



کمیته ملی روبو کاپ ایران



RoboCup Iran open Self-driving Car league rulebook

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1. Introduction

1.1. RoboCup

RoboCup is an international joint project to promote AI, robotics, and related fields. It is an attempt to foster AI and intelligent robotics research by providing standard problems where a wide range of technologies can be integrated and examined. More information can be found at <http://www.robocup.org/>.

1.2. RoboCup Self-Driving Car league

According to the statistics, 90% of road accidents are due to human error, and about 1.35 million people die each year as a result of road traffic crashes. Self-driving cars can ensure the safety of people and vehicles are becoming more valuable every day. Therefore, in this competition, our priority is safety. That means in scoring, obeying rules and driving safe, have more score than finishing in time. The competition's objective is the development of a 1/10 scale self-driving electric car that must accomplish different tasks, such as lane-keeping, acting according to traffic signs, giving way, parking, emergency braking, etc.

1.3. Participation in the Competition

Participation in Self-Driving cars league requires successfully passing a qualification procedure. This procedure is to ensure the quality of the competition event and the safety of participants.

1.4. Steps to Participate

All teams that intend to participate at the competition have to perform the following steps:

1. Preregistration (by sending email to the TC)
2. Submission of qualification material, including a team description paper and possibly additional material like videos or drawings.
3. Final registration (qualified teams only)

All dates and concrete procedures will be communicated in due time in advance.

1.5. Registration

- The maximum number of team members is 10.
- Only the team leader can lead two teams, provided the two teams have completely different hardware and software specifications, as verified by the

technical committee. No other team member is allowed to be a part of more than one team. The technical committee will verify this distinction.

1.6. Team Description Paper

The Team Description Paper (TDP) is a central element of the qualification process and has to be provided by each team as part of the qualification process. The TDP should at least contain the following information in the author/title section of the paper:

- Name of the team (title)
- Team members (authors), including the team leader
- Link to the team web site (if any)
- Contact information

The body of the TDP should contain information on the following:

- focus of research/research interest
- description of the hardware, including an image of the robot
- description of the software, esp. the functional and software architectures
- innovative technology (if any)
- applicability and relevance to **real-world** tasks

The team description paper should cover in detail the technical and scientific approach.

2. General rules

2.1. Design of Car

The cars used in these competitions must be powered by electric motors. Both 4WD and 2WD cars are allowed, with a minimum requirement of four wheels. At least one axle must be steerable, and the use of differential steering is prohibited.

All cars must adhere to the following specifications:

1. The wheelbase must measure a minimum of 200 mm, as shown in Fig. 1.
2. The track width must measure a minimum of 160 mm, as shown in Fig. 1.

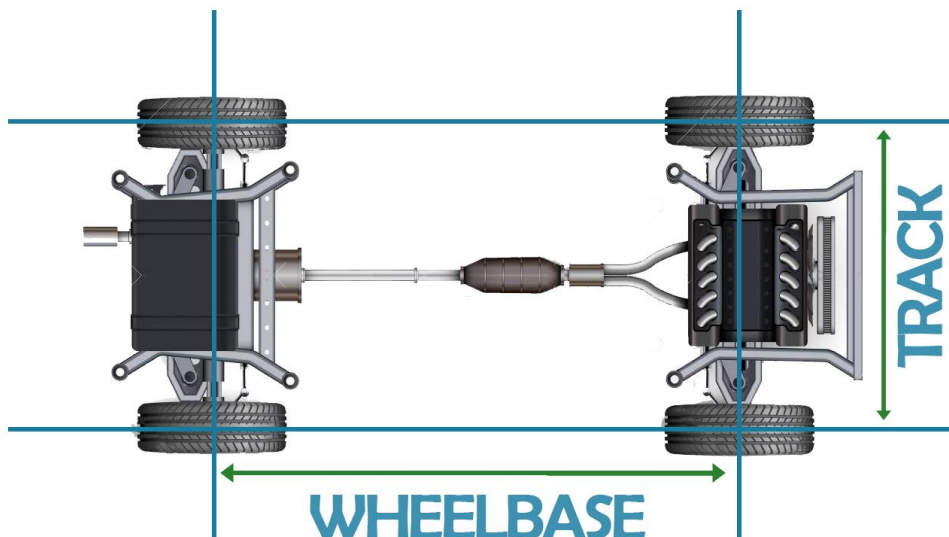


Figure 1

3. The car must not exceed a width or height of 300 mm.
4. The car must be capable of passing through a gate with inner dimensions of 300 mm in height and 300 mm in width.
5. All processing must be performed onboard, and any external data or signal transmission during the race is strictly prohibited. Violation of this rule will result in disqualification.
6. The use of ready-made solutions such as Donkey Car or JetRacer is prohibited.
7. In terms of using a remote control, a flashing light must be installed on the top of the car to indicate RC-mode.
8. The car is not allowed to save the race track.
9. Any wireless mobile communications, including 2G/3G/4G/5G, are prohibited.
10. All parts of the robot should be observable by the technical committee.

2.2. Competition track

2.2.1. Course

The competition track will adhere to the following specifications:

- The course surface is dark black with white lines, resembling a typical street.
- The width of the lines varies: 20 mm for roadway boundaries (outer lines), 15 mm for lane boundaries (dashed centerline), and 30 mm for stop lines (refer to Fig. 2).
- Dashed lines on the course have a length ranging from 200 to 300 mm, with a distance of 100 to 200 mm between them (see Fig. 2).
- The inner roadway width falls within the range of 300 mm to 400 mm (refer to Fig. 2).
- All bends are constructed from circular segments with a minimum radius of 1000 mm (see Fig. 3).
- The roadway may feature both dashed and continuous lines.

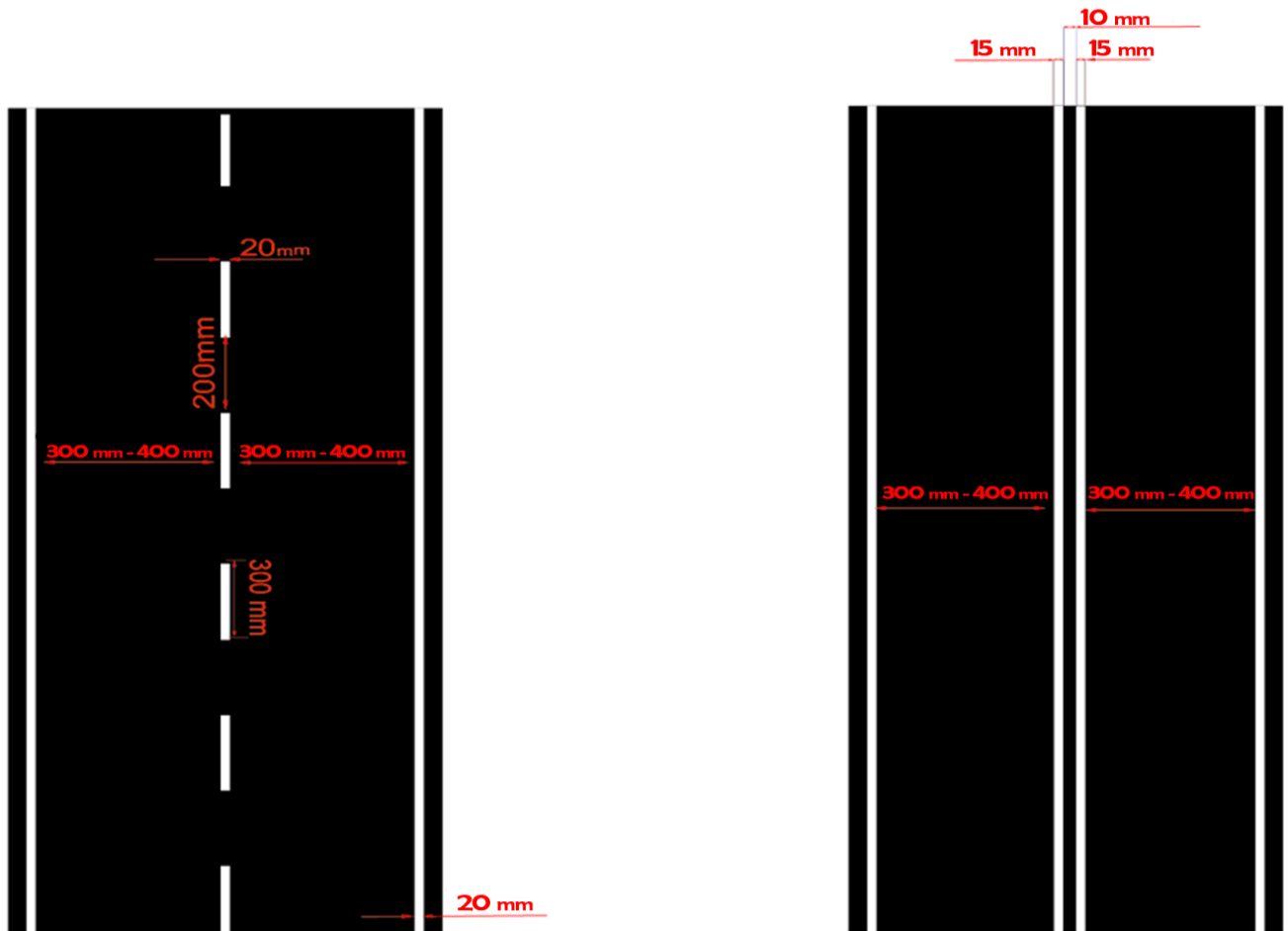


Figure 2

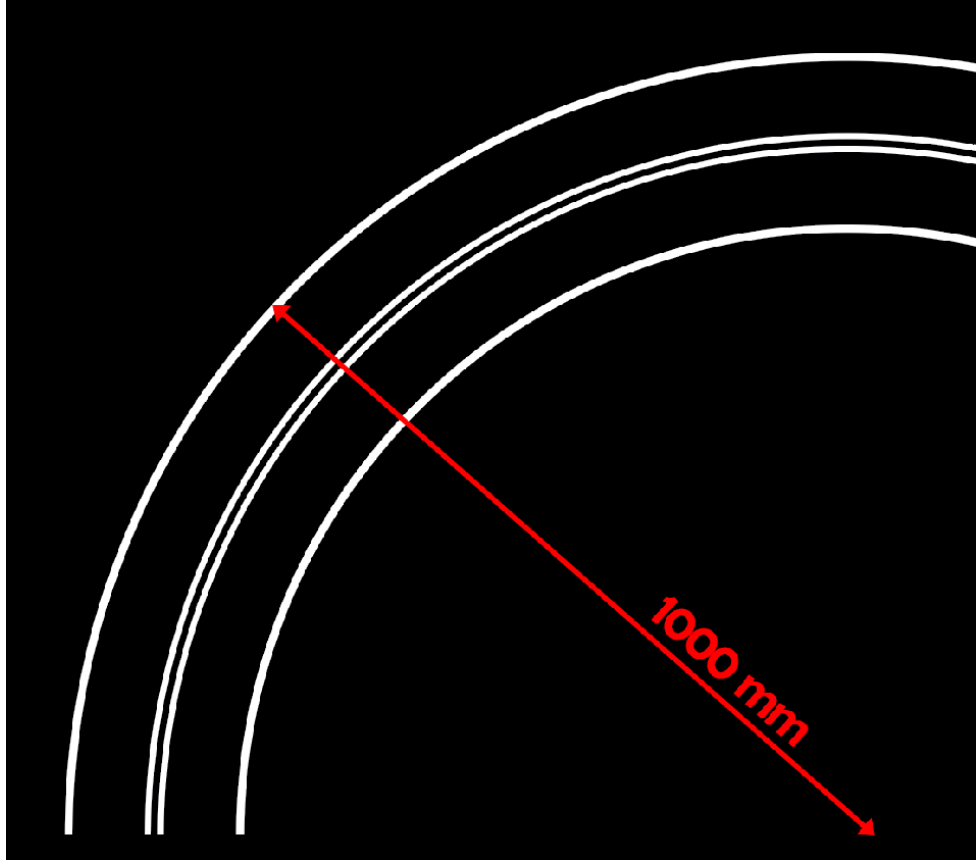


Figure 3

2.2.2. Traffic signs

The type and position of traffic signs on the competition track is described as below.

Traffic signs can also be replaced with an AprilTag upon the competitor's request. Each AprilTag includes a white boundary measuring 10-20 mm around it as shown in fig. 4,5,6 and table 1.

