資料型別和各類矩陣運算函式
- 多種科學計算模組，例如線性代數，微積分，濾波等
- 可引用豐富的電腦視覺函式庫
- 互動式的編輯環境
- 深度學習套件



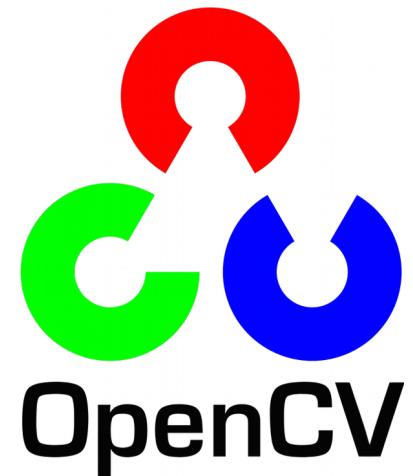
NumPy



SciPy

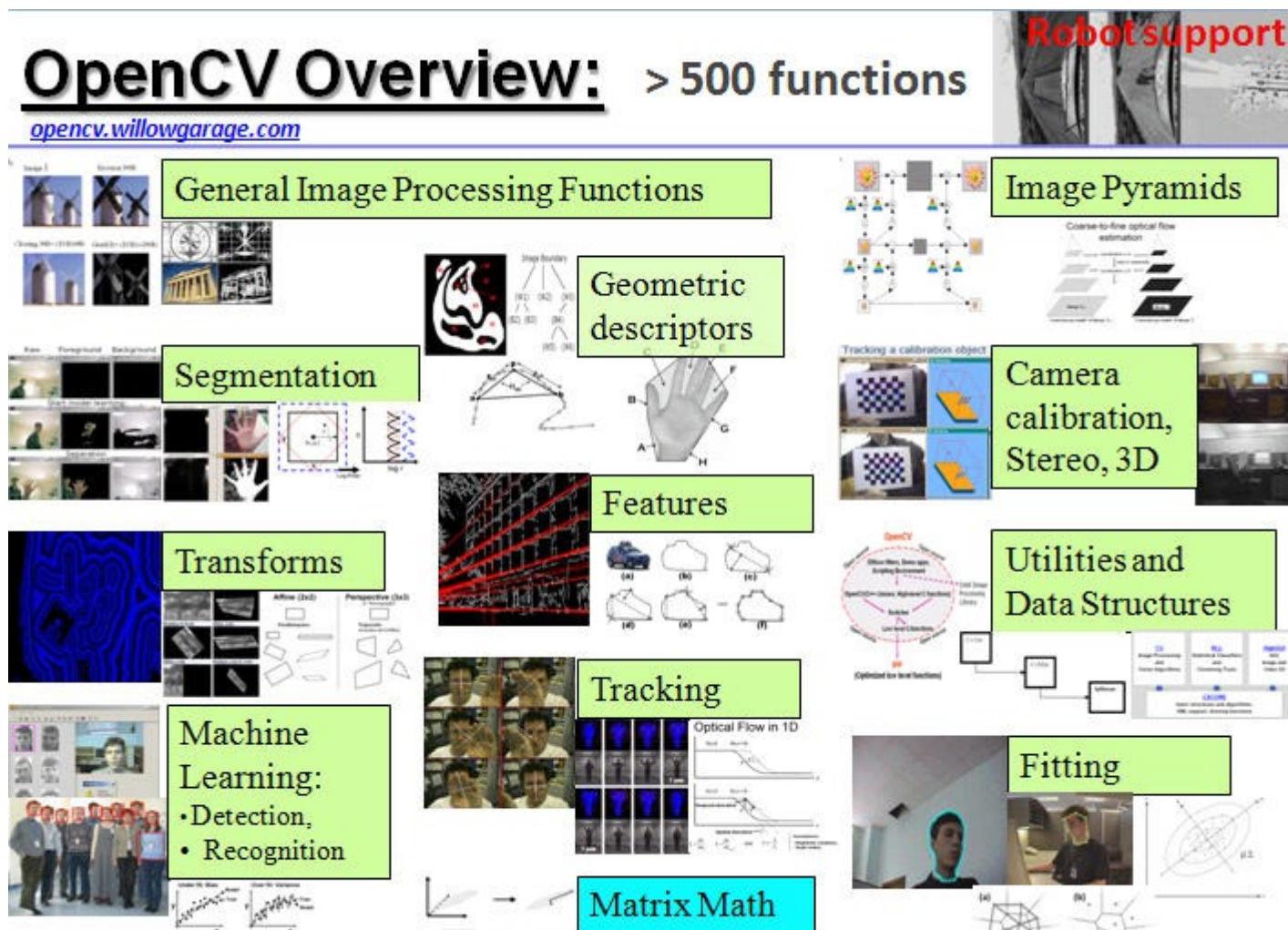
Caffe

IP[y]:
IPython

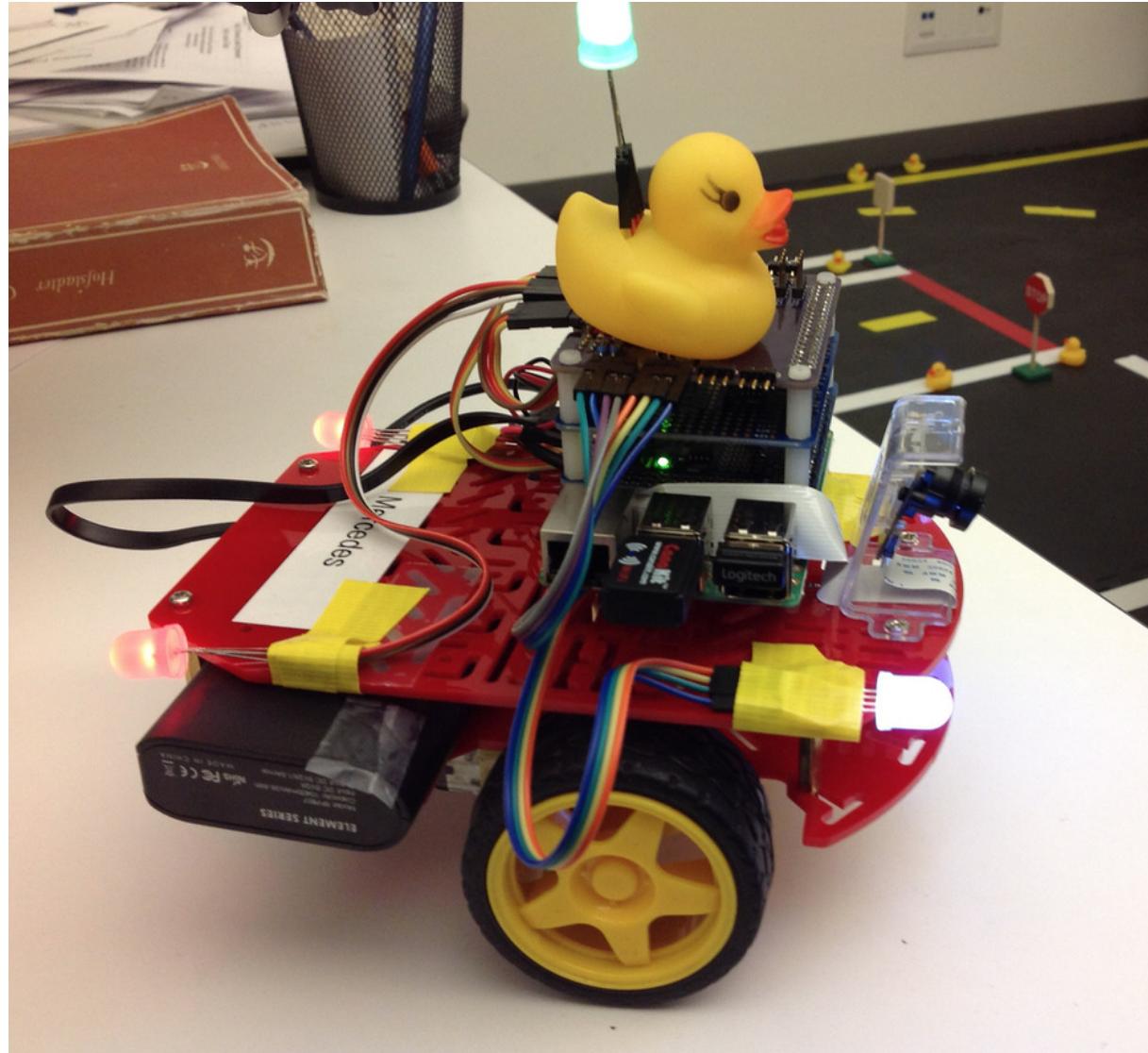


OpenCV

- 跨平台的電腦視覺函式庫，主要由 C/C++ 撰寫

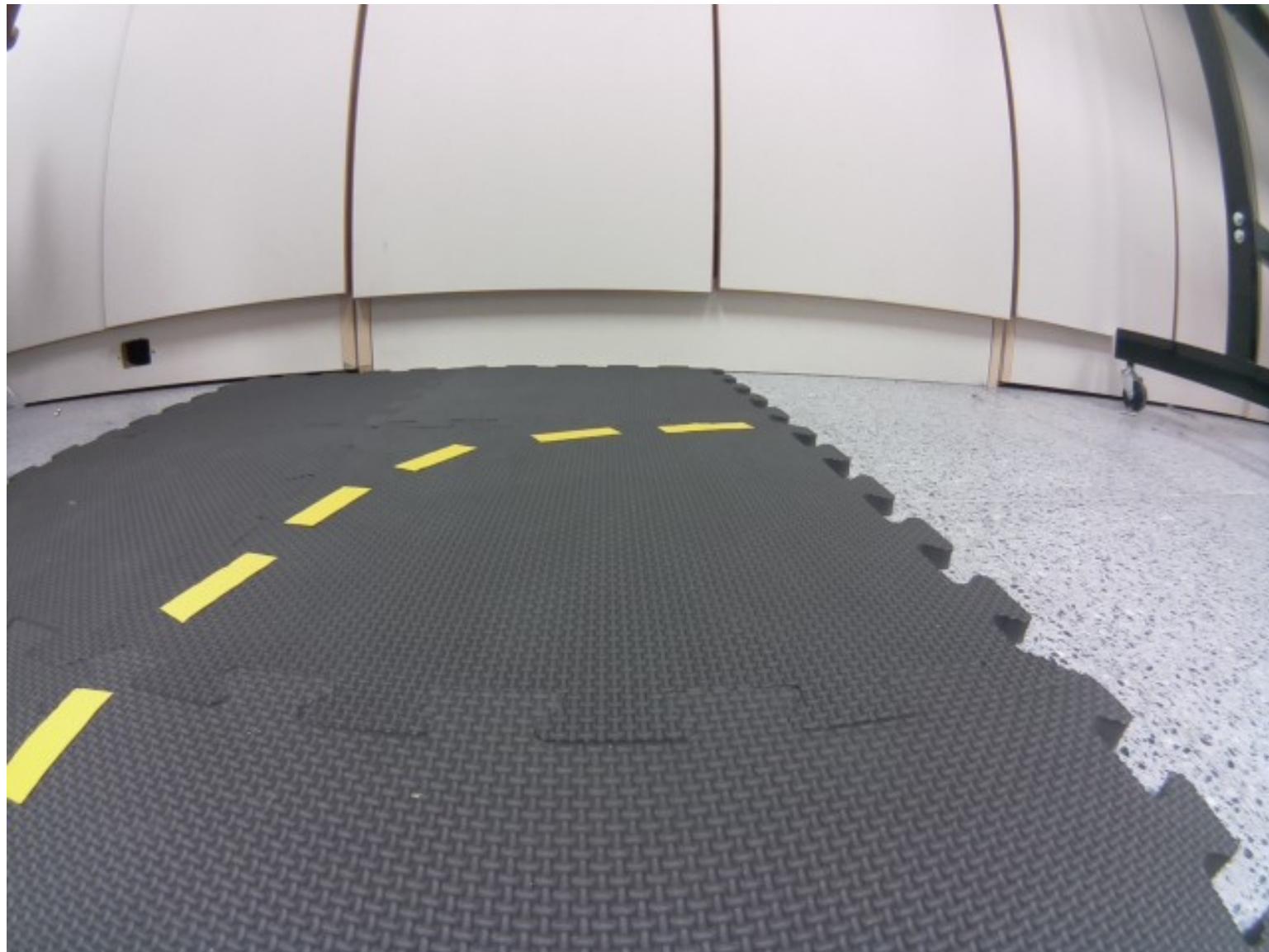


