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AI autonomous driving	Participation Category	Team	How to Create
	Junior / Senior	1-3 people, teams	Preproduction

1. Description

AI autonomous driving is an event in which a four-wheeled car-like robot autonomously drives a lane between two lines on a stadium and performs a given mission through learning. It evaluates technical skills such as AI programming, including data collection, data processing, modeling, and model utilization, as well as problem-solving skills appropriate to the stadium environment.

2. Robotics

2.1 Type of robot: A robot with a four-wheeled structure that can drive on wheels.

2.2 Robotics: Proceed to preproduction.

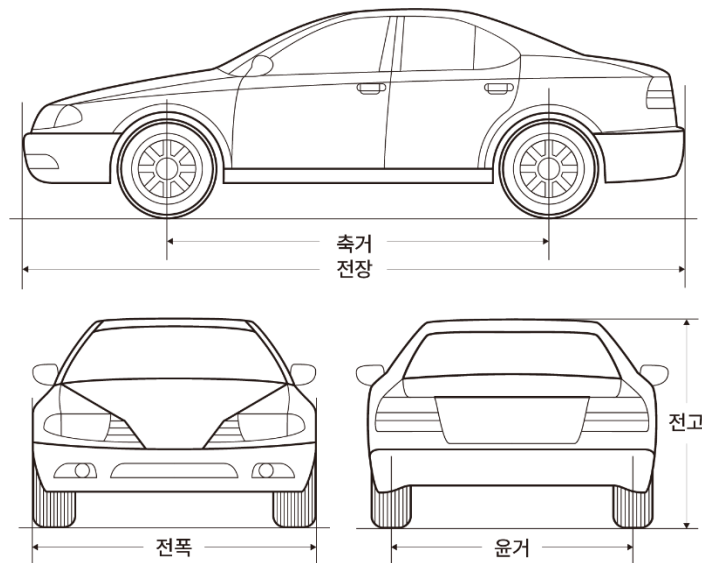
2.2.1 Dimensions of the robot

2.2.1.1 Size of the robot

- 1) Dimensions: no more than 18 cm x 20 cm x 25 cm (W (full width) x D (full length) x H (full height))
- 2) Wheeltrack: The robot must have a minimum of 6 centimeters of wheeltrack on each axis of the front and rear wheels.
- 3) Wheelbase: Each axis of the robot must have a minimum wheelbase of 6 centimeters.

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<Figure 1> Standard name of the robot

2.2.1.2 Computing resources: If you are using a GPU, it should be configured with the same learning environment as the Jetson TX1 or 2 board, but other Arduino or Raspberry Pi boards can be used.

2.2.1.3 Cameras: No limit on the number of cameras .

2.2.1.4 Measuring Robot Size

- 1) Participants can autonomously measure the size of their robots during build and practice time.
- 2) The referee will personally measure the size of the robot before the start of the match.

2-1) Measurement method: The contestant shall measure the size of the robot with a measuring tool after powering on the robot under the observation of the referee, and may not dispute the referee's judgment.

2-2) Correction time: If the size of the robot exceeds the standard, the robot will be given one minute to correct the problem and must be corrected at the scoreboard of the venue. If the correction is not made within the allotted time, the record will not be recognized as a violation of the standard. However, only hardware modifications are allowed, not software modifications.

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- 3) If the size of the robot is different from the size at the time of measurement and the size changes before crossing the starting line during the competition, the robot shall be disqualified as a violation of the standard.

2.2.2 Robot Motors

- 1) Drive : 1 servo motor, 1 DC motor
- 2) Sensor part : 1 servo motor

2.2.3 Robot sensors: Camera (smartphone camera not available)

2.2.4 Robot controllers: Controllers are unlimited (smartphone controllers are not allowed)

2.2.5 Powering the Robot

2.2.5.1 Power source: Must use an autonomous mobile off-grid power source, no combustion engines.

2.2.5.2 Capacity of the power source: There are no limits on current and voltage.

2.2.5.3 Driving the robot: The robot must learn and drive the mission map presented at the stadium on the day of the competition.

