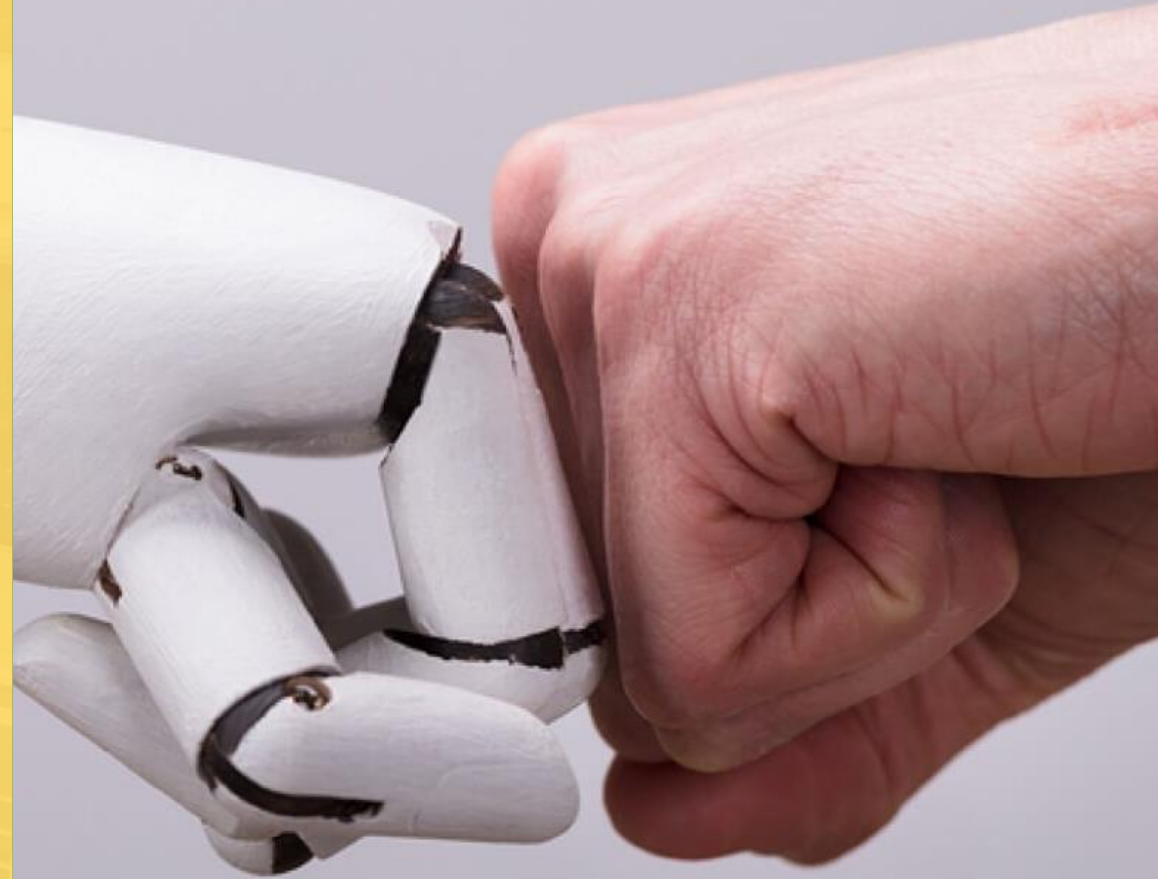# Robotic Education to Enable The Future

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SP Singapore Polytechnic

Outline

- Current Situation
- Challenges for the future
- ROS in Educational Projects
- Case Studies:
  - Receptionist Robot
  - Tray Returning Robot
  - Social Robot
  - Delivery System in Hospital
  - SORA
  - Utensils Trolley
  - Driverless Car
  - AMR for Outdoor
  - RoboCup@Work
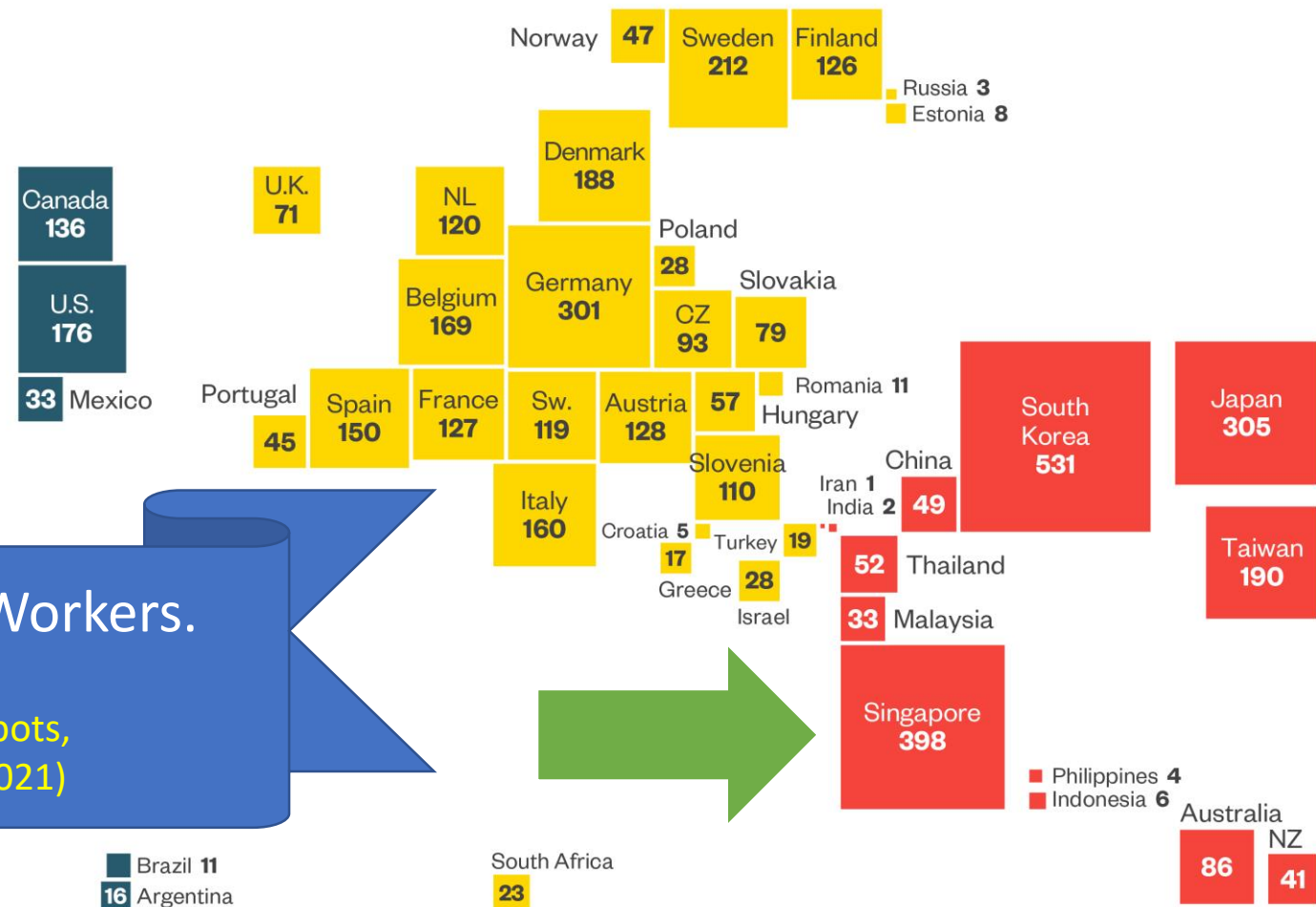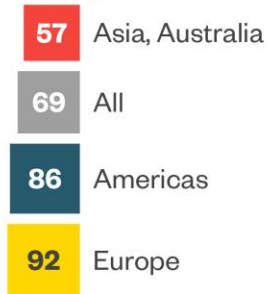- Conclusions

Singapore Polytechnic

- First polytechnic to be established in Singapore in 1954

- Current enrolment of 13,000+ full-time and part-time students.

- Offers 30 full-time diploma courses and three common entry programmes.

- SP adopts a proven creative teaching and learning framework and offers students a holistic, authentic and industry-relevant curriculum, innovative and vibrant learning spaces, and enriching overseas programmes.

- SEEE has 10 Co-location Labs. That focus on R&D and industrial collaborations.

- Robots for industrial purposes and autonomous mobile robots.

- Humanoid Robots, Service Robots, and Intelligent Systems.

- Collaborative work with +30 local and overseas universities and institutions.

- 15 Staff and +100 Students

Number of Industrial robots / 10,000 workers

Number of industrial robots per 10,000 manufacturing workers

By region

57	Asia, Australia
69	All
86	Americas
92	Europe

Canada 136
U.S. 176
33 Mexico

Norway 47 · Sweden 212 · Finland 126
Russia 3
Estonia 8
Denmark 188
U.K. 71 · NL 120 · Poland 28 · Slovakia
Belgium 169 · Germany 301 · CZ 93 · 79
Portugal 45 · Spain 150 · France 127 · Sw. 119 · Austria 128 · 57 · Romania 11
Hungary
Italy 160 · Slovenia 110 · China 49 · South Korea 531 · Japan 305
Iran 1 · India 2
Croatia 5 · Turkey 19 · 52 Thailand · Taiwan 190
17
Greece 28 · 33 Malaysia
Israel
Singapore 398
Philippines 4
Indonesia 6
Australia 86 · NZ 41

Source: International Federation of Robotics (2015)