組裝完成的 Duckiebot 要上路啦

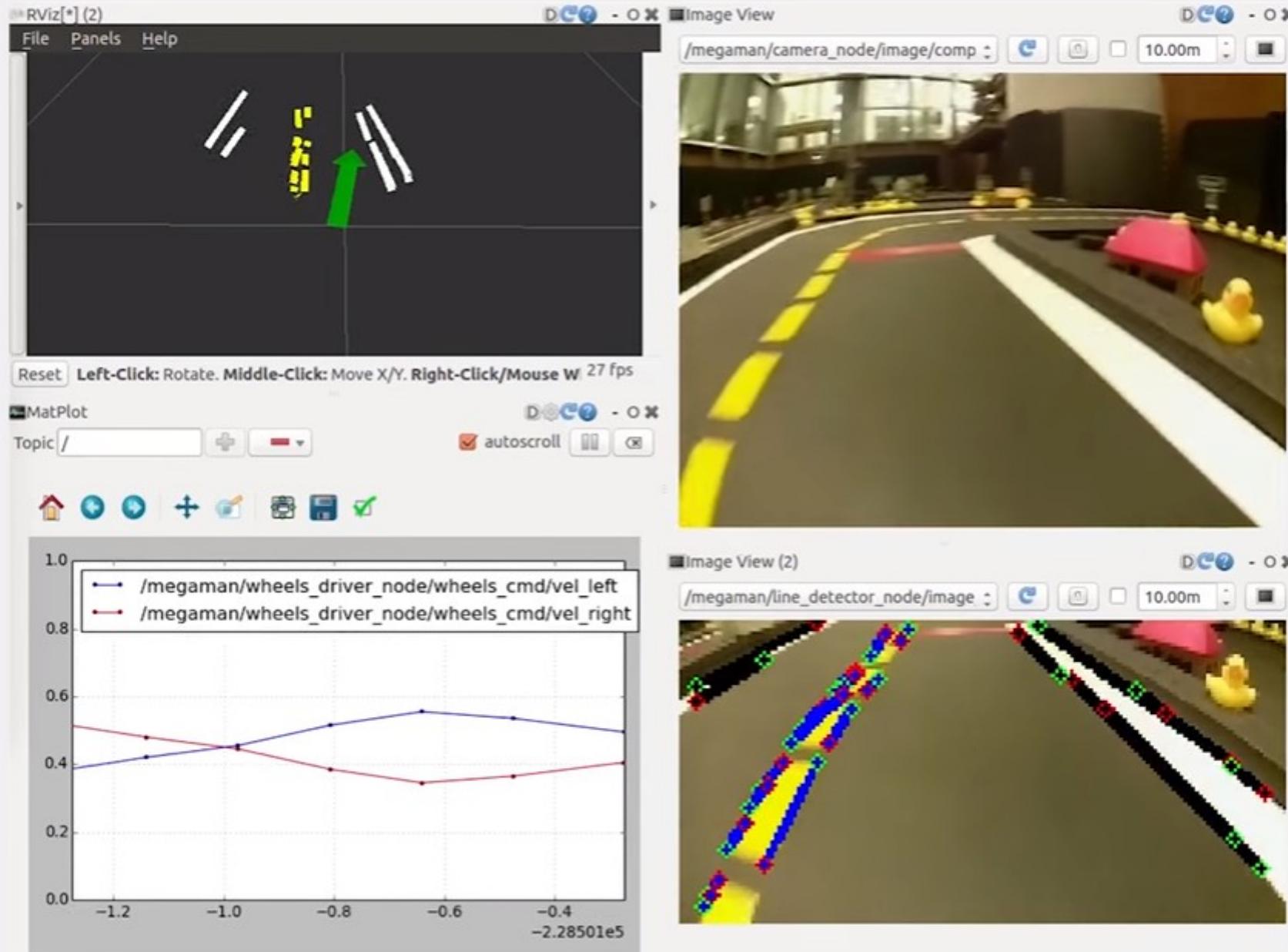


<http://goo.gl/KTMpuu>

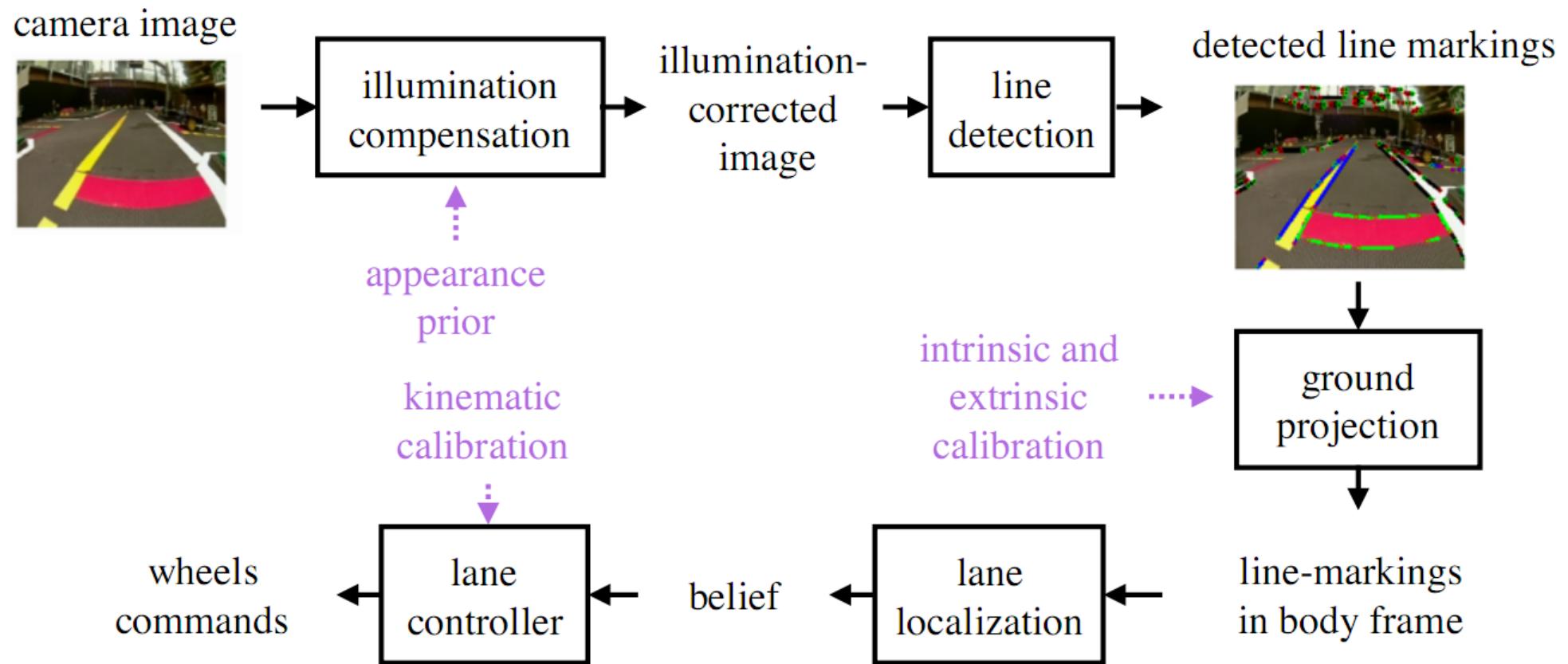
DuckieBot 看到什麼？



Cars have only a single onboard camera



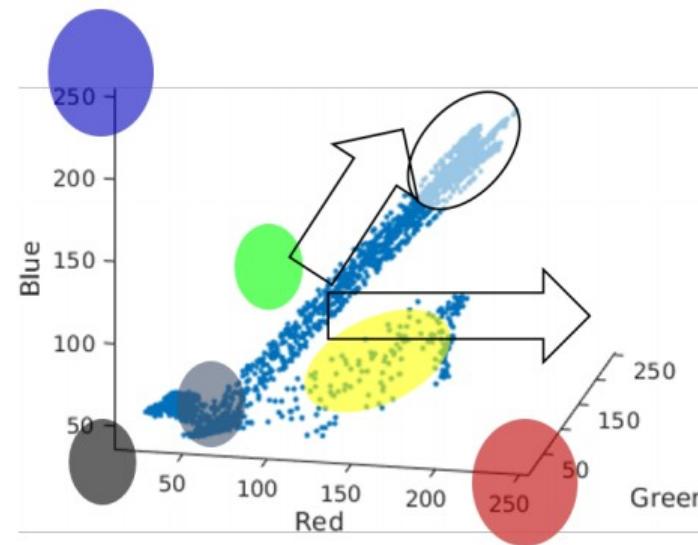
車道跟隨流程 (Lane Following Pipeline)



亮度補償 (Illumination Compensation)