2.3 Programming and Piloting: The robot must be capable of autonomous operation through a program created on-site and must not be controlled from the outside except for departure.

2.3.1 Communication: Programming must be done using the WIFI provided by the organizers and any use of personal communication devices will result in disqualification.

2.3.2 Laptops: All programming materials, messengers, etc. related to the competition must be removed from the laptop, and any violation will result in disqualification, and if found after the competition, will result in disqualification and invalidation of the award.

Violations include the following details

- 1) Cheating by saving pre-built code using Notepad, which comes pre-installed on your laptop.
- 2) The cheating is discovered by staff, other participants, or other moderators.

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- 3) Evidence of cheating left on a laptop after a match is over is discovered
- 4) engaged in other behavior that is considered a violation of the rules, etc.

3. Arena Configuration

3.1 Authorized venues: Use authorized venues as defined by the International Robotics Olympiad Committee.

3.2 The dimensions and configuration of the arena: It consists of curved and straight lanes in a space of 3M x 3M.

3.2.1 Playing field tolerance: Tolerance Playing fields can have a slope of no more than 2° ($\pm 10\%$ tolerance) and unevenness or gaps of no more than 3 mm ($\pm 10\%$ tolerance).

3.3 Stadium Field

3.3.1 Mission Map: This uses a printed mission map, secured to the playing field with sheets and tape.

3.3.2 Lines: 2 cm wide ($\pm 10\%$ margin of error) and the color will be revealed on the day of the competition. The color will be white. <Revised on June 12, 2024

3.3.3 The shape of the lane: A lane is formed by two lines running parallel to each other. Lanes exist in straight and curved shapes. The space between lines is 20 centimeters.

3.3.4 Background: The background space outside of the lane is colored black. <Revised June 21, 2024

3.4 Obstacles: Each mission will contain the following obstacles

3.4.1 Traffic light: Traffic lights that were red turn green when the robot is recognized.

3.4.1.1 Traffic lights use LED lamps with RGB representation.

3.4.1.2 A signal is displayed with a single lamp, which changes color to indicate a signal.

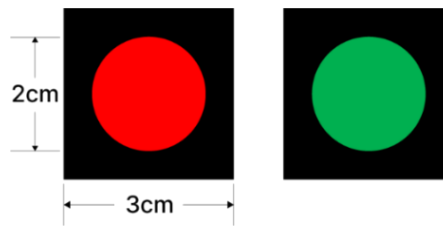
3.4.1.3 Traffic lights that are initially set to red will turn green after robot recognition.

3.4.1.4 Position the traffic light and sensor on the right or left side.

3.4.1.5 The dimensions of the traffic signal lamp are 3 cm (± 0.5 cm) by 3 cm (± 0.5 cm) (H x W x D), including the rim. (The border of the traffic signal lamp is black.) Install the traffic signal lamp so that its bottom is 8 cm (± 2 in) above the ground.

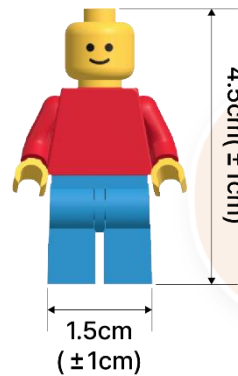
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<Figure 2> Traffic light example

3.4.2 Sudden Missions: Will be assigned by the organizers on the day. The location of the sudden mission will be changed between the first and second periods, and the location of the sudden mission will be the same in the same period. <Revised on June 5, 2024> When a human model is found, the robot must stop or avoid it as shown in Figure 3.