Brazil 11
16 Argentina

South Africa 23

6 Robots* per 100 Workers.

*Including Service Robots,
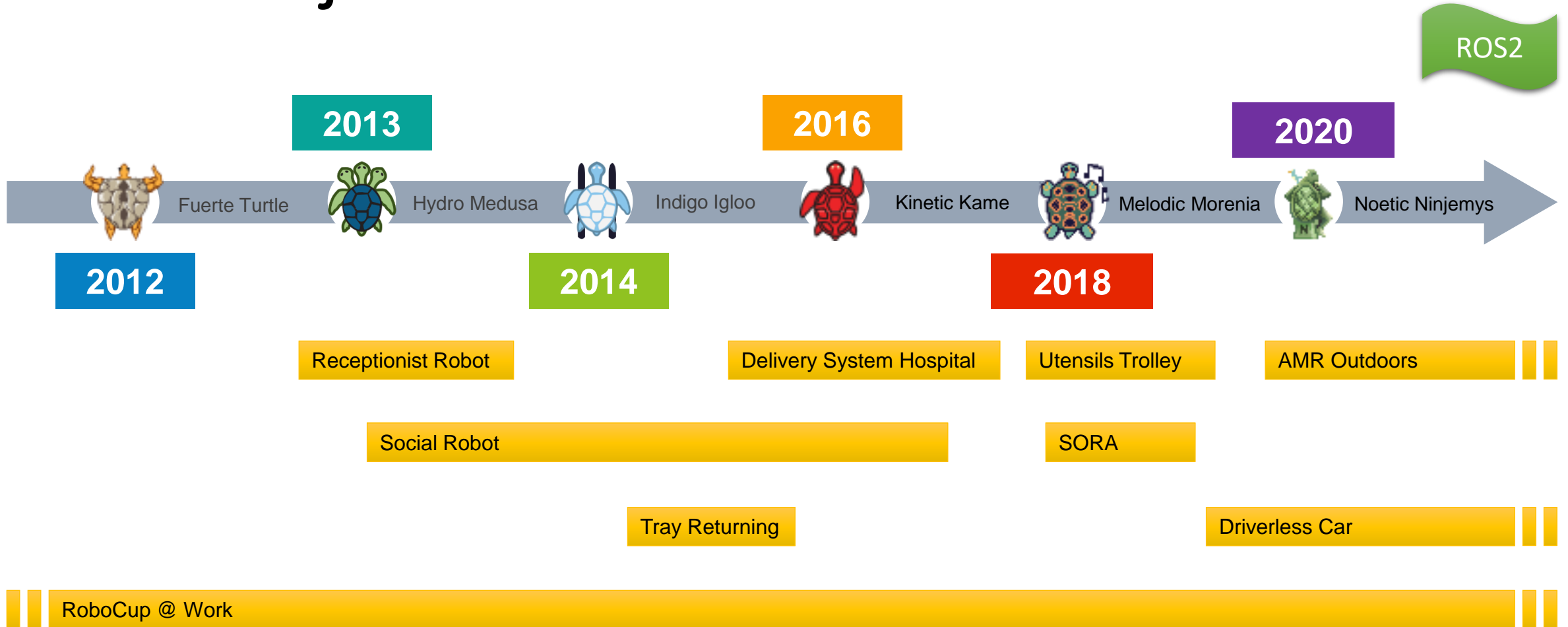Source: LogisticsIQ (2021)

Challenges for the future

- Singapore is one of the fastest ageing countries in Asia. Problems raised like shortage of manpower, as well as issues raised with covid demand new solutions.

- Autonomous Robots are one way to approach these issues. Many companies are turning to robotics to create relevant solutions.

- Is there a lack of fearless engineers???

- Robotics CCA's attract and engage potential future engineers.

- More Challenging Robotics Projects (in schools and internships) help to build confidence and skills of our future engineers.

ROS for Educational Projects

- Before ROS, Students develop systems, which were difficult to improve, difficult to maintain, impossible to change hardware ☹

- ROS provide fast development, hardware abstraction, distribution of process, standard communication.

- Now students are able to create more complex systems, upgrade hardware, expand and improve in existing components of the system ☺

- It provides opportunity to explore new solutions, to share and reuse much of the already solutions. Students have opportunity to learn algorithms that are advanced for their level.

