OneWorld Robotics Competition Rules

Spirit of the Competition

In the next thirty years, seventy-five percent of the fastest growing occupations will require essential STEAM skills. Mastering these skills will be critical for the students of today to navigate the future successfully. The OneWorld Robotics Competition is aimed to help students globally enhancing these essential STEAM skills, through the immersive robotic competition learning and competing experience.

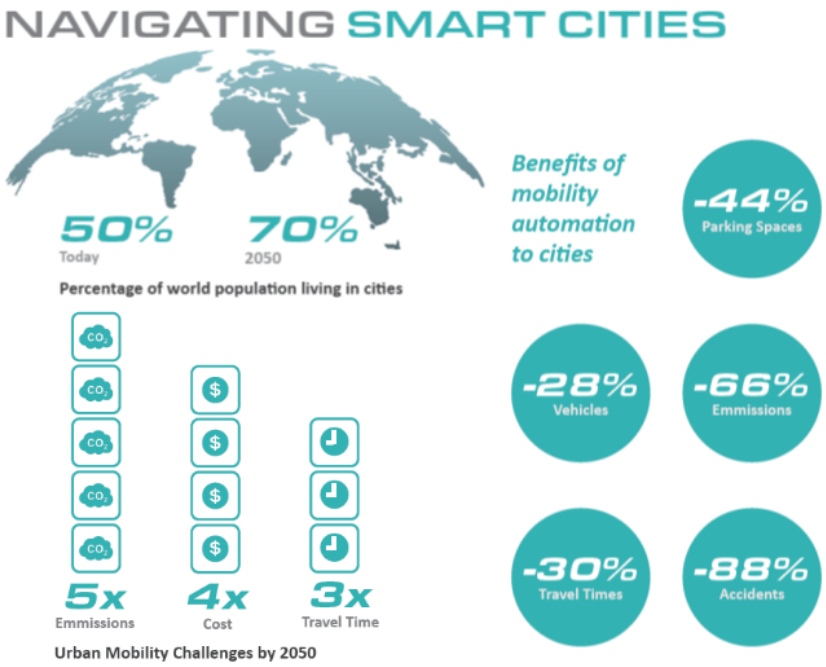
Specifically, OneWorld Robotics Competition (OWRC) focuses on enhancing students in the following future survival skills throughout the entire competition journey. These skills are also known as the 'Seven Survival Skills' created by the famous world-renowned educator Dr Tony Wagner.

- Critical Thinking and Problem Solving
- Collaboration Across Networks and Leading by Influence
- Agility and Adaptability
- Initiative and Entrepreneurial Skills
- Effective Oral and Written Communication
- Accessing and Analysing Information; and
- Curiosity and Imagination

Competition Theme

The competition category for this year is "Navigating Smart Cities". A smart city is a city that is better able to cope with the demands of an increasingly over-populated, more globalised world. A smart city will be a city that is highly data-driven, demanding that world leaders to understand technology such as the Internet of Things (IoT), Artificial Intelligence, and the myriad of digital technologies now available.

It is forecasted that by 2050, seventy percent of the world's population will reside in cities – which will mean an increase in carbon emissions by five times, an increase in the cost of living by four times and travel time will increase by up to three times the current rate.



This solution category will challenge you to think globally and to consider the legal, social and ethical aspects to the problems associated with our cities of the future – including transport congestion, over-population, and environmental impact. Critical to this, will be considering the key role that the Automated Vehicle (AV) plays in helping to alleviate these issues. For example, AV will help solve many of the problems such as cutting urban travel time, reducing greenhouse emissions and improving traffic congestion and safety.

Competition Structure

There are three key challenges within each of the OneWorld Robotics Competition Area Competitions this year. Please see the table below for the competition structure breakdown.

Challenge Reference	Challenge Name	Percentage weight in total score
Challenge I	Future Skills Demonstration Challenge	20%
Challenge II	Robotics Technical Challenge	50%
Challenge III	Solution Presentation Challenge	30%

For more information on the timing of each challenge, please refer to the Competition Schedule below.

Competition Schedule

DAY 1

Time	Description
9:00-10.00	Team Registration and Draw
10:00-10.30	Opening Ceremony
10:30-16:00	Challenge Practice
12:30-16.00	Future Skills Demonstration Challenge
16:00	End of Day 1

DAY 2

Time	Description
8:00-9:00	Team registration
9:00-9:30	Day 2 Opening Address
9:30-10:30	Challenge Practice
10:30-15:30	Robotics Technical Challenge | Solution Presentation Challenge
15:30-16:30	Award and Closing Ceremony

Challenge I: Future Skills Demonstration Challenge

The importance of the future skills of your team

It is important to develop the future skills of your team, and it will unite you and your team members to work towards a common goal. Establishing the future skills of your team will be the first challenge you need to take on. You need to establish common understanding, find ways to trust each other, divide workload fairly and effectively, and face the upcoming challenges collaboratively together.