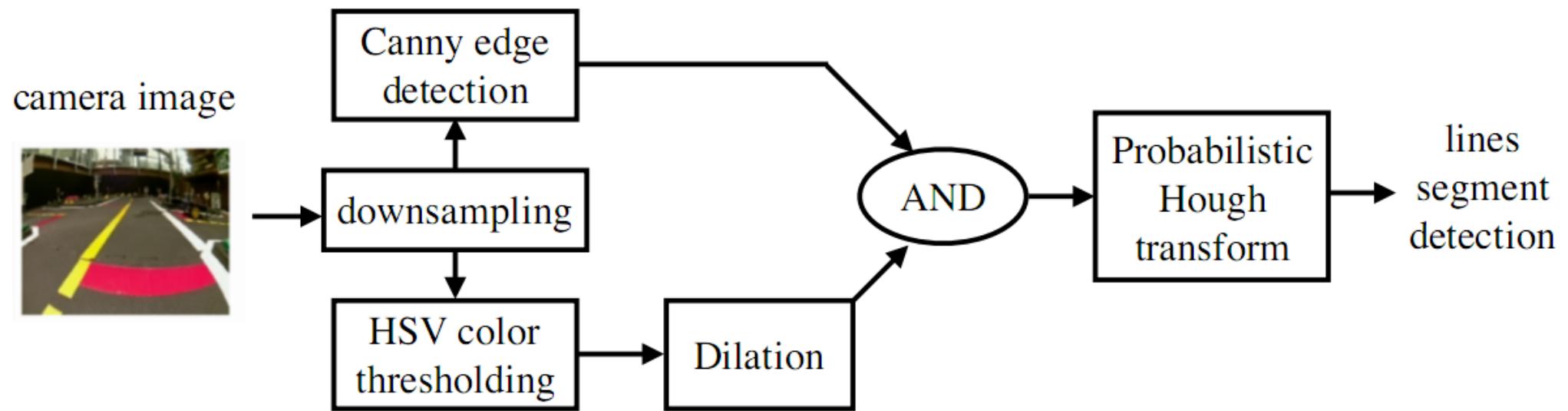


(a) before

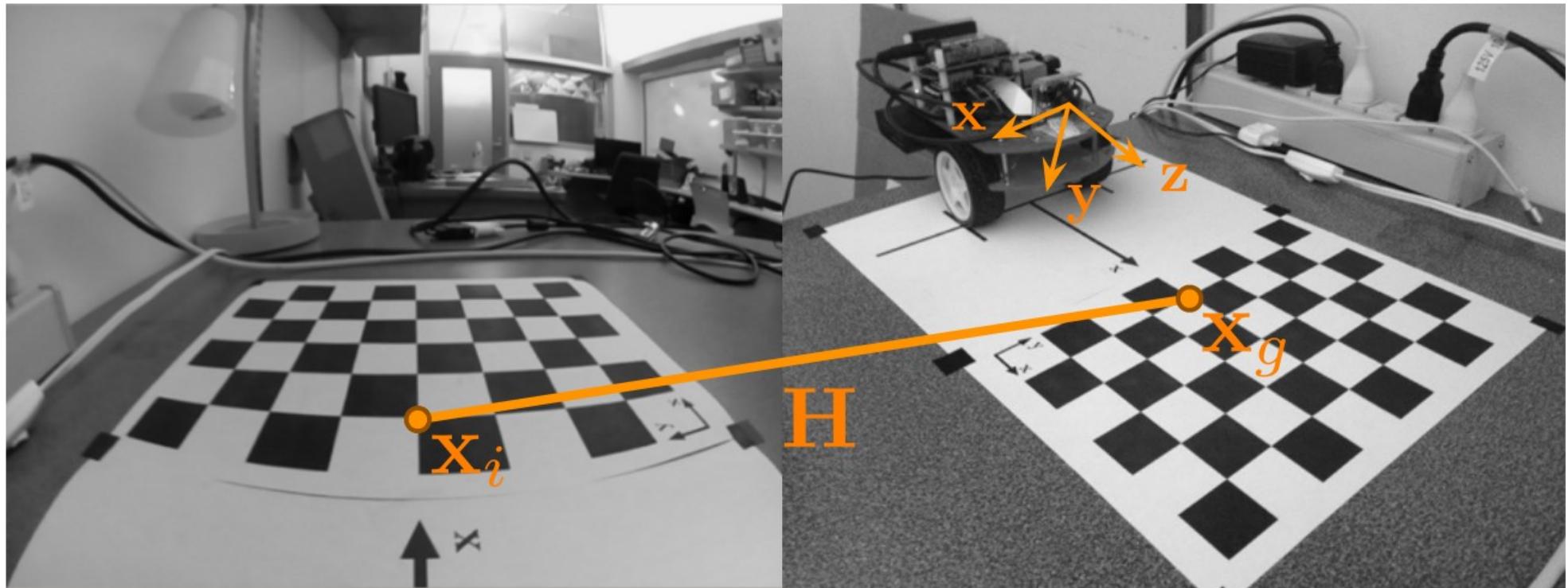


(b) after

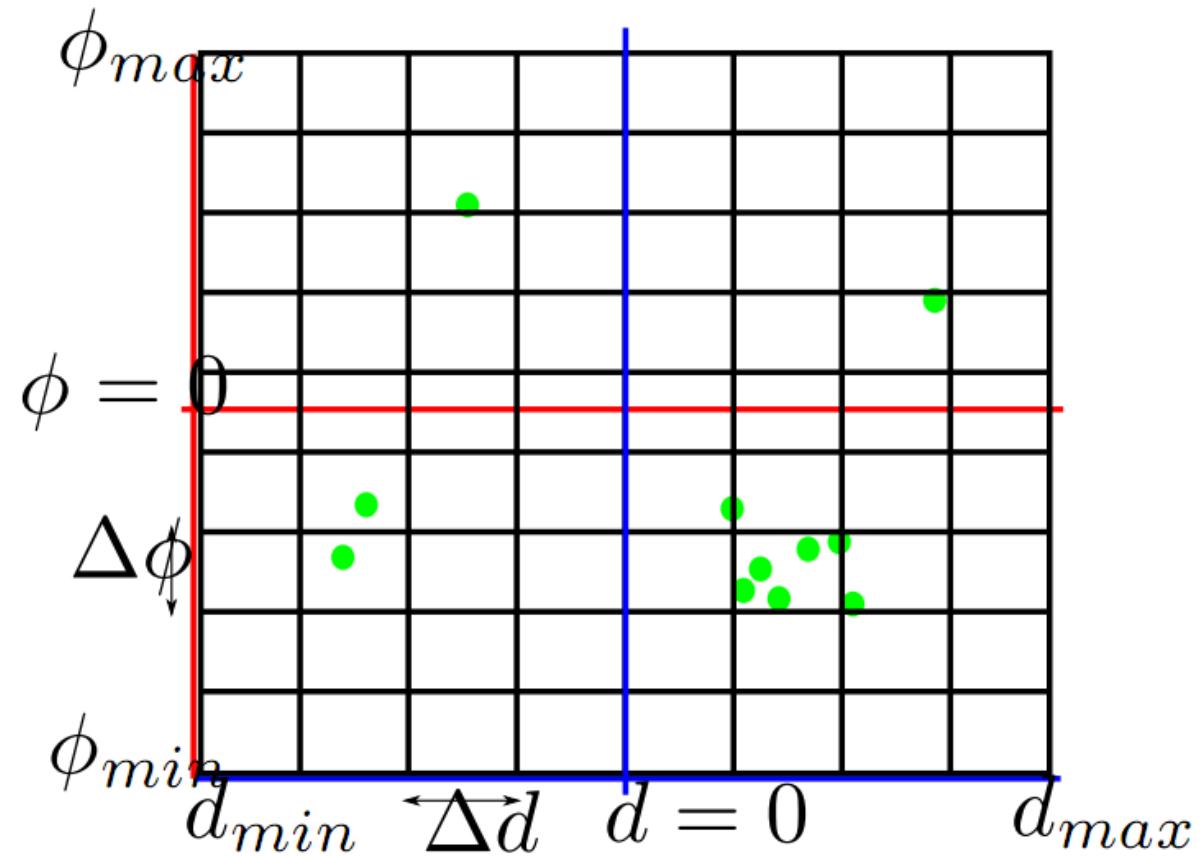