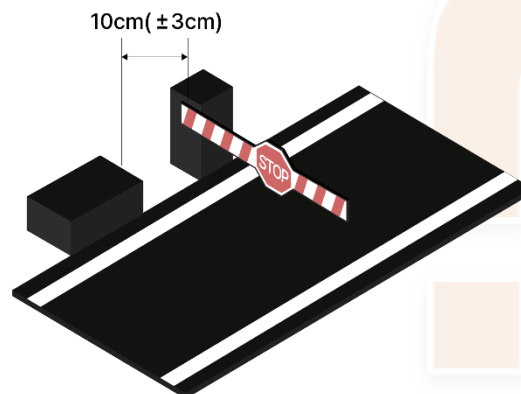


<Figure 3> Example of a human model in Sudden Mission

3.4.3 Blockbar: The blockbar is closed and opens automatically 5 seconds after robot recognition.

3.4.3.1 The barrier is 20 centimeters (± 2 centimeters) long. The bar is 2.5 centimeters off the ground.

3.4.3.2 Barriers and sensors are installed on the left or right side of the lane.



<Figure 4> Example of blockbar installation (when installed on the left)

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4. Match progression

- 4.1 How the match works:** The match is a record match, with a total of two chances, with a correction period between each attempt.
- 4.2 Robot construction and practice time:** The robot will be given a minimum of 4 hours to build and practice, which will be announced on the day of the competition. The amount of practice time can be adjusted depending on the number of participants, but the minimum is 4 hours.
- 4.3 Assign arenas:** Assign arenas based on the number of players and difficulty level of the competition.
- 4.4 Production and Practice:** Participants may practice in their assigned arena until the end of the announced production and practice time, and may not begin practice before their arena assignment.
- 4.5 End of Build and Practice Time:** When Build and Practice Time is over, stop your robot and follow the instructions of the moderator to your seat.
- 4.6 First period of the match:** Immediately following the build and practice period (or after lunch), conduct the first period.
- 4.6.1 Match Preparation:** All competitors must come out with their robots and wait as directed by the referees and officials at each venue.
- 4.6.2 Waiting after a match:** All participants take their turn to play and wait in a queue until all participants have finished playing, rather than returning to their seats.
- 4.7 Modification Time:** After the first period of the match, all competitors will be given time to modify or practice their robots. The modification time will be announced on the day of the match.
- 4.8 Second Period:** The second period of the match will be held immediately after the end of the correction period.
- 4.8.1 Match Preparation:** All competitors must report to the designated location with their robot and wait as directed by the referees and officials at each venue.

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4.8.2 Wait: All participants take their turn to play and return to their seats to wait.

5. Mission

5.1 Scoring Points Points are awarded for the sum of course time and mission completion. Course time means the score for each checked section in the arena. These sections are marked on the map on the day. (See 6.2 for the scoring table). <Revised 06/05/2024>.

5.1.1 Deduction factors

5.1.1.1 If one or more of the robot's wheels are completely off the line, award a penalty of 1 point. (One or more wheels must be completely off the line to be penalized; if they are slightly off the line, it is considered normal behavior.)

5.1.2 Non-Mission Scoring Driving: If a Robot is driven with one or more wheels completely out of line, the Mission Score for that segment will not be recognized and a penalty will be assessed in accordance with Section 5.1.1.1. <Revised June 5, 2024

5.1.3 Obstacle Missions

5.1.3.1 Traffic Light: There is a stop zone in front of the light, the extent of which depends on the mission. The robot must stop within the stop zone, and if the robot stops outside of the stop zone provided by the mission, the sensor will not work and the light will not change color. The stop zone is not marked. The stopping zone will be learned by the participants through on-the-job training.

5.1.3.2 Blockbar: The stopping distance between the robot and the bar depends on the mission. If the stopping distance is longer than the mission requires, the sensors will not work and the bar will not be raised.

5.1.3.3 Sudden mission: Will be placed on the day's map by the host referee at random locations and must be stopped when given a stop (see 3.4.2). Failure to stop or hitting a target will result in no points for the stop. <Revised 06/05/2024

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5.1.3.4 Stopping within the stop zone: **Stopping** within the stop zone means that the robot stops within the range recognized by the sensors, that part of the robot must be within the stop zone, and that the robot stops so as not to interfere with the operation of traffic lights or barriers. Failure to stop or interfering with the operation of a barrier or traffic light will result in no mission points and a 2 point penalty. <Revised June 6, 2024

5.1.3.5 Failure to complete an Obstacle Mission: Failure to complete an Obstacle Mission will result in a deduction and will be assessed against your driving record.