Complete future skills posters

Through the team's communication and discussion, define your team's seven areas of competencies: Critical Thinking and Problem Solving, Collaboration Across Networks and Leading by Influence, Agility and Adaptability, Initiative and Entrepreneurial Skills, Effective Oral and Written Communication, Accessing and Analysing Information; and Curiosity and Imagination. Then gradually transform your team's agreement into abilities to complete challenges successfully in this competition.

Demonstrate your team's seven key competencies level in writing from your competition preparation commencement to competition participation with examples each on a A4 paper (e.g. mindmap, images, text)

The judge scoring system:

- Each team's score for the Future Skills Demonstration Challenge is recorded on the score sheet by the judges. The score sheet will list the scoring criteria items, which are the seven key competencies listed below.
- Each criteria is to be scored out of 10 points.
- The team's score will be added up and counted toward the total score of their competition participation accordingly.

Seven key competencies

- **Critical Thinking and Problem Solving** (10 points)
  Team can gather evidence, draw conclusions and reflect on their thinking ability and utilise knowledge gathered in different aspects to solve problems.
- **Collaboration Across Networks and Leading by Influence** (10 points)
  Team can cooperate and learn together, as well as lead each other in order to achieve the common goals.
- **Agility and Adaptability** (10 points)
  Team can be agile and adaptable in dealing with situation changes or new problems.
- **Initiative and Entrepreneurial Skills** (10 points)
  Team can demonstrate their ability to take on initiatives and be entrepreneurial.
- **Effective Oral and Written Communication** (10 points)
  Team can effectively exchange and express knowledge and information internally and externally.
- **Accessing and Analysing Information** (10 points)
  Team can demonstrate their ability to research, gather and analyse information effectively.
- **Curiosity and Imagination** (10 points)
  Team can demonstrate their creativity in solving problems, designing solutions.

Challenge II: Robotics Technical Challenge

Robotics Technical Challenge tasks

- The goal for each team is to get four of their five designated robots to their respective destinations within the shortest amount of time, and get the remaining one robot to its destination successfully by applying AI visual recognition from FlipAIOT.

- Each robot autonomously drives from their designated starting point and cross the designated finishing line.

- Each team can have maximum all five of their robots performing tasks simultaneously on the field.

Robot Requirements

1. Teams must use OWRC officially designated robots, hardware and software for robot design and programming activities for the competition.

2. The size of the robot must not exceed 200mm (length) × 200mm (width) × 150mm (height) (including robot body parts and all wires) before the race. After the start of the challenge, there is no size limit if the robot transform itself.

3. Unless otherwise specified, the robot should be placed from the top to the bottom in the measurement box before competing (including any extension items). The robot can touch the walls of the measuring box. However, The robot is not allowed to be forced into the measuring box, if the robots exceeds any size requirements, it is not fit to compete. If the robot does not pass the size requirement test and still been put onto the competition field to compete, it will be disqualified once it's identified.

4. Each team's robots must be checked by the referees before competing. Only when the referee confirms that the FlipAIOT visual recognition function is used to perform the technical challenges by each of the team's competing robots, the team can then commence their technical challenge performance.

5. After the robot has started competing on the competition field, the player must not interfere or assist the robot in any way unless they receive referee's confirmation. Otherwise, the round will not be scored.

6. All robots must complete the competition task independently. Any use of wireless communication or remote control/wire control to influence the robot's performance while competing is not allowed.

7. The power source used by the robot must only be the lithium-ion battery provided in the competition practice kit. It is possible that the venue will not provide charging during competition period, so if teams might need to prepare spare lithium-ion batteries as back-up, which needs to be the same version as the one provided in their practice kit. They can be purchased on OWRC website.

8. If the robot does not meet the requirements during the pre-competition check, the team has 3 minutes to modify their robots on the review table. When the robot is ready to compete, it must be placed on the competition field in the same position as they were in the measurement box. The robot must remain switched-off during the pre-competition check until the team member decides to switch it on when starting the competition.

9. Each team has 2 minutes preparation time prior to their technical challenge competition time starts. If the preparation time is exceeded, the team must start competing immediately with the current state of the robot. The entire robot (including all the wires and extension parts) needs to be inside the start zone.

Technical Challenge Participation

Before your team's technical challenge participation:

1. On Day 1 of the Area Competition, OWRC officials will randomly select five technical challenge competition field Routes by lottery draw at the scene. All teams must compete only on these 5 designated Routes, one for each of their team's robots.

2. The term Route mentioned above only refers the designated starting and finishing points. As long as the robot starts at the starting point and reaches the finishing point, the Route is considered to be completed, regardless the path taken.

3. The competing orders of all participating teams is also completed by lottery draw at the scene on Day 1 of the Area Competition.