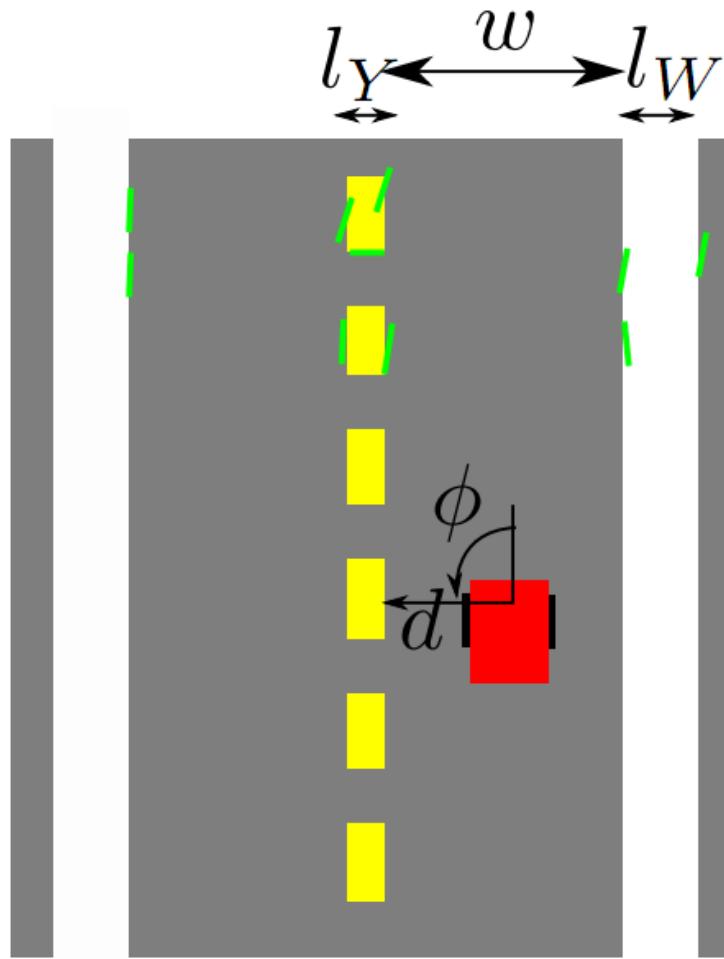
直線偵測 (Line Detection)



圖像到路的映射轉換 (Ground Projection)



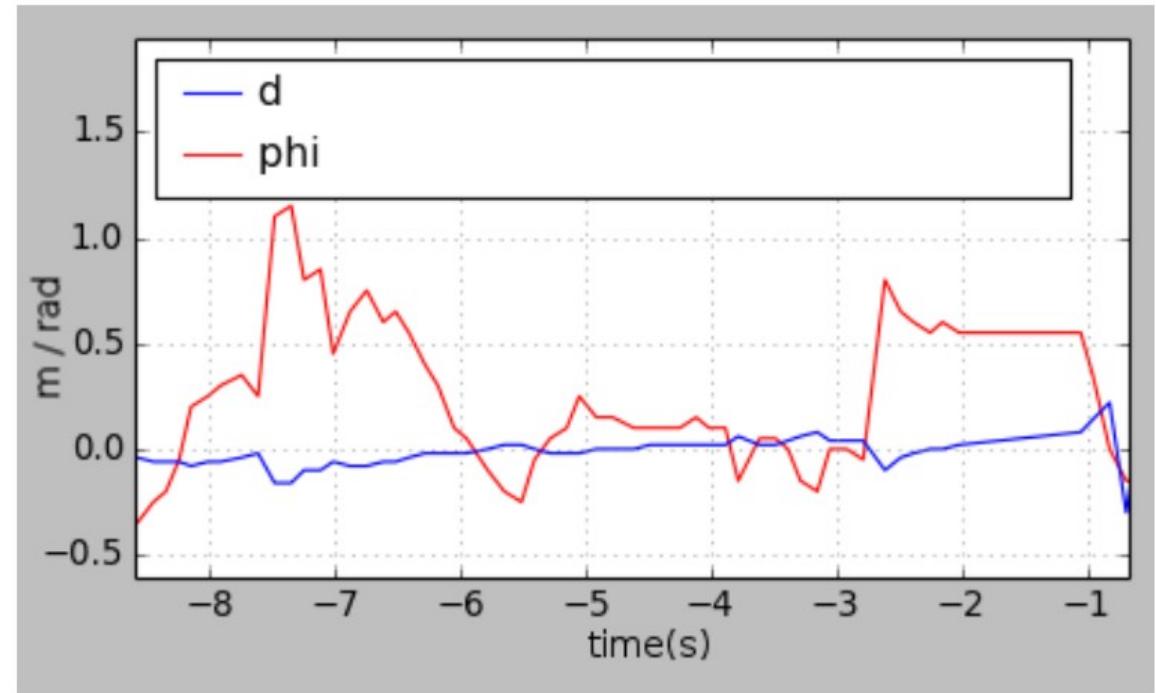
車道相對估計 (Lane-Relative Estimation)