Singapore Polytechnic

ROS Projects Timeline

ROS2

2013

2016

2020

Fuerte Turtle | Hydro Medusa | Indigo Igloo | Kinetic Kame | Melodic Morenia | Noetic Ninjemys

2012

2014

2018

Receptionist Robot

Delivery System Hospital

Utensils Trolley

AMR Outdoors

Social Robot

SORA

Tray Returning

Driverless Car

RoboCup @ Work

Receptionist Robot (2014-2015)
School of Electrical and Electronic Engineering

It is desktop top robot with a height of 0.9m. It is able to detect users and engage them in simple interaction.
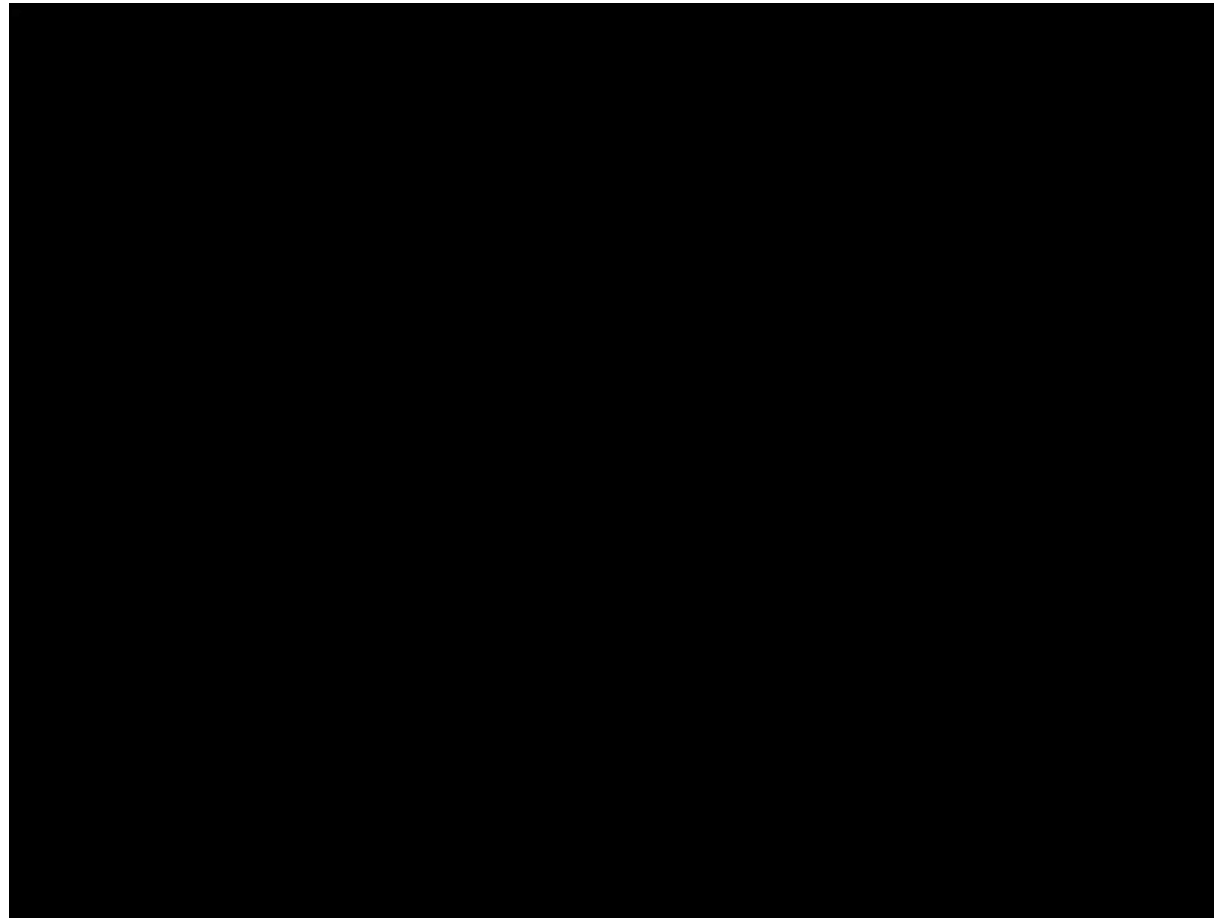
Technologies:

- User detection
- Gesture detection
- Speech generation
- Voice recognition
- User interaction
- Manipulation
- Facial expression modelling

Receptionist Robot (2014-2015)

School of Electrical and Electronic Engineering

Social Robot (2014-2016)
Multi-disciplinary project, SP wide.

Developed a Social Robot that was able to interact with human, dance and provide simple directions.

Technologies:

- Sensor Drivers
- Autonomous navigation
- Obstacle avoidance
- Human-robot interaction
- Speech Recognition

Tray Returning Robot (2015)
Developed with National Environment Agency (NEA)

Developed a prototype for a proof of concept of tray returning robot in hawker centres in Singapore. Robot was developed and tested with SP open food courts.

Technologies:

- Motor Driver
- Sensor Driver
- Mapping
- Autonomous Navigation
- Obstacle Avoidance
- Human Detection and Interaction

![SP Singapore Polytechnic logo]

Automated Delivery System for Handling Laboratory Sample Logistics in Hospital (2015-2017)

## *MOE – Translational Innovation Fund (TIF)*

Developed a robotic system prototype to transfer safe and securely lab samples in a hospital environment. The system included scheduling and self charging.

