The Journey of Local Innovation and Invention of the Intelligent Road Works Robot: The Roadbot

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Maintenance of the Hong Kong Road Network

- High traffic volume in the Hong Kong road network

- Works to maintain the roads often have to be carried out late at night when:
  - Visibility is not as good as daytime
  - Vehicle speed is often higher
  - Drivers could be tired

- Risk of live traffic runs into road works sites

Traffic Accidents Involving Road Works

- Safety of construction workers is always top priority of Highways Department
- Explore the use of technology to:
  - Take over higher risk operations from workers
  - Minimize workers' exposure to live traffic

Automatic Cone Laying Machine - Products Search

- Setting up and removal of road works sites are amongst the higher risk operations
- In Hong Kong, the Code of Practice (CoP) requires road works to:
  - Place and collect traffic cones up to 1 m high
  - Place and collect lanterns intermittently on cones
  - Place and collect cones in:
    - taper layout
    - parallel to road markings

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Automatic Cone Laying Machine - Products Research

- 8 systems available in the markets studied
  - The Netherland, Sweden, Switzerland, the UK, and the USA
- The systems had difficulty to:
  - Place and collect cones of 1 m high
  - Place and collect lanterns on cones
- Most of them could not place and collect cones in taper layout

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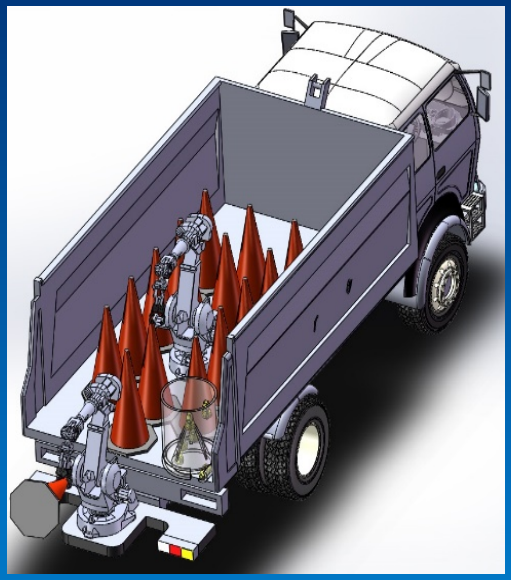
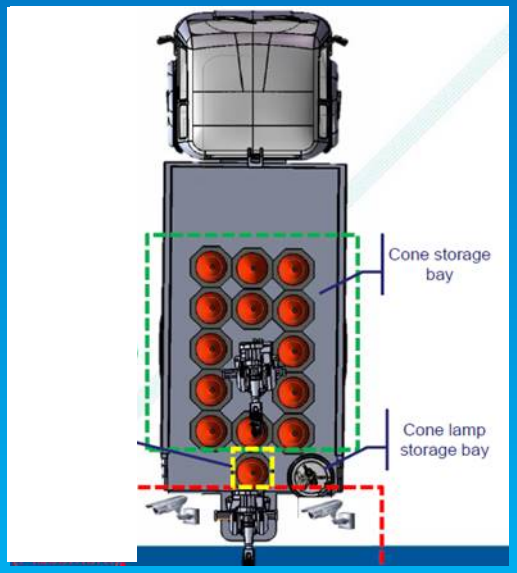
Automatic Cone Laying Machine - Our Own Solution

- Highways Department therefore:
  - Formulated our own cone laying machine
    - Using robot arms and sensors
    - Meeting all Hong Kong requirements
  - Initiated research to develop our road works robot locally
    - With the Hong Kong Productivity Council

Our Automatic Cone Laying Machine - The Concept

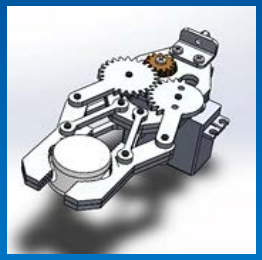
- 2 robot arms with cameras and sensors on works vehicle
- On-board computer to:
  - Provide cognitive abilities
  - Control the arms to handle cones and lanterns
  - Coordinate with the driver