車道控制 (Lane Controller)



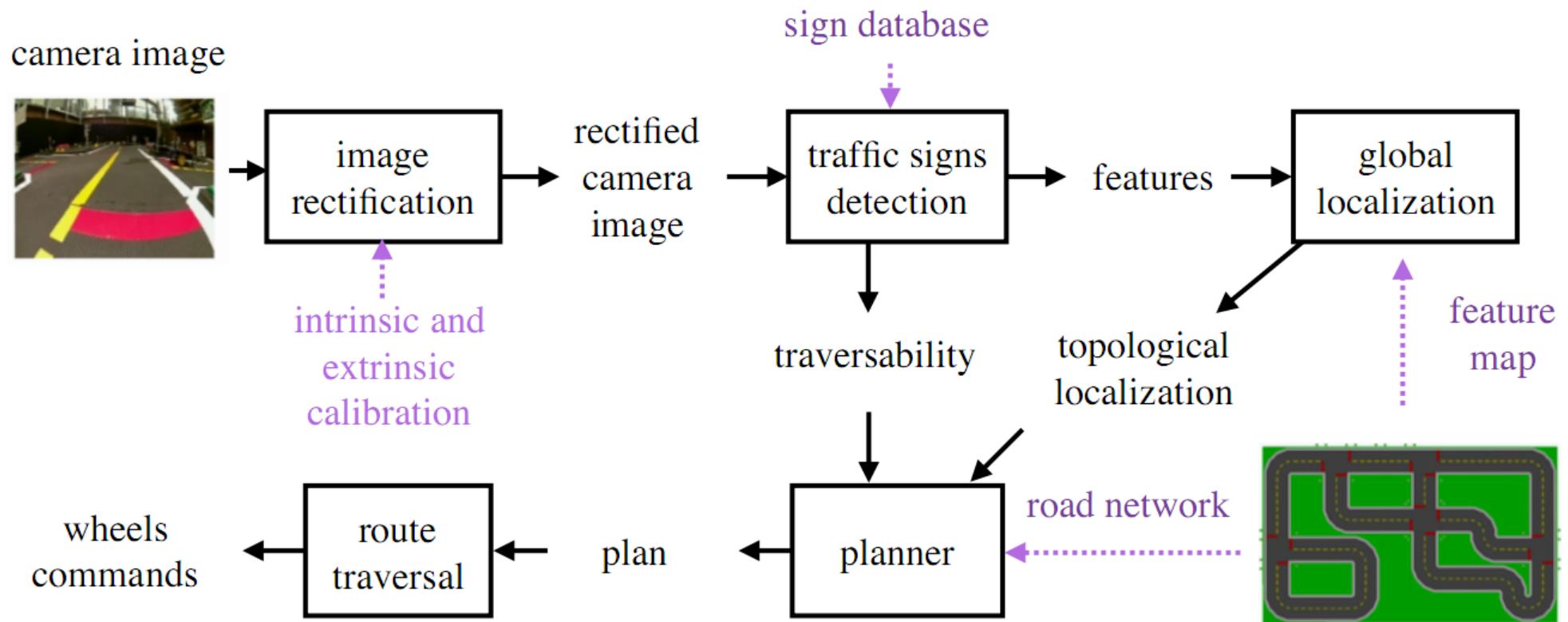
(a) test



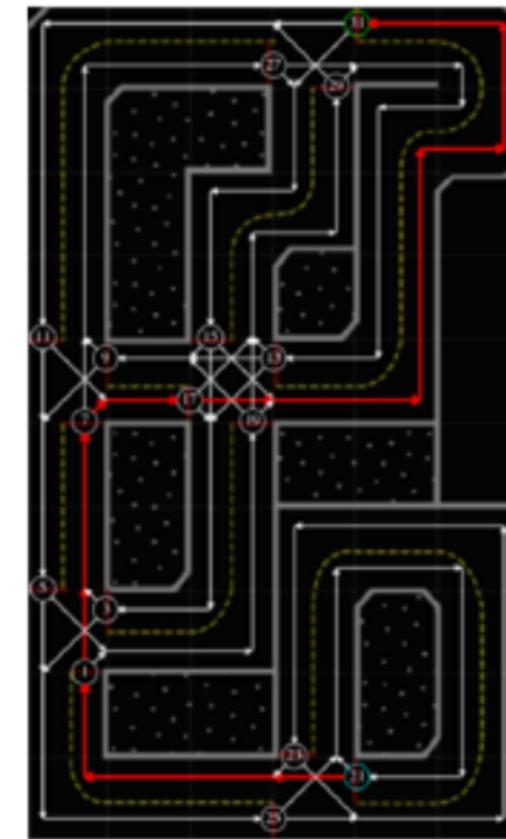
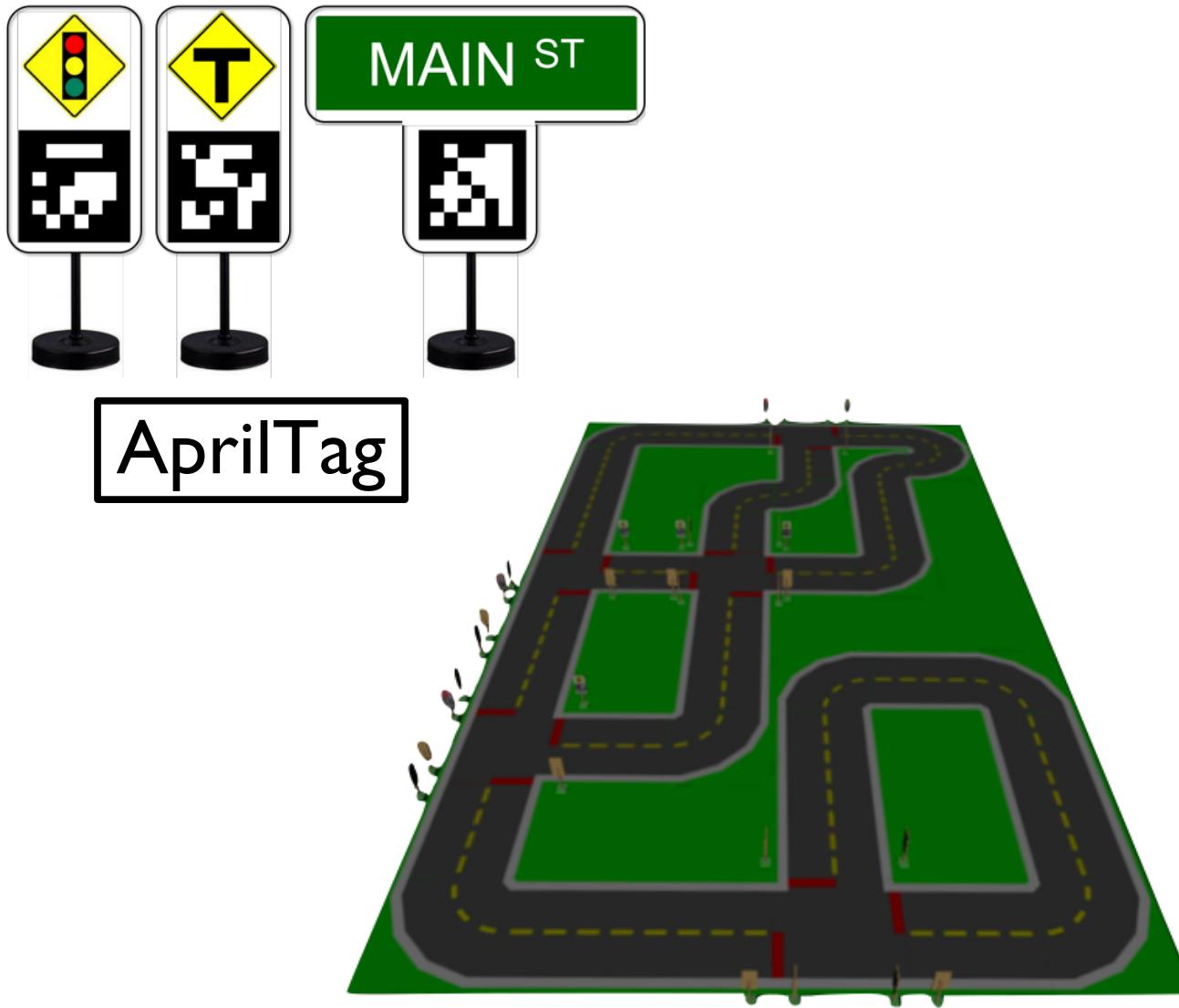
(b) performance