4. OWRC officials will provide each team with their challenge kit, including flag (terminate their competition run) x 1, flag (accident) x 1, AI visual recognition plates x 12, robot identification number sticks (depending on how many robots the team has), the necessary tools being used during the competition.

5. The technical challenge has two rounds. The higher score of each team's performance during these two rounds will be recorded as their final score for the technical challenge.

6. Each team need to have exactly 5 team members and exactly 5 robots competing in the competition field at the same time. Each robot must have a robot identification number on them.

7. Each team must design their own visual recognition plates according to the specifications specified by OWRC. The visual recognition plates can only be designed by painting in the scope of size requirements, and they can arrange themselves in terms of where placing these plates in the competition field.

8. The time limit for each team technical competition time allocation is 300 seconds.

9. Before each team starts their technical challenge competition, the referee will ask them to confirm whether they have any issues with their robots, software, venue etc. If there is any problem, teams need to inform the referee prior to their technical challenge commencement.

During your team's technical challenge participation:

1. No matter how many members each team has, you must have 5 members to prepare exactly 5 independent robots to participate in the technical challenge during the designated time.

2. Once the competition starts, each team decides the order in which each of the 5 robots will complete their route.

3. Total time limit for each team's technical challenges competition is 300 seconds. If team fails to get all 4 of these designated robots reaching destinations successfully within the time limit, the completion time recorded for that team will be 300 seconds.

4. After the start of the competition, each team can decide on their own order in terms of releasing their robots into the field. The referee will start the countdown by verbal command. If the team is identified to start initiating their robot performance before the starting command, the referee has the right to restart the competition and complete the competition according to the following two possible conditions.

    a. Calculate the score by the time when the last robot reaches its specified destination.

b. When a team member holds up the "stop competition" sign, the referee will freeze the time countdown, and the score is calculated based on the time counted for.

5. Teams can raise the “Stop Challenge” sign to request termination of the challenge run they are attempting due to a specific reason (e.g. technical difficulties). When the team raise this sign, the referee will record the current duration and the number of robots that reached destinations at the time as their team score for that particular run.

6. After the end of each round of competition, the referee will record their competition score. If the team has no objection to the judgment of the referee, they need to sign the score sheet as approval.

7. If there is any question/concern while competing, the team shall immediately submit it to the referee on the spot, and the referee shall review it or make a judgment. If there are differences of opinion or differences in rules and cognition, the consensus of the referee group is the final judgement.

8. If the referee determines that the team is disqualified, the team's robot should immediately withdraw from the competition and the round results will not be counted.

The competition accident occurred

- Failure to follow the team planned route: When the robot does not follow the team planned route, the team can raise an "Accident" card and shout out “Accident” and the “Number of the robot that needs to be taken out”. After the referee confirms, the team need to quickly move the robot to the original starting point to restart its run.

- A collision or failure to operate due to an accident: When a collision occurs and a robot can’t operate as expected, the team can raise an "Accident" card and shout out “Accident” and the “Number of the robot that needs to be taken out”. After the referee confirms, the team should quickly move the robot to the original starting point to restart its run.

- If the team member needs to step into the competition field to take out the robot, they need to take off their shoes first.

- Note, the countdown clock is not reset during this process.

Code of Conduct (if the circumstances are serious, the team might be disqualified)

1. Damage or destroy competition field, props or other teams’ robots.

2. Use dangerous goods or dangerous behaviours that might have detrimental impact to the competition.

3. Behave inappropriately to the teams, spectators, referees, and staff members participating in the competition.

4. Any matter that is determined by the referee to be negatively impactful to the competition or against the spirit of the competition.

5. Use mobile phones or any wired or wireless communication equipment during any of their OWRC challenges participation period.

6. If the team fails to rectify their behaviour after warning, they will be disqualified.

Technical Challenge Scoring Structure

Each team's technical challenge total score will be the sum of their scores from the Time-based Technical Challenge and AI Technical Challenge.

Time-based Technical Challenge scoring structure:

1. The competition provides team scores for their Time-based Technical Challenge based on their rankings.

2. The first ranking rule is to look at how many robots out of the 4 designated robots from each team has successfully reached to their assigned destinations.

3. Each team designates 4 out of the 5 robots to participate in the Time-based Technical Challenge. The remaining one robot is assigned to the AI Technical Challenge.

4. If two teams have the same number of robots reached their destinations, then they need to compare their total completion duration for their 4 robots.

5. There is a 3 points interval among each ranking, so the score is calculated according to the rank after the first rank which is 100 points.

Time-based Technical Challenge Scoring Examples are as follows:

Ranking	No of robots reached destination	Completion duration	Points scored
1	4	180 seconds	**100**
2	4	220 seconds	**97**
3	3	210 seconds	**94**
4	3	250 seconds	**91**
5	2	250 seconds	**88**
6	2	280 seconds	**85**
7	1	250 seconds	**82**
8	1	300 seconds	**79**

AI Technical Challenge scoring structure:

1. The team will get 20 points for demonstrating AI vision recognition by using FlipAIOT successfully and navigate the robot to its designated destination successfully.