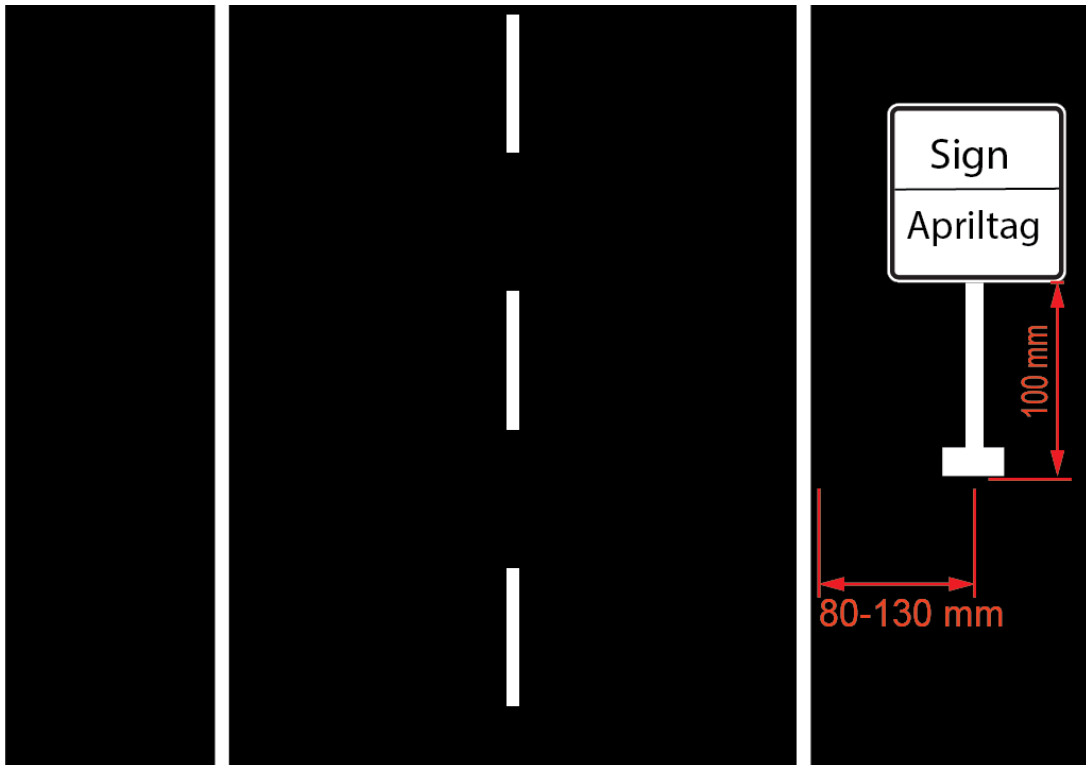


Figure 5

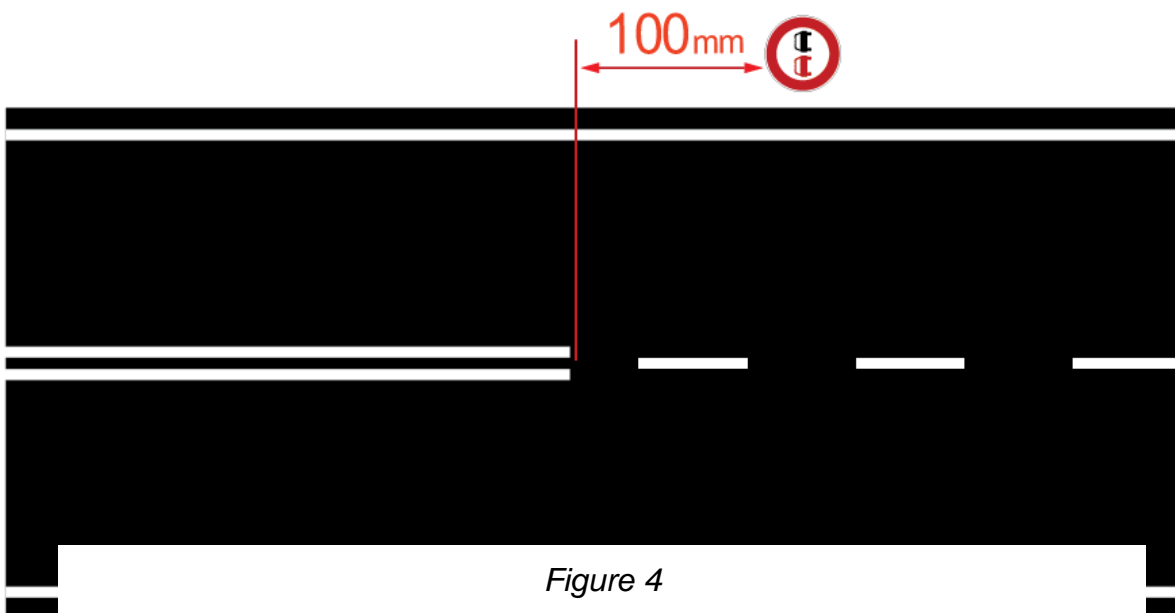


Figure 4