Our Automatic Cone Laying Machine - From Concept to Prototype

- Explore suitable robot arm for moving platform outdoor
- Design gripper to hold cones and lanterns



- Explore suitable cameras and laser scanners to “see” objects, road markings and surroundings
- Tailor-made the robot body
- Develop the ‘brain’ of the robot to take charge of its operations in coordination with the driver

The Prototype - Roadbot 1
1st Intelligent Road Works Robot in the World

- On-board computer with Artificial Intelligence:
  - Sees its surroundings with cameras
  - Detects objects with laser scanner
  - ‘Feels’ the cones with proximity sensor in the grippers

The Prototype - Roadbot 1
1st Intelligent Road Works Robot in the World

- With ‘knowledge’ of its surroundings, the on-board computer controls:
  - The rear arm to:
    - *place and collect cones and lanterns on roads*
  - The arm at the centre to:
    - *support these operations by housekeeping cones and lanterns on the vehicle*

- The computer also coordinates the arm operations with the vehicle movement

The Prototype - Roadbot 1
1st Intelligent Road Works Robot in the World

- Roadbot 1:
  - Recognises road markings
  - Distinguishes cones from other objects
  - Adapts to:
    - Different outdoor conditions
    - Different road configurations
  - Mimics workers to handle cones & lanterns
    - According to CoP and at a rate of < 10s

47th International Exhibition of Inventions Geneva 2019

The Exhibition had:

- 1000 inventions
- 800 exhibitors
- from 40 countries

Many European visitors expressed deep interest to deploy our road works robot in their countries

47th International Exhibition of Inventions Geneva – Prize and Medal

Roadbot 1 won:

- **The Honorable Mention Prize of the Chinese Delegation for Invention and Innovation**; and


DIPLÔME

inventions Geneva

SALON INTERNATIONAL DES INVENTIONS

GENÈVE

Après examen, le Jury International a décidé

de remettre à: Highways Department, the Government of the Hong Kong Special Administrative Region of the People's Republic of China, Hong Kong Productivity Council

pour l'invention: Système de robot pour le placement et la collecte des cônes de signalisation et des lanternes dans les travaux routiers.

MÉDAILLE D'OR GOLD MEDAL GOLDMEDAILLE

Avec les félicitations du jury
With the congratulations of the jury
Mit höchsten Empfehlungen des Preisgerichtes

Genève, le 12 avril 2019

Le Président du Jury: David Taj

Le Président du Salon: Jean-Luc Vincent

- **The Gold Medal with Congratulations of the Jury**

More Recognitions of Roadbot 1 in 2019

Silicon Valley International Invention Festival 2019: **Gold Medal**	 
Hong Kong Information and Communications Technology Awards 2019: **Gold Award in Smart Transportation**	
Construction Safety in Construction Innovation Award 2019 of the Hong Kong CIC: **2nd Prize**	

Full Scale Implementation - Roadbot 2

- Roadbot 2:
  - For real life operations
  - Designed and assembled on a 14 tonne works vehicle
  - Can carry up to 250 cones 125 lanterns
    - for setting out road works up to 2 km
  - Trials on public roads are on-going

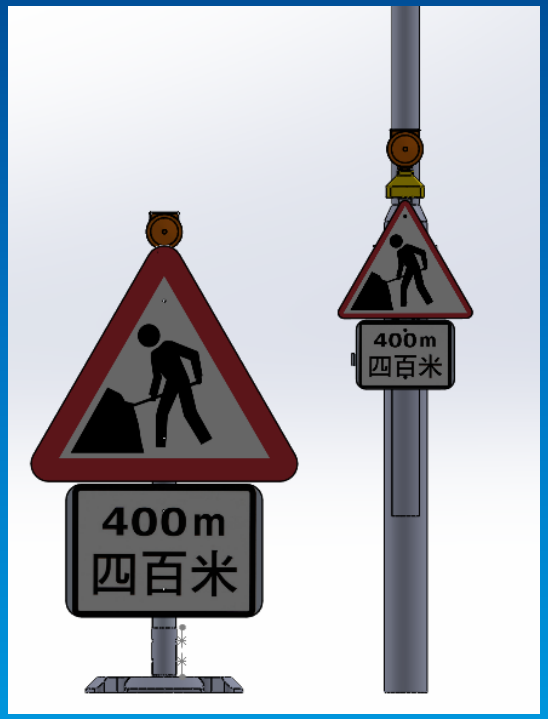
Full Scale Implementation - Roadbot 2 for Operations on Public Roads

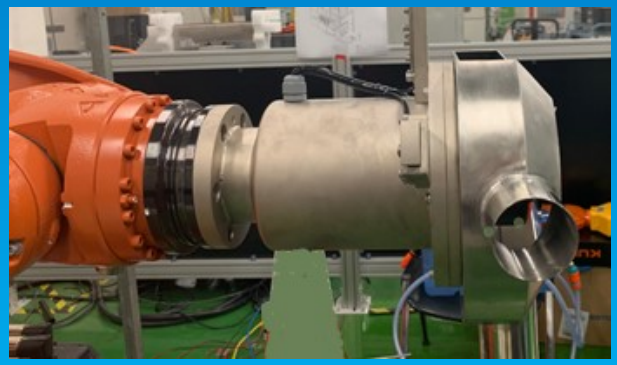
1. *Assembled in Local Workshop*

2. *Under Trial*

Roadbot 2: Further Applications

- HyD is exploring further applications of Roadbot 2 to road works
  - *Providing different tools to its arms to:*
    - *Place and collect temporary road signs*
    - *Remove unwanted vegetation*
    - *Remove foreign objects on public roads*





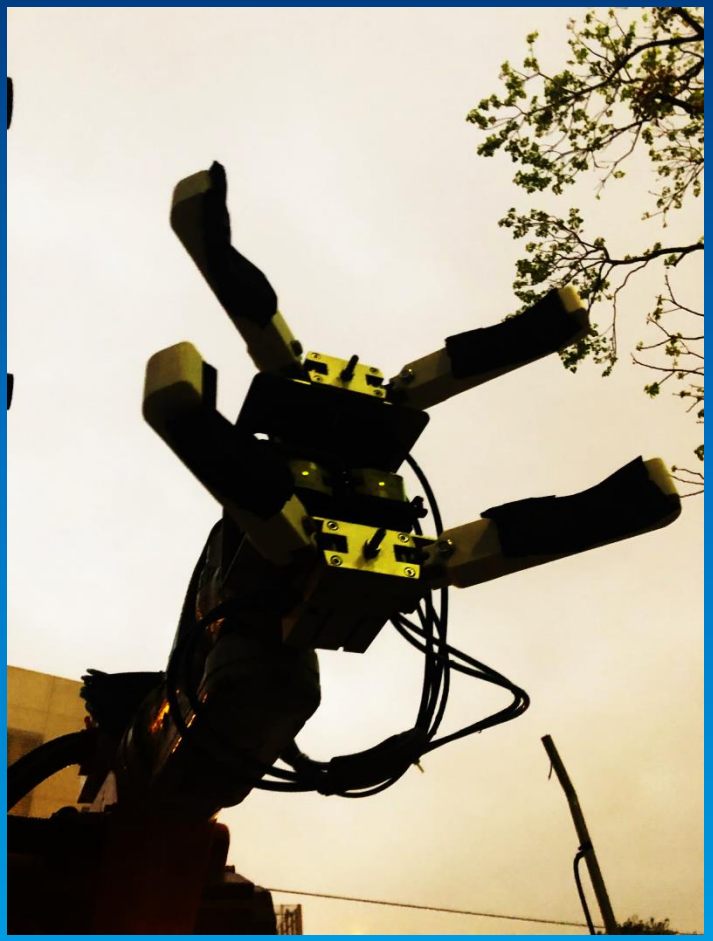
Roadbot 2: Further Applications

- The research and development of these functions are:
  - Making good progress
    - *Tools to perform the work have been fabricated*
    - *Coding to provide Roadbot 2 the intelligence is being developed*
- Continuing to explore more potential applications of the Roadbot to road works

Roadbot 2: Practical Uses

Striving to put Roadbot 2 into real life applications to take over higher risk operations in road works:

- The Very Mission



Thank you

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