2. The team will get 10 points for demonstrating AI vision recognition by using FlipAIOT successfully but failed to navigate the robot to its designated destination.

3. The team will get 0 points for not being able to demonstrate AI vision recognition successfully by using FlipAIOT and failed to navigate the robot to its designated destination.

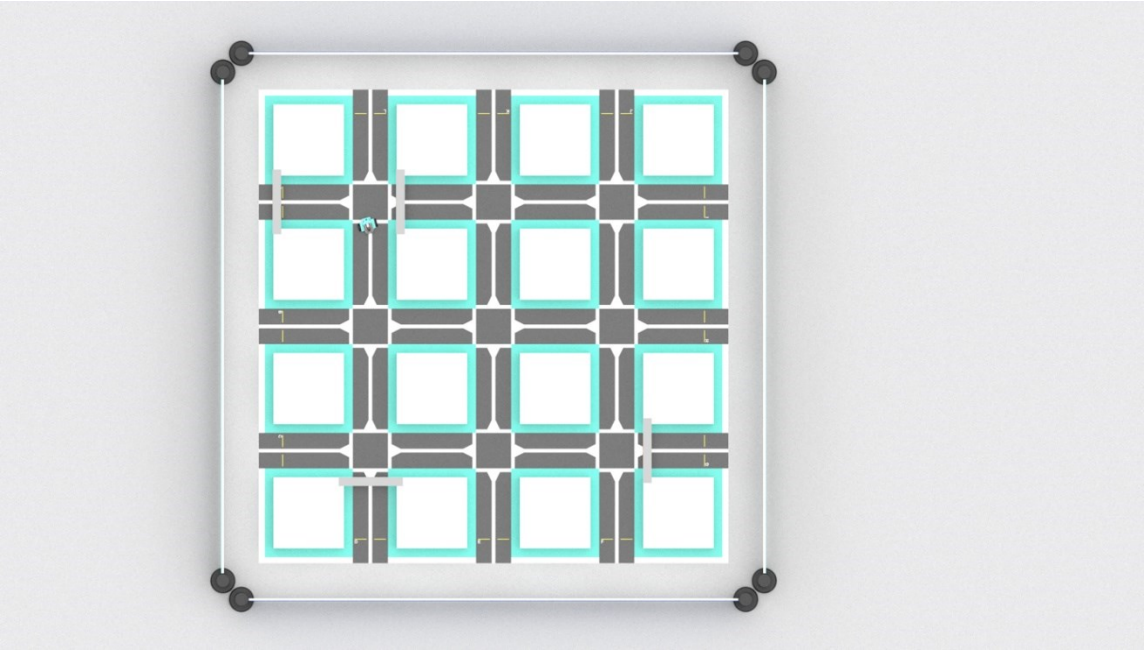
4. "Demonstrating AI vision recognition by using FlipAIOT successfully" means that:

    - The designated robot will make correct turns by using FlipAIOT and successfully recognising their team generated AI vision recognition signs, and

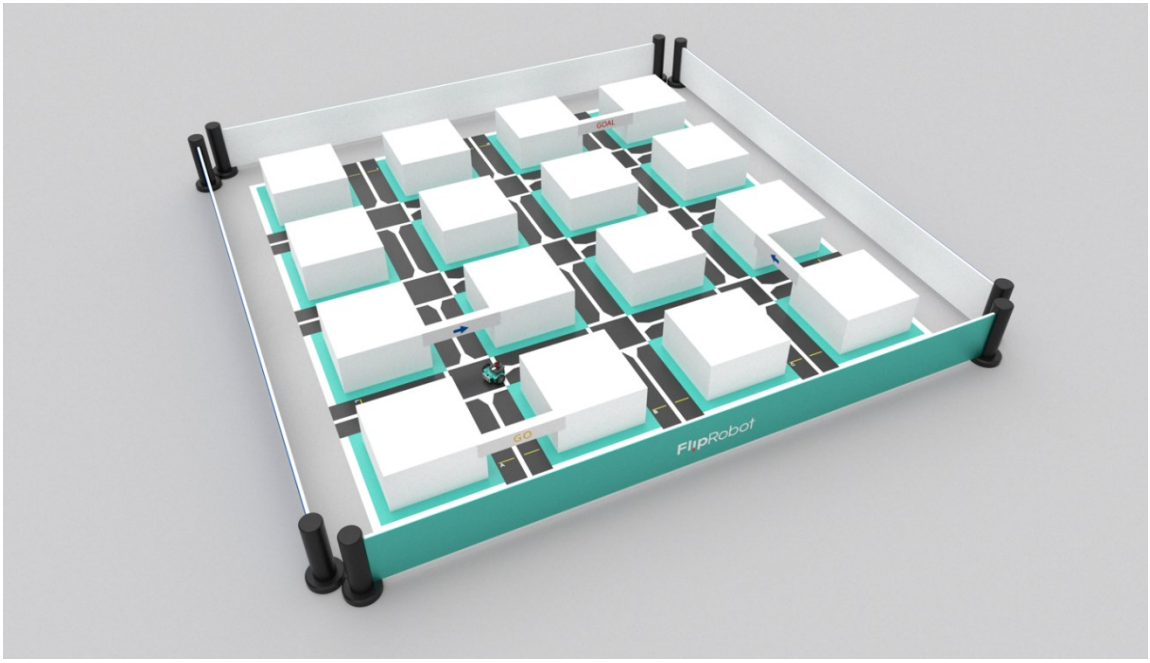
- The robot stops for at least 2 seconds at the OWRC designated “Pick Up” area by using FlipAIOT and successfully recognising the ‘Pick Up’ sign.