更多進階功能

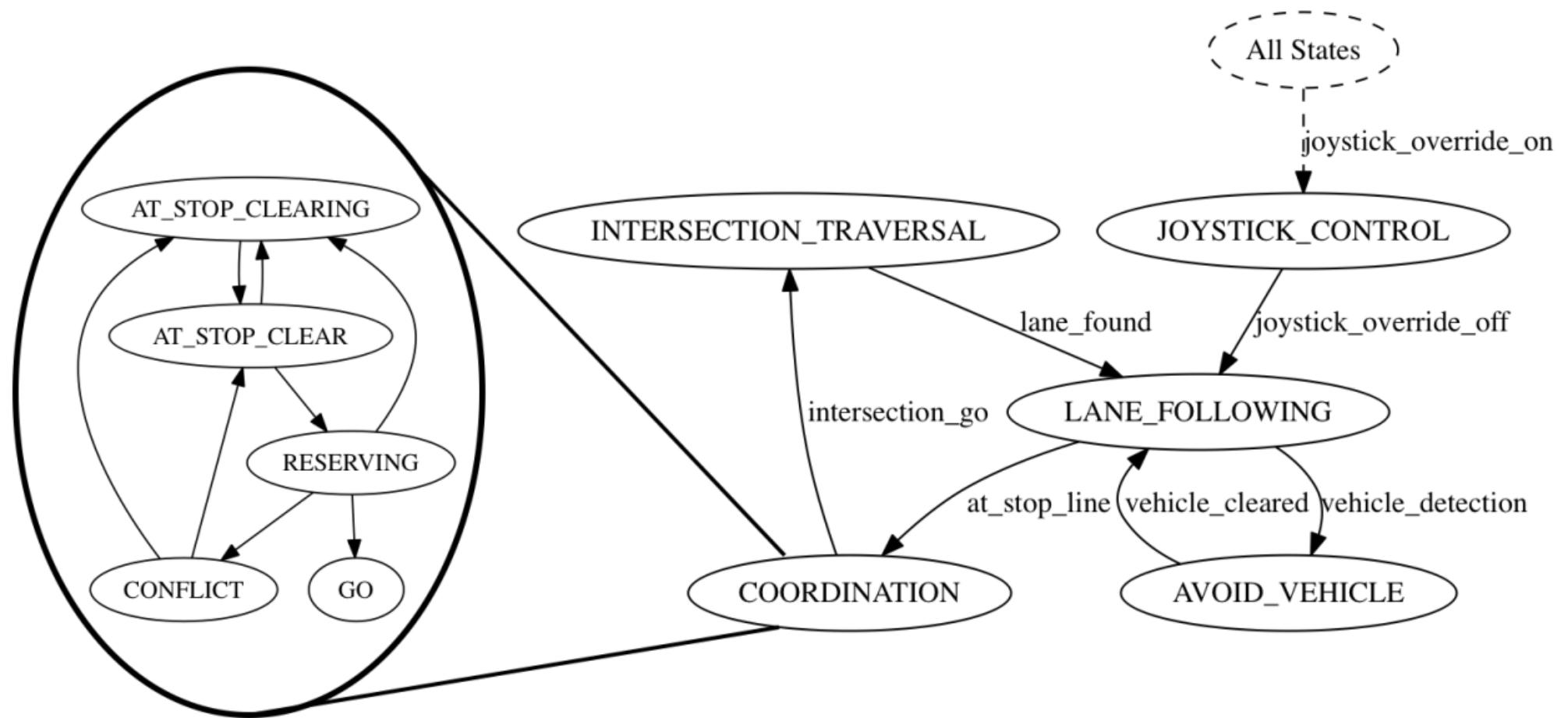
導航 (Navigation)



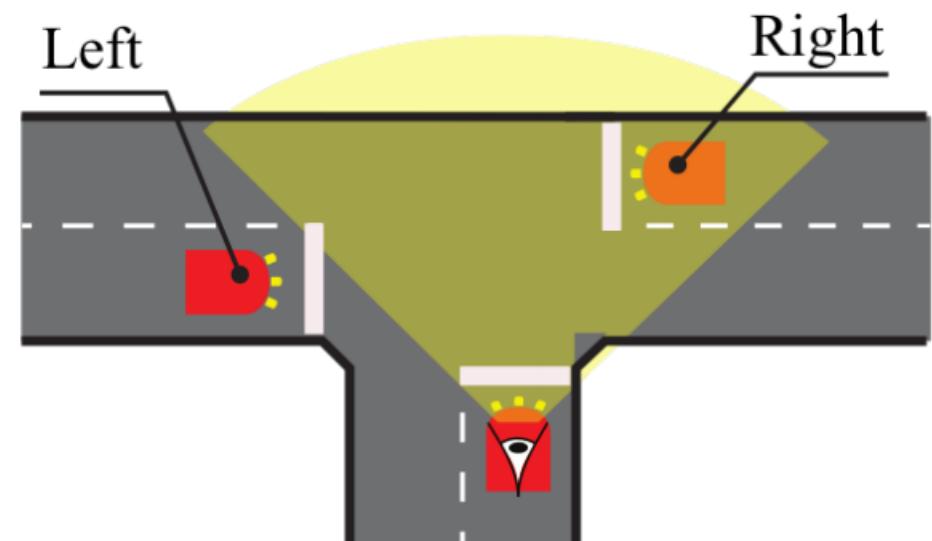
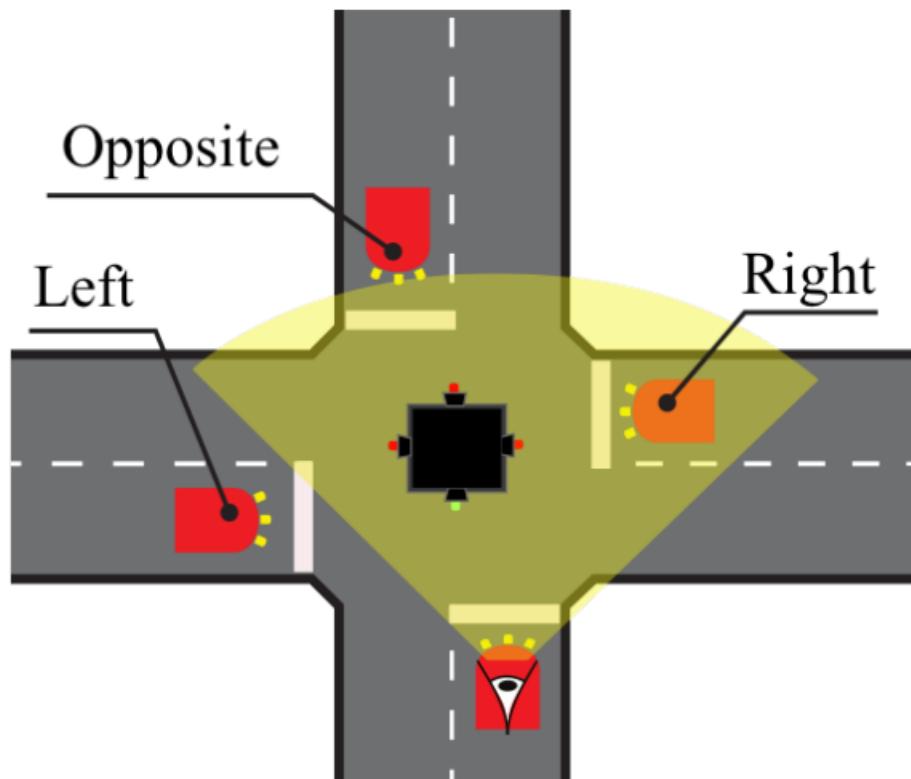
地圖與信號 (Map and Signs)