Technologies:

- Motor Driver
- Sensor Driver
- Mapping
- Autonomous Navigation
- Scheduling for pick and delivery
- Self Charging
- Communication with monitoring station

SORA (2018)

School of Electrical and Electronic Engineering

Drink Holder

Screen

Emergency switch

LIDAR

Neopixels
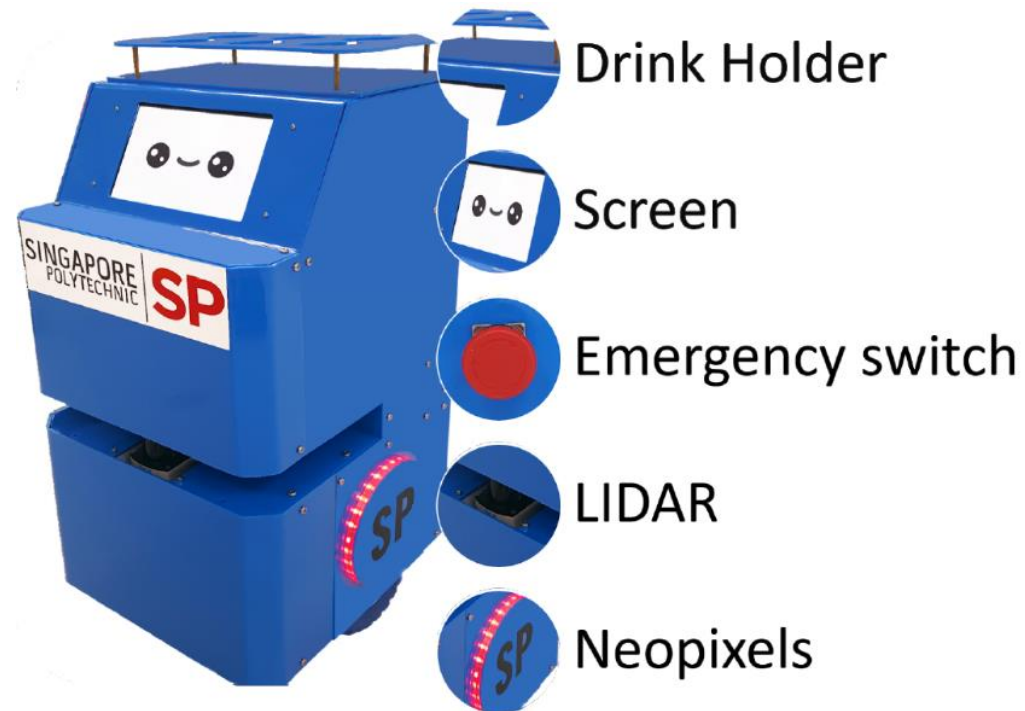
Developed originally to serve drinks to visitors at the school of EEE office; SORA is now used in exhibition to provide leaflets, or guiding visitors around.
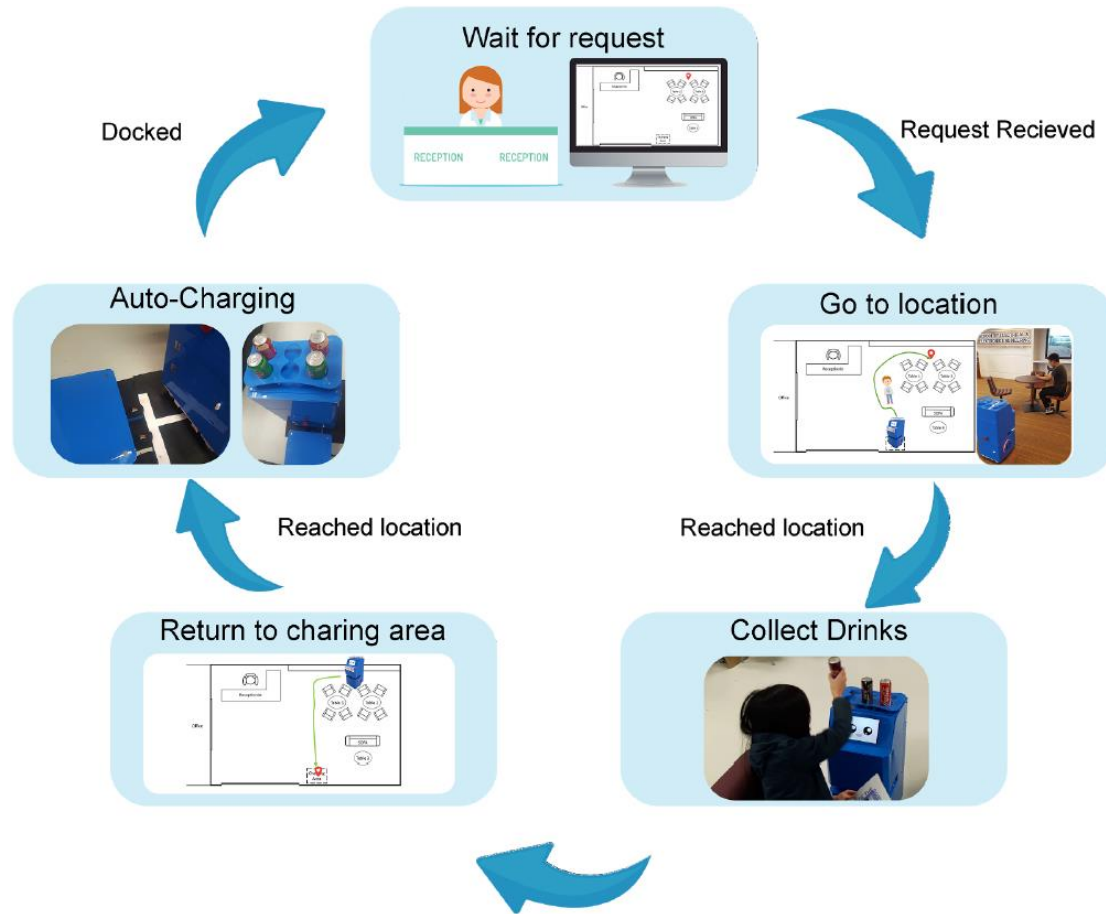
Technologies:

- Motor Driver
- Mapping
- Autonomous Navigation
- Obstacle avoidance
- Self Charging
- Social Interaction

SORA (2018)
School of Electrical and Electronic Engineering

SORA (2018)
School of Electrical and Electronic Engineering

In the office…

Automated Utensil Trolley (2018-2019)

Developed with Infocomm Media Development Authority (IMDA)

Developed to safely navigate in crowded environments. This trolley was meant to bring back the utensils from a tray return station to the washing area. To free the foodcourt staff from these duties.

Technologies:

- Motor Driver
- Sensor Driver
- Autonomous navigation
- Mapping
- Obstacle avoidance
- Perception
- Deep Learning
- Fleet Management

Autonomous Driverless Vehicle (2019-Present)
School of Electrical and Electronic Engineering

This project is to develop a driverless vehicle.

Technologies:

- Motor Driver
- Sensor Driver
- 3D / 2D Mapping
- Autonomous Navigation
- Obstacle Avoidance
- Pick up Scheduling
- Path Planning

Autonomous Driverless Vehicle (2019-Present)

School of Electrical and Electronic Engineering

SP Singapore Polytechnic

# Autonomous Mobile Robot for Outdoor Delivery (2020-Present)

School of Electrical and Electronic Engineering

- The project explores Autonomous Mobile Robots (AMR) operating in an outdoor environment. The AMRs are able to collect and deliver items, based on request, from one building to another. It is able to navigate around on its own, avoiding obstacles, and return to its source if any unexpected situation arises.

- Technologies:
  - Motor Driver
  - Sensor Driver
  - 3D / 2D Mapping
  - Autonomous Navigation
  - Obstacle Avoidance
  - Scheduling
  - Path Planning