Competing field

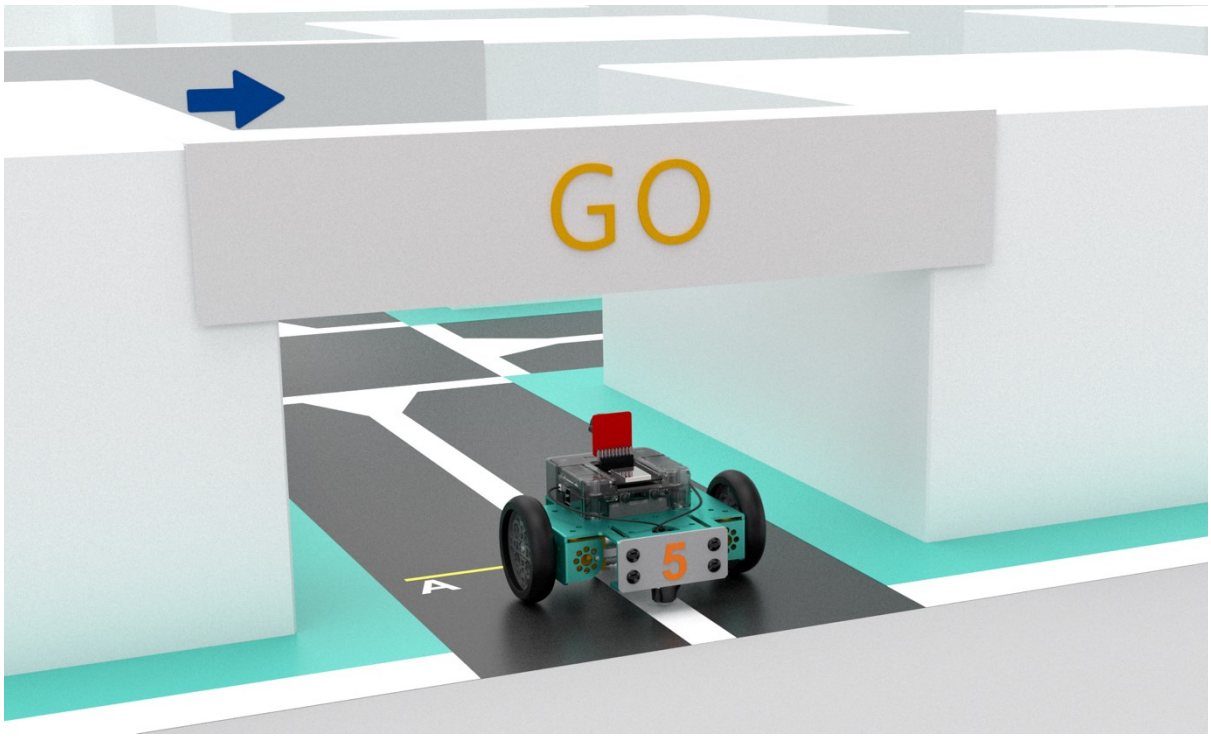
- Competition field is created to simulate smart city urban roads, and all the roads are one-way.
- Please see the illustration images below for the competition field design.