有限狀態機 (Finite State Machine)



多機器人協同 (Multi-robot Behaviors)



學習資源

MIT 2.166 Duckietown

- 使用 Pi 2 + ROS indigo + Virtualbox

The screenshot shows a web browser window with the title bar "Materials". The address bar displays a secure connection to <https://duckietown.mit.edu/materials.html>. The main content area is titled "Basic Setup Documents" in orange. Below the title is a list of 17 blue links, each preceded by a small blue folder icon:

- [Getting Started](#) : Start here your Duckietown experience.
- [Setup Step 0 - buy the parts](#) : purchasing all of the parts to build a Duckiebot
- [Setup Step 0.5 - soldering boards](#) : how to solder the boards for a Duckiebot
- [Setup Step 1 - assembling the Duckiebot](#) : all the information you need on assembling a Duckiebot
- [Setup Step 1.1 - reproducing the Ubuntu image](#) : the ubuntu image we are using on the Duckiebots
- [Setup Step 1.2 - traffic light assembly](#) : creating a custom Duckiebot traffic light
- [Setup Step 1.5 - burn the image](#) : burning a Duckiebot image onto an sd card
- [Setup Step 1.7 - setting up the Buffalo access point v2.0](#) : more information about that buffalo
- [Setup Step 1.8 - setting up Ubuntu laptops and the Duckietops](#) : all you could ever want to know about ubuntu duckietops
- [Setup Step 1.9 - Github basics](#) : how to commit and pull correctly
- [Setup Step 2.00 - from SD image to RC control](#) : how to get a remote controlled Duckiebot
- [Setup Step 2.05 - RC control, launched remotely](#) : did the remote control work? see why here!
- [Setup Step 2.1 - joystick + camera output in remote laptop](#) : getting camera output with that remote

<https://duckietown.mit.edu/materials.html>

Duckiebook

- 使用 Pi 3 + Ubuntu Mate + ROS Kinetic

The screenshot shows a web browser window titled "The Duckietown boo". The address bar indicates the page is not secure and shows the URL book.duckietown.org/master/duckiebook/index.html. The main content area displays the title "The Duckietown Book (Duckiebook)" in large, bold, dark font. Below the title, a subtitle reads: "From kits of parts to an autonomous fleet in 857 easy steps without hiding anything". To the left of the main content, there is a sidebar containing a list of links labeled "Part A" through "Part X", each describing a different aspect of the project or documentation. At the bottom right of the page is a yellow cartoon duck logo.

Part A - The Duckietown project
Part B - Duckumentation documentation
Part C - Operation manual - Duckiebot
Part D - Operation manual - Duckietown
Part E - Duckiebot - DB17-1c configurations
Part F - Operation Manual - demos
Part G - Preliminaries
Part H - A course in autonomy
Part I - Exercises
Part J - Software reference
Part K - Software development guide
Part L - Duckietown system
Part M - Fall 2017
Part N - Fall 2017 projects
Part O - Packages - Infrastructure
Part P - Packages - Teleoperation
Part Q - Packages - Lane control
Part R - Packages - Indefinite navigation
Part S - Packages - Localization and planning
Part T - Packages - Coordination
Part U - Packages - Additional functionality
Part V - Packages - Templates
Part W - Packages - Convenience
Part X - Packages - Deep Learning

<http://book.duckietown.org/master/duckiebook/index.html>

Duckietown 交大分支

Duckietown NCTU x

Secure | https://duckietown-nctu.github.io/index_ch.html

首頁 專案 成員 研討會課程 暑期學校 課程教材

首頁 EN中文

什麼是 Duckietown?

1. 一堂在國立交通大學開立的課程
2. 一個研究型任務課程
3. 一個與一般課程不同的學習經驗
4. 一個開源且可以重複思考的課程
5. 低成本、高經濟價值
6. MIT duckietown的第一個分支



A photograph showing a large group of approximately 30-40 students standing in a room. They are positioned behind a long, grey rectangular table that has a black racing track on it. Several small, red and yellow robot cars are on the track. The room has a polished wooden floor and fluorescent lighting on the ceiling.

<https://duckietown-nctu.github.io/>

交大軟體創意專題

國立交通大學開放式課程

Not secure | ocw.nctu.edu.tw/course_detail-c.php?bgid=8&gid=0&nid=557&pid=887

English | 聯絡我們 | 相關連結 | 網站導覽 | 常見問題 | 交大首頁



軟體創意專題 Creative Software Project (English)

課程專區

理學院

單元主題

- 單元1 Introduction to Creative Software Project
- 單元2 Self-driving Car Related Projects
- 單元3 Assitive Technology Related Projects
- 單元4 Duckietown Architecture
- 單元5 Duckietown Line Detector Python & CV
- 單元6 Python Tutorial & Lane Filter
- 單元7 Lane Filter : Bayes' Filter
- 單元10 Object Detectors
- 單元11 Path Planning
- 單元12 Problem Formulation
- 單元13 Duckietown Unit Test
- 單元14 Duckietown Description

課程綱要

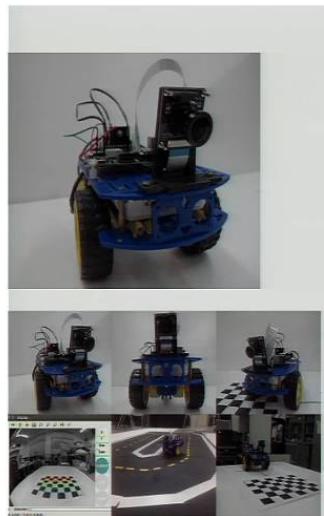
課程目標/概述

This course aims at developing software projects usable in real-world, and focuses on "learning by doing," "team work," and "research/startup oriented." We will cover fundamental and advanced development tools (git, ROS, OpenCV) in C++ or Python through "Duckietown," an open course "MIT 2.166 Autonomous Vehicles." Students are also welcome to form own teams and propose software projects (Android etc).

http://ocw.nctu.edu.tw/course_detail-c.php?bgid=8&gid=0&nid=557&pid=887

Duckietown Bunny

- Fork from MIT duckietown
- Pi 2/ Pi 3 + Ubuntu Mate + ROS Kinetic
- 使用 L298N 馬達驅動板



Autonomous car base on ROS

a fork from MIT autonomy open-source class
duckietown <http://duckietown.mit.edu/>
we prefer to introduce it as a material for
learning ROS.

ubuntu®
16.04



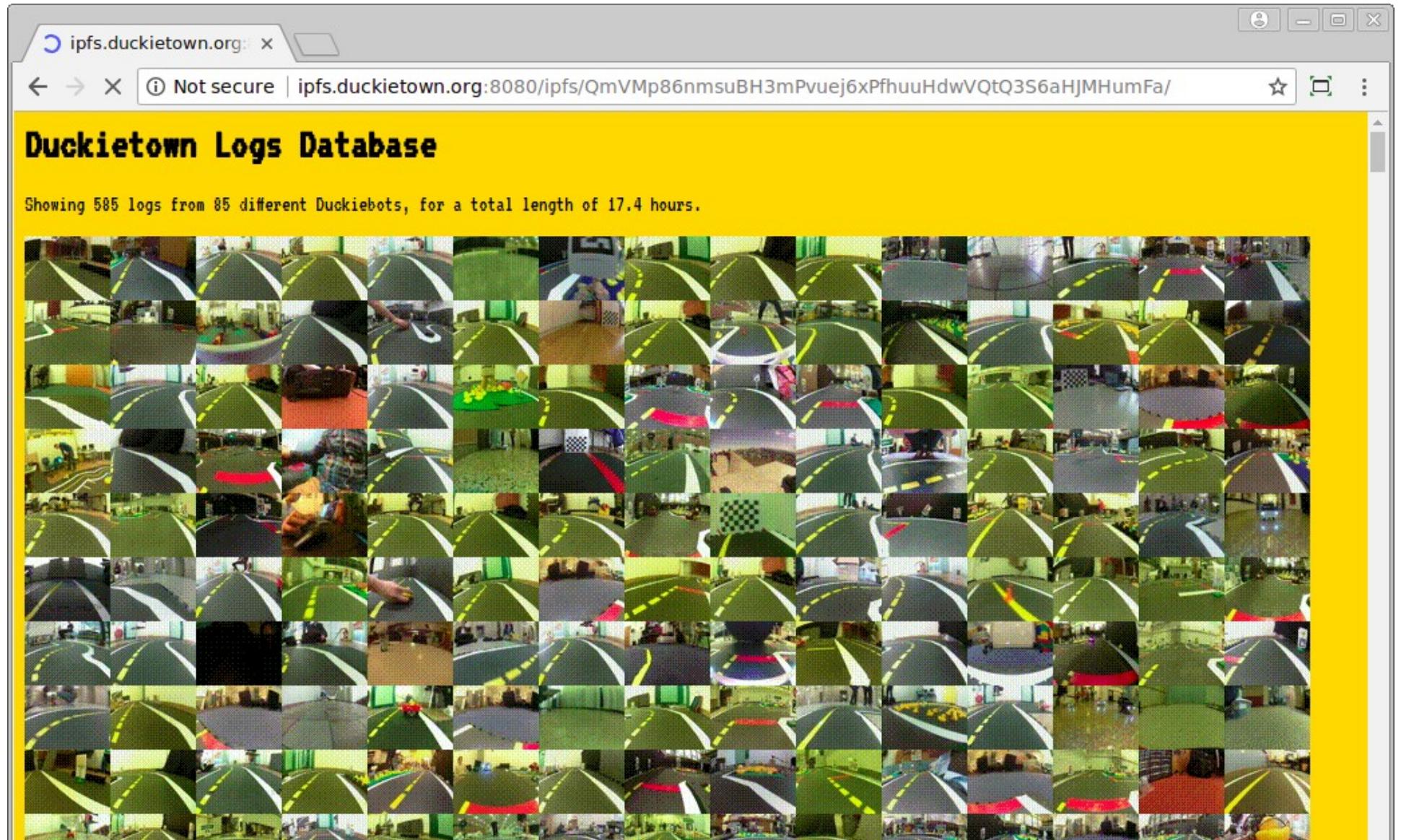
Video Recordings Supported By **ubuntu®**