5.2 Start: Launch the robot and position it behind the blockbar at the start point. At this point, the robot must be drivable and must first recognize the blockbar at the starting point and remain stationary. The robot must start when the referee gives the signal by pressing the Start button or when the barrier is raised, and the timer starts at the same time as the button is pressed. <2024.06.14 Revision

5.2.1 Failure to Start: A robot will be declared a failure to start if it is not in a drivable condition within 10 seconds. In addition, if the robot fails to start within 10 seconds after the barrier is raised, it will be declared a non-start and given a chance to restart. Teams will be given two (2) restarts for a non-start.

5.2.2 False Start: If the robot is activated before the referee presses the start button and hits the barrier or leaves the playing field, it will be declared a false start and will have one chance to restart.

5.2.3 Restart: You will be given one restart opportunity per false start. However, you can get a maximum of 2 restarts. (Restarts do not count toward the number of restarts for a missed or false start. Example: No restarts for a missed start after a false start. One restart after a missed departure. One restart opportunity for a false start after a missed departure. No restart after a second no-show).

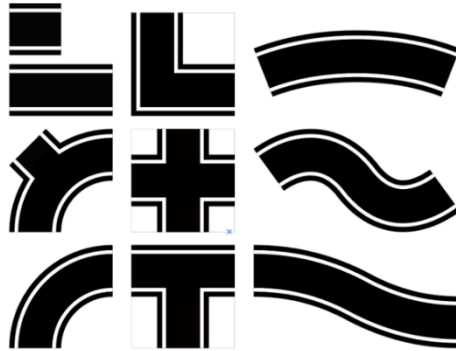
5.3 Arrival: The match ends when the robot passes the endpoint.

5.4 Time Limit: Total match duration is up to 5 minutes.

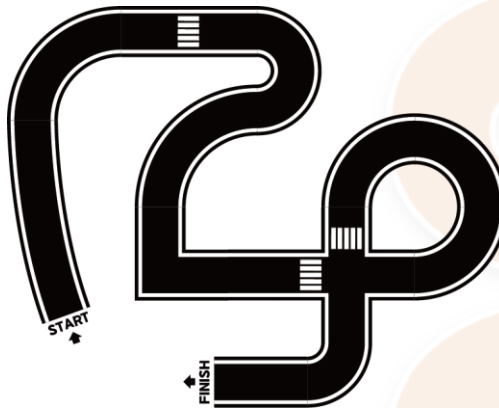
5.5 Reveal the mission: The course to be traveled by the robot is revealed on site before the start of the competition and consists of a combination of lanes as shown in Figure 5. Each combination of tiles is composed of 30cm x 30cm / 60cm x 60cm / 60cm x 60cm / 60cm x 120cm. See archive <revised on June 14, 2024>.

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<Figure 5> Shape of a lane



<Figure 6> Example of a Combined Stadium Course

5.6 End of match

- 5.6.1 **Robot Arrival:** 5.3 ends the match. <Revised June 5, 2024
- 5.6.2 **End of time:** If you do not pass the arrival point, your score at the end of the time limit will be accepted as your record.
- 5.6.3 **Robot Stop:** If a robot stops moving during a match, the referee will give it 10 seconds. If the robot does not start up again within the count, the robot is declared to be stopped and the score at the time of the stop will be recognized.
- 5.6.4 **Technical Knock Out (TKO):** If the robot is unable to run normally, the referee may declare a TKO, which is equivalent to stopping the robot without the 10 seconds. The final driving time will be reflected without the 10 seconds of TKO, but the time will be recognized in case of a tie. <2024.06.14 Revision
 - 1) Repeatedly moving an area
 - 2) You've stopped progressing at a point because you're stuck or blocked by a structure, obstacle, etc.

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3) Leaving the arena (falling robots), etc.

5.6.5 Lane out: When a robot is not in the line that constitutes a lane, the match is over and the results up to the time of the declaration of the end are recognized.

5.7 Ending a match by disqualification: If a player violates the rules of the game or engages in behavior that disrupts the game, the match will end by disqualification and the player's score will not be recognized.

5.7.1 Robot Touch: If a player touches a robot during a match without the permission of the referee and supervisors, a robot touch will be declared and the player will be disqualified.

5.7.2 In-Competition Robot Repairs: and Program Modifications Adding, removing, exchanging, or altering parts of the robot during competition is prohibited, and any competitor found with spare parts, tools, batteries, laptops, etc. for the purpose of repairing or modifying the robot's programming while waiting to compete will be disqualified.

5.7.3 Sensor tuning: Anyone attempting or caught tuning sensors in the arena before the start of the match will be disqualified.

5.7.4 Failure to honor venue assignment: Participants caught practicing or competing in a venue other than their assigned venue will be disqualified.

5.7.5 False Start: Two false starts in a given race will disqualify the competitor.

5.7.6 Miss start: Two miss start in each race will disqualify the competitor.

5.8 Rematch: In the event of an unforeseen event, such as a power outage, a rematch may be held at the discretion of the referee and supervisors.

5.9 Referee's Rulings: The referee has the authority to preside over all situations and supervise the participants from the start to the end of the match. Deciding the outcome of a match is the sole authority of the referee and his/her declaration is final.

6. Match history

6.1 Referee's Rulings: The referee has the authority to preside over all situations and supervise the participants from the start to the end of the match. Deciding the outcome of a match is the sole authority of the referee and his/her declaration is final.

6.2 Missions Performed: Adds up the points for missions performed for each leg of the trip. <Revised June 5, 2024

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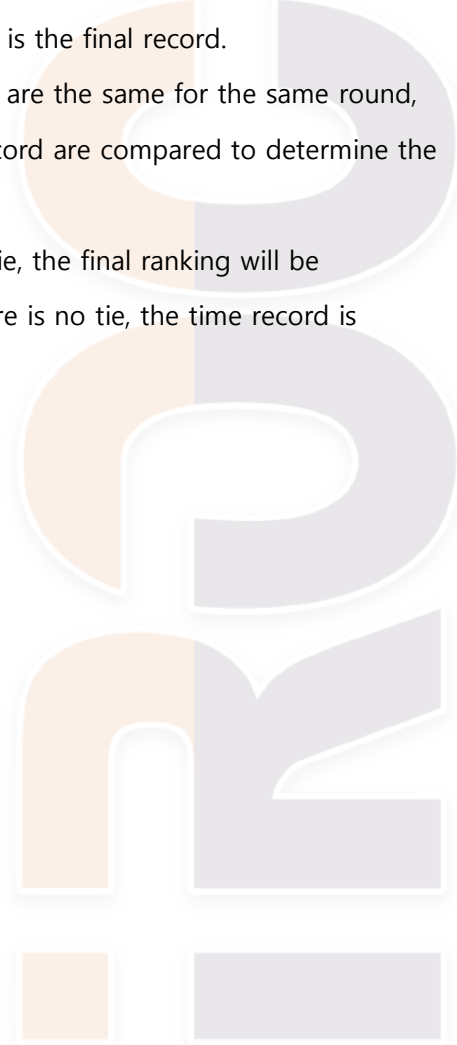
Course driving time (10 points total)	Score by zone, net10 / 9 / 8 / 7 / 6 / 5 / 4 / 3 / 2 / 1	
Mission accomplishment (20 points total)	Traffic lights	4
	Blockbars	6
	Sudden Missions	10

<Course duration + Mission accomplishment >.

6.3 Final Score: The better of the first and second rounds of two runs by summing the course driving time and mission performance score is the final record.

6.3.1 Prioritization by time: If the driving results are the same for the same round, the records from different rounds's time record are compared to determine the ranking.

6.3.2 Priority in case of a tie: In the event of a tie, the final ranking will be determined by time record. However, if there is no tie, the time record is irrelevant <2024.06.14 revision>.



International Robot Olympiad Committee