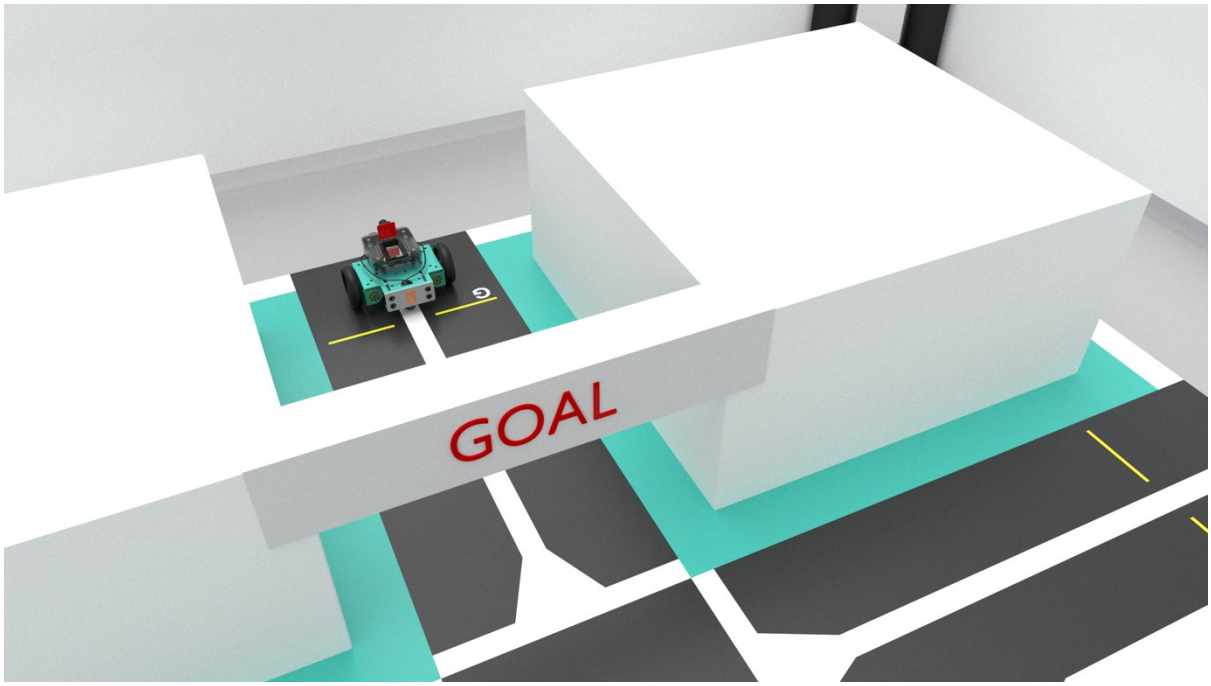
Competition field (Birdseye view)



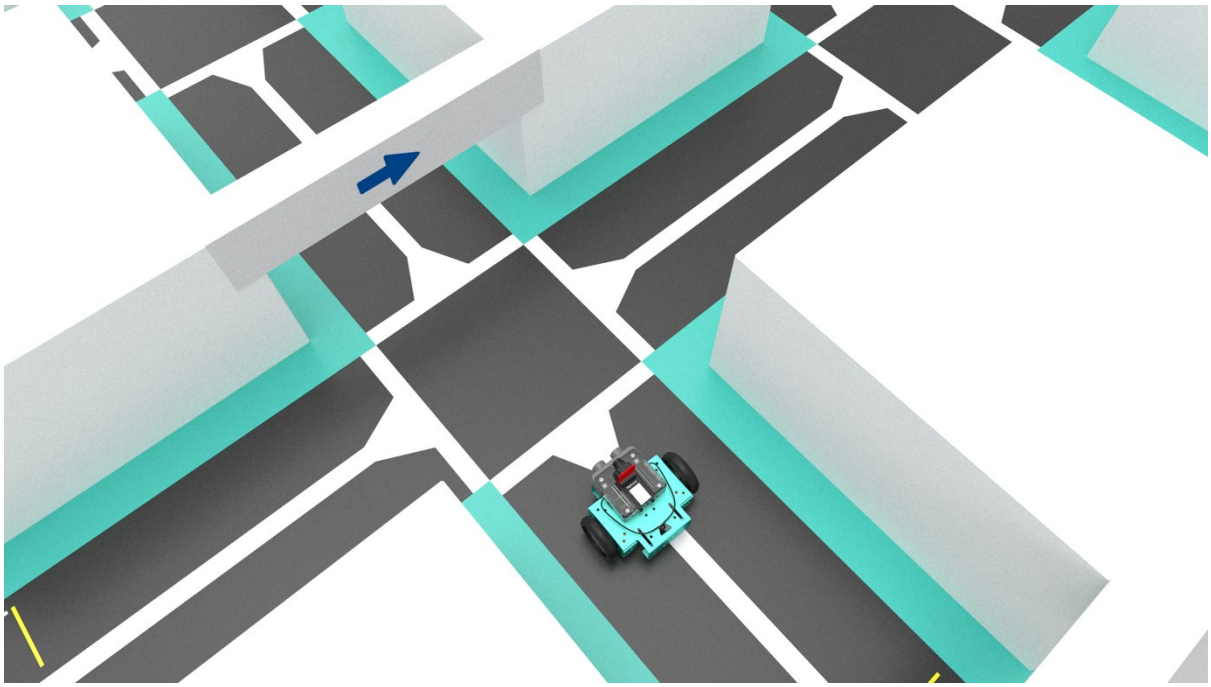
Competition field (3D view)