<http://roscon.ros.org/2016>

<https://www.duckietown-bunny.com/>

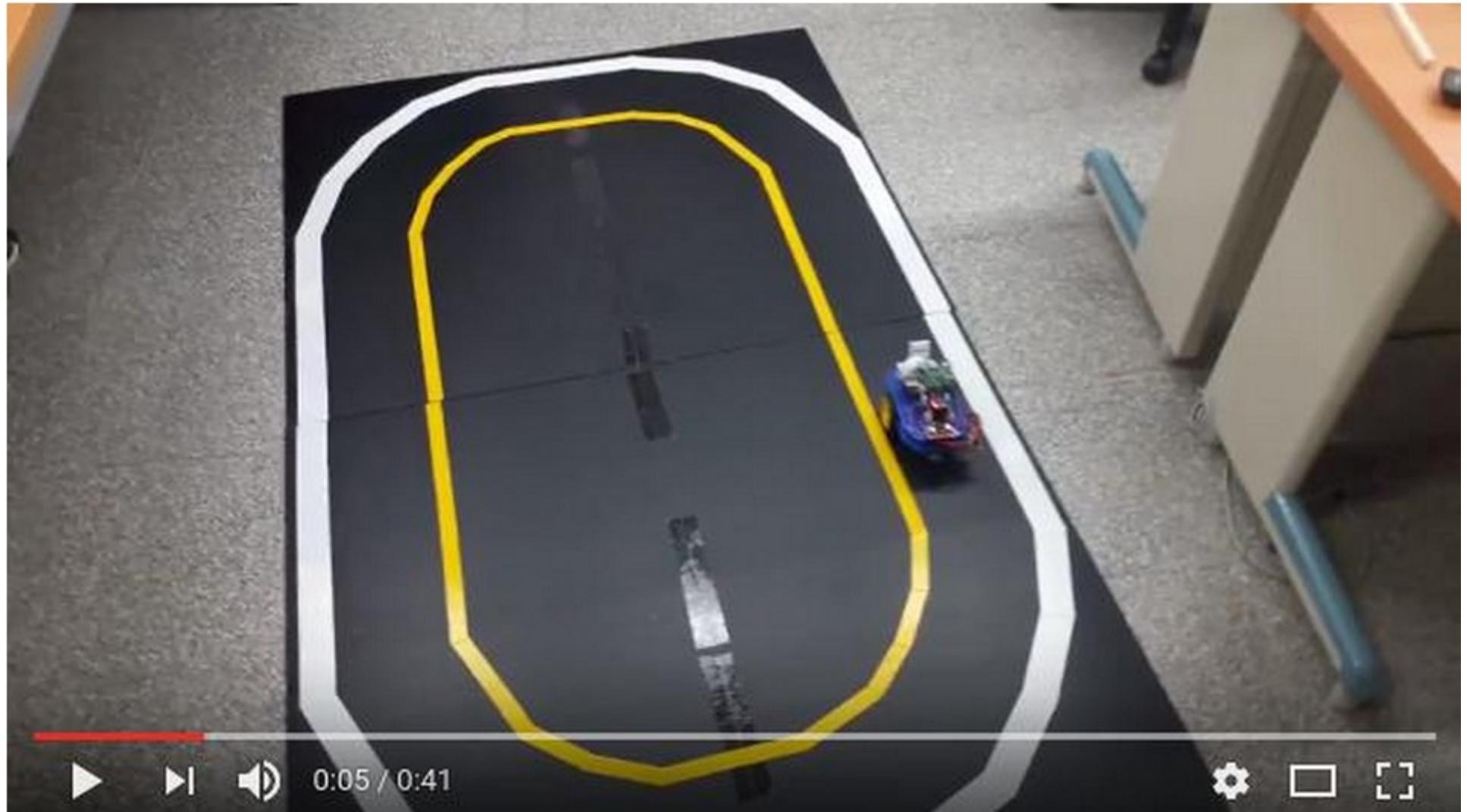


Duckietown Logs Database



<http://ipfs.duckietown.org:8080/ipfs/QmVMp86nmsuBH3mPvuej6xPfhuuHdwVQtQ3S6aHJMHumFa/>

延伸專案： Puyuma Linux real-time extensions



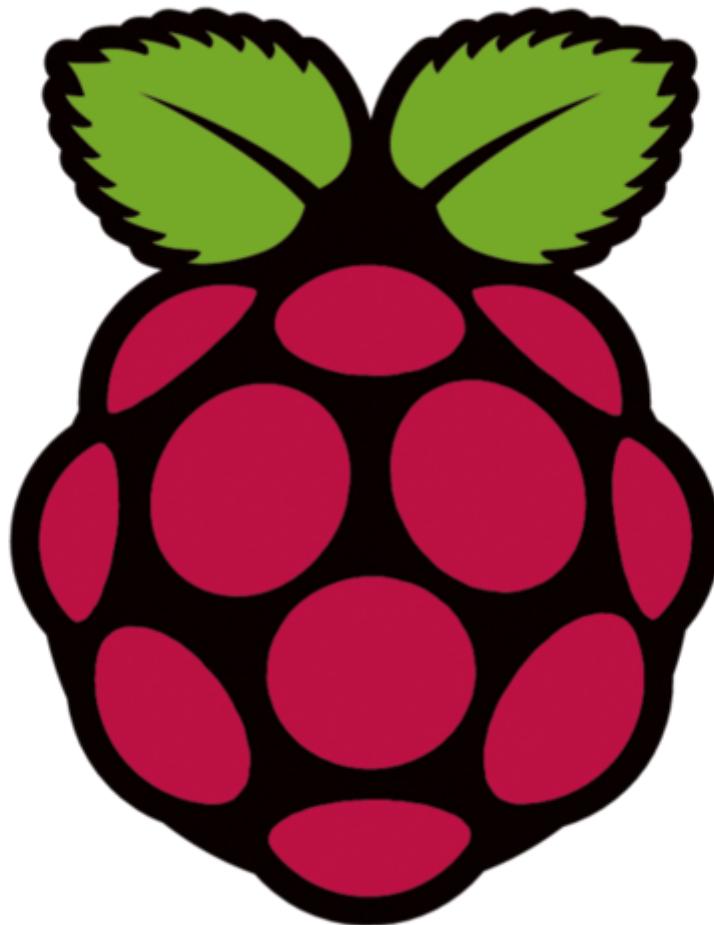
<https://github.com/Puyuma/puyuma-core/blob/master/README.md>

感謝

- Jeffrey Liu
- Jessica Wu
- YuehChuan "Johnson" Chang
- Nick Wang

DEMO

Raspberry Pi Rocks the World



Thanks