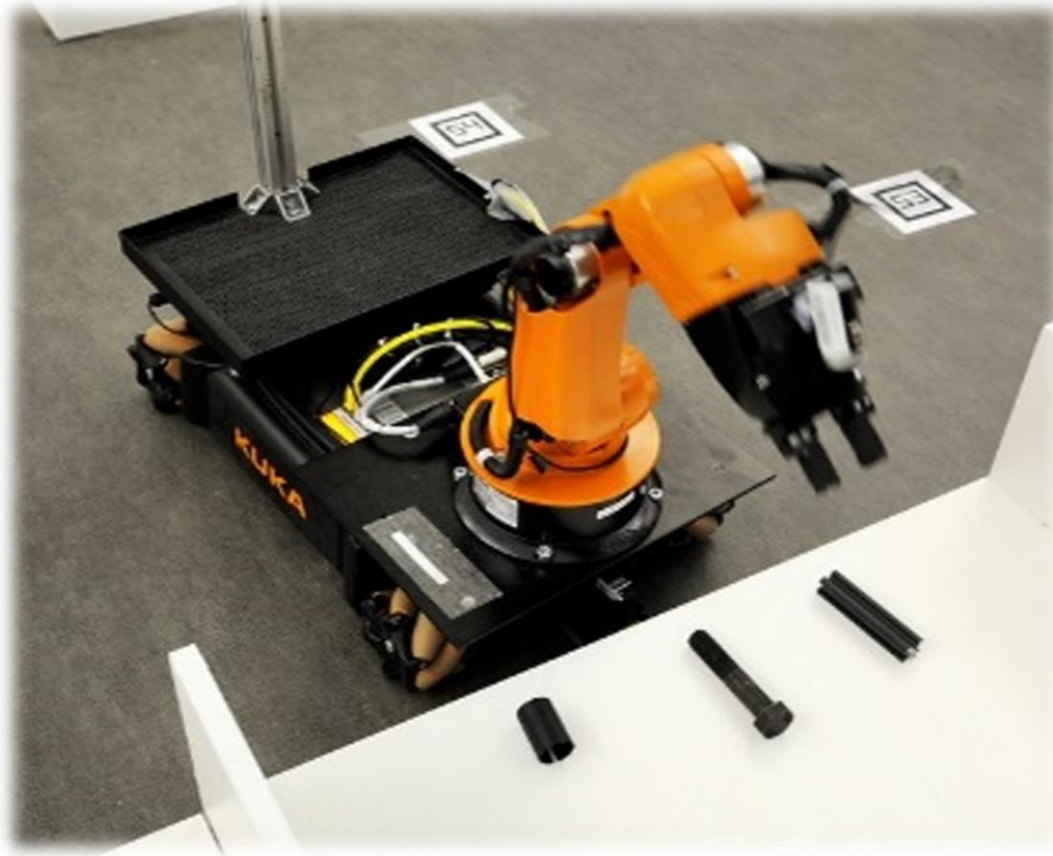# Delivery Logistic Outdoor AMR (2020-Present)
School of Electrical and Electronic Engineering
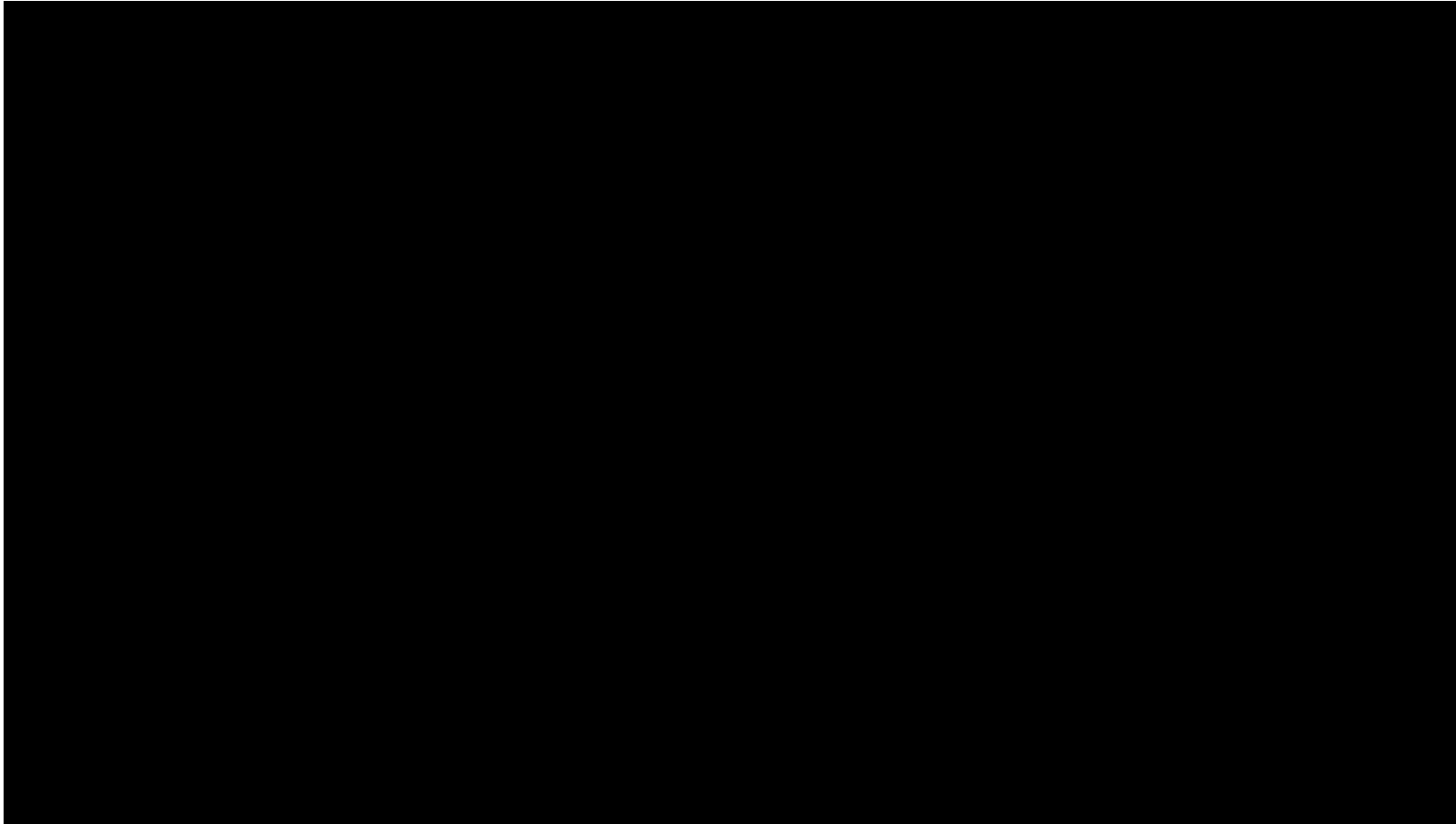
# RoboCup@Work (2010-Present)

International Competition RoboCup

This project develops an industrial mobile manipulator for the RoboCup@work competition. The task are upgraded every year to become as close as possible to real industrial scenarios.