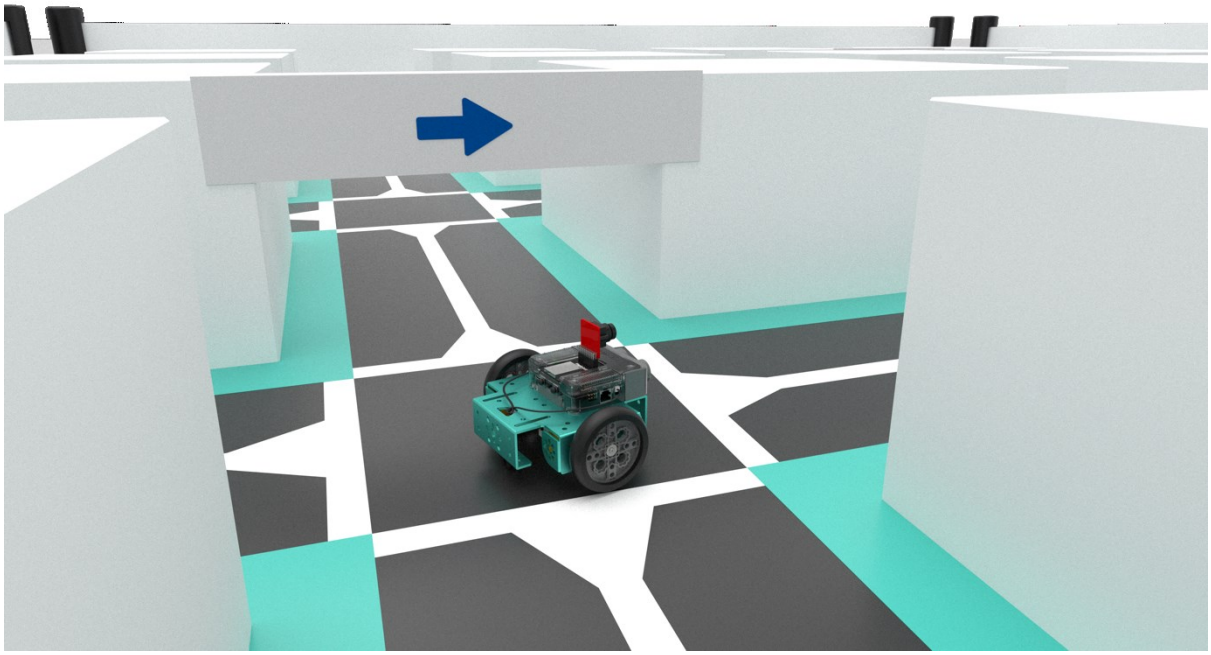
Starting point illustration image



Finishing point illustration image



Intersection illustration image



Visual recognition object illustration image

Challenge III: Solution Presentation Challenge

Solution Presentation Challenge task:

During the challenge, your team will present a future traffic problem that you foresee in the smart cities and propose a solution.

Presentation challenge process:

- Your team should finalise the problem to be explored through collaboration and communication. The judges will pay close attention to your team's cooperation and communication.
- Present your research findings and solution clearly through PowerPoint presentation and try to use the following structure.
    - Motives
    - Objective
    - Thought process
    - Solution
    - Conclusion
- The presentation is to be completed on the second day of the Area Competition. Please note that the time limit for the presentation is 5 minutes, and the question and answer time with the judges is 5 minutes.
- Each team should have exactly 5 team members presenting during the Solution Presentation Challenge. Any team member who did not compete in the Robotic Technical Challenge need to participate in this challenge.

Presentation challenge assessment system:

The judge scoring system:

- Each judge will have a presentation challenge score sheet. The score sheet will list the scoring criteria items, which is also listed below.
- Each item is to be scored out of 10 points.
- The team's total scores will be added up and ranked accordingly.

Scoring Criteria:

- **Communication**
    - Written communication:
        - Quality visual aids materials (10 points)
        - Clear and concise presentation content (10 points)
    - Verbal communication:
        - Passionate presentation delivery (10 points)
        - Presentation delivery cohesiveness among team members (10 points)
- **Solution content**
    - Creativity of the solution (10 points)
    - Feasibility of the solution (10 points)
    - Sustainability of the solution (10 points)
    - Comprehensiveness of the solution (consider the following aspects but not limited to) (10 points)
        - Social impact/aspect
        - Legal impact/aspect
        - Ethical impact/aspect
    - Critical thinking level demonstrated within the solution (10 points)
    - Research thoroughness for the solution presented (10 points)

The judging panel:

- Judges will be experts or scholars in the field of robotics and STEM education.
- The presentation challenge judging panel consists of 5 judges to ensure the scoring fairness.

Background information

Introduction: Consider the potential future traffic problems in smart cities

A Smart City uses various technology to integrate urban systems and services, and improve resource utilization efficiency, in order to optimize the city 's management and services and improve citizen's quality of life.