Technologies:
- SLAM
- Autonomous Navigation
- Obstacle avoidance
- Manipulation
- Plan Planning
- Perception
- Deep learning
- Power Management

RoboCup@Work (2010-Present)

International Competition RoboCup
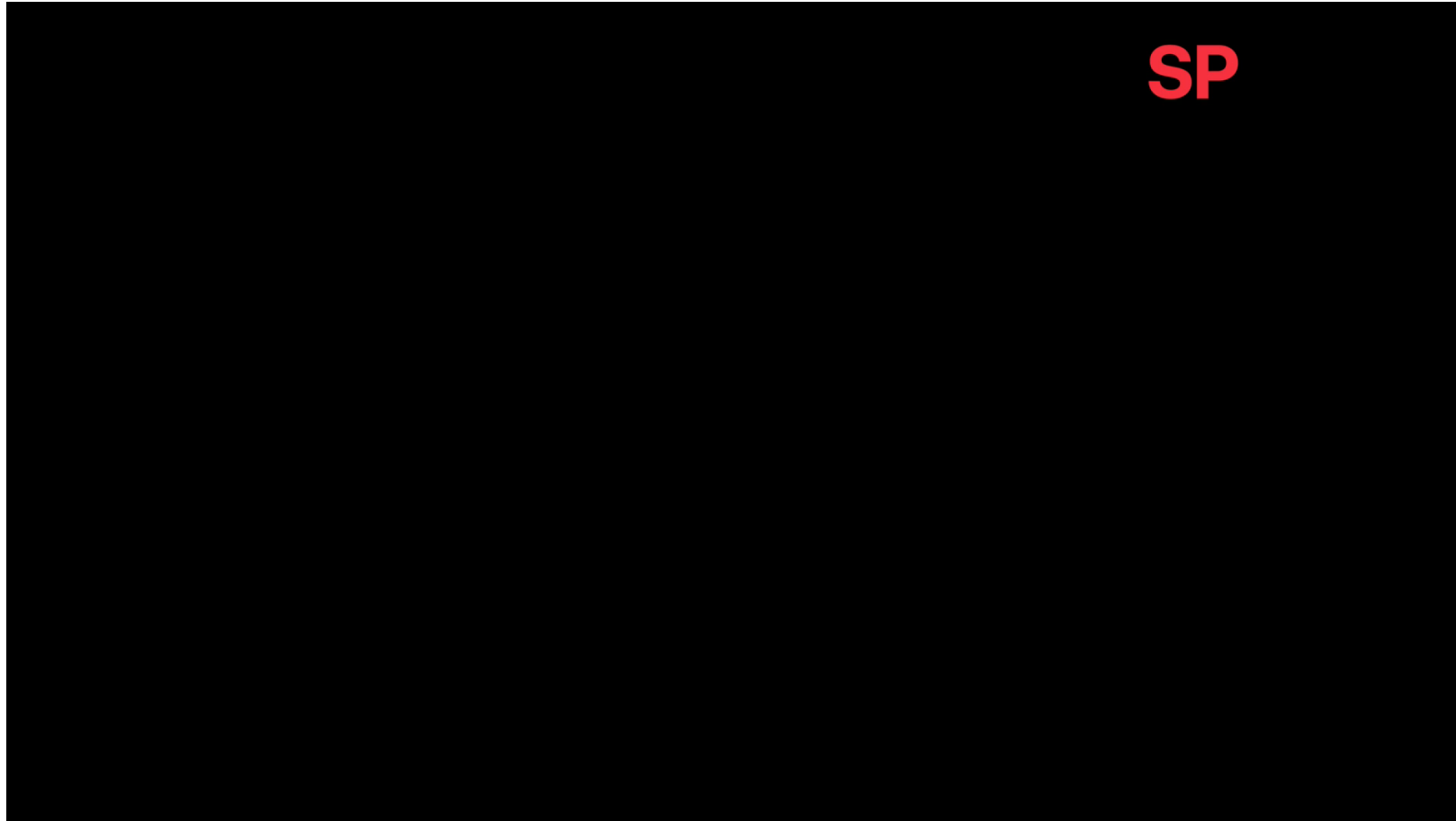
Conclusions

- Singapore is one of the fastest ageing countries in Asia. Problems raised like shortage of manpower, as well as issues raised with covid demand new solutions.

- Autonomous Robots are one way to approach these issues.

- Many companies are turning to robotics to create relevant solutions.

- The maturity of technology makes robotics adoption exponential.

- Creating capable engineers is responsibility of the whole community.

Dr Carlos Antonio Acosta Calderon

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