A Smart City must apply the latest information technology in various urban areas to develop the future city that suitable for new generation's needs. Through further digitisation and industrialization, the smart city management can improve the effectiveness of urban management and the quality of life of citizens.

Transportation is the key to city development. How to utilise the latest AI and IoT technology to accelerate a city's development efficiency is an important subject to us all. Here are some questions your team can start brainstorming with:

- What should the transportation in a smart city look like?
- What are the needs of people in transportation?
- What are our requirements for smart vehicles?
- What needs can the smart autonomous vehicle deliver?
- What is the relationship between people and smart vehicles?
  - How cars interact with each other? Why interact?
  - How people interact with the cars? Why interact?
- What are the possible problems in the future traffic?
  - How to improve traffic congestion?
  - The safety between car and people?
  - The safety of among cars?
- What are the possible legal issues that may rise from the future traffic situations?
  - Fairness of accessing roads.
  - The fairness of speed control.

If you are not sure where to start:

Identify the motives for exploring problems through critical thinking:

Try reading the questions below to find out what your team wants to discuss.

- Use concept map to brainstorm and consolidate your team's discussions in order to summarise the potential problems that might be encountered in smart cities.

- Maybe you can consider some of these questions:

  - Semi-automated machine, fully- automated machine and people, what are the legal relationship among them?

  - Why is it easy to have traffic jam during rainy weather? If the future cars are all operated by AI, can this problem be solved by that?

  - In the future, if all vehicles are all operated by AI technology, in case when a vehicle needs to violate standard traffic rules to get to destination due to emergency (e.g. ambulance on duty), how can you design the traffic rules to incorporate this consideration?

Conduct a feasibility reflection:

To ensure that the solution proposed by your team is achievable and feasible, try to analyse it critically:

- Why your solution is more successful than other solutions?
- What information do you need to evaluate the solution delivery?
- What kind of technology is needed to implement your solution program?
- Who can use it?

Tip: Your solution does not need to be a completely new solution. Smart inventors quite often make improvements or innovation on existing products or apply it in a different field.

Review and summarise:

Regularly reviewing team discussions is a good process. During team discussions, many pieces of information may come out, but this information will tend to be neglected over the course of solution development. However, sometimes when team is getting stuck with their idea or discussion, this fragmented information can be helpful.

Reference A:

When an autonomous vehicle causing human injury or object damages while driving, how should the law determine responsibilities?

https://technews.tw/2019/01/10/tesla-s-in-autonomous-mode-kills-robot-in-hit-and-run-at-las-vegas-ces-show/

09/01/2019: A Tesla self-driving car accidentally "crashed" into a robot in Las Vegas, making it unable to participate in the CES show.

Reference B:
The National Highway Traffic Safety Administration (NHTSA) has proposed a formal five-level classification system for autonomous driving (2016 version):

LEVEL 0 No Automation
At Level 0 Autonomy, the driver performs all operating tasks like steering, braking, accelerating or slowing down, and so forth.

LEVEL 1 Driver Assistance
At this level, the vehicle can assist with some functions, but the driver still handles all accelerating, braking, and monitoring of the surrounding environment. Think of a car that brakes a little extra for you when you get too close to another car on the highway.

LEVEL 2 Partial Automation
Most automakers are currently developing vehicles at this level, where the vehicle can assist with steering or acceleration functions and allow the driver to disengage from some of their tasks. The driver must always be ready to take control of the vehicle and it still responsible for most safety-critical functions and all monitoring of the environment.

LEVEL 3 Conditional Automation
The biggest leap from Level 2 to Levels 3 and above is that starting at Level 3, the vehicle itself controls all monitoring of the environment (using sensors like LiDAR). The driver's attention is still critical at this level but can disengage from "safety critical" functions like braking and leave it to the technology when conditions are safe. Many current Level 3 vehicles require no human attention to the road at speeds under 37 miles per hour.

LEVEL 4 High Automation
At Levels 4 and 5, the vehicle is capable of steering, braking, accelerating, monitoring the vehicle and roadway as well as responding to events, determining when to change lanes, turn, and use signals.

At Level 4, the autonomous driving system would first notify the driver when conditions are safe, and only then does the driver switch the vehicle into this mode. It cannot determine between more dynamic driving situations like traffic jams or a merge onto the highway.

Level 5 Complete Automation
Last and least (in terms of human involvement), is Level 5 autonomy. This level of autonomous driving requires absolutely no human attention. There is no need for pedals, brakes, or a steering wheel, as the autonomous vehicle system controls all critical tasks, monitoring of the environment and identification of unique driving conditions like traffic jams.

The above is based on the SAE International's publication of another classification system based on these five different levels (from driver assistance to fully automated systems). The design concept is the classification of "who is doing, what to do".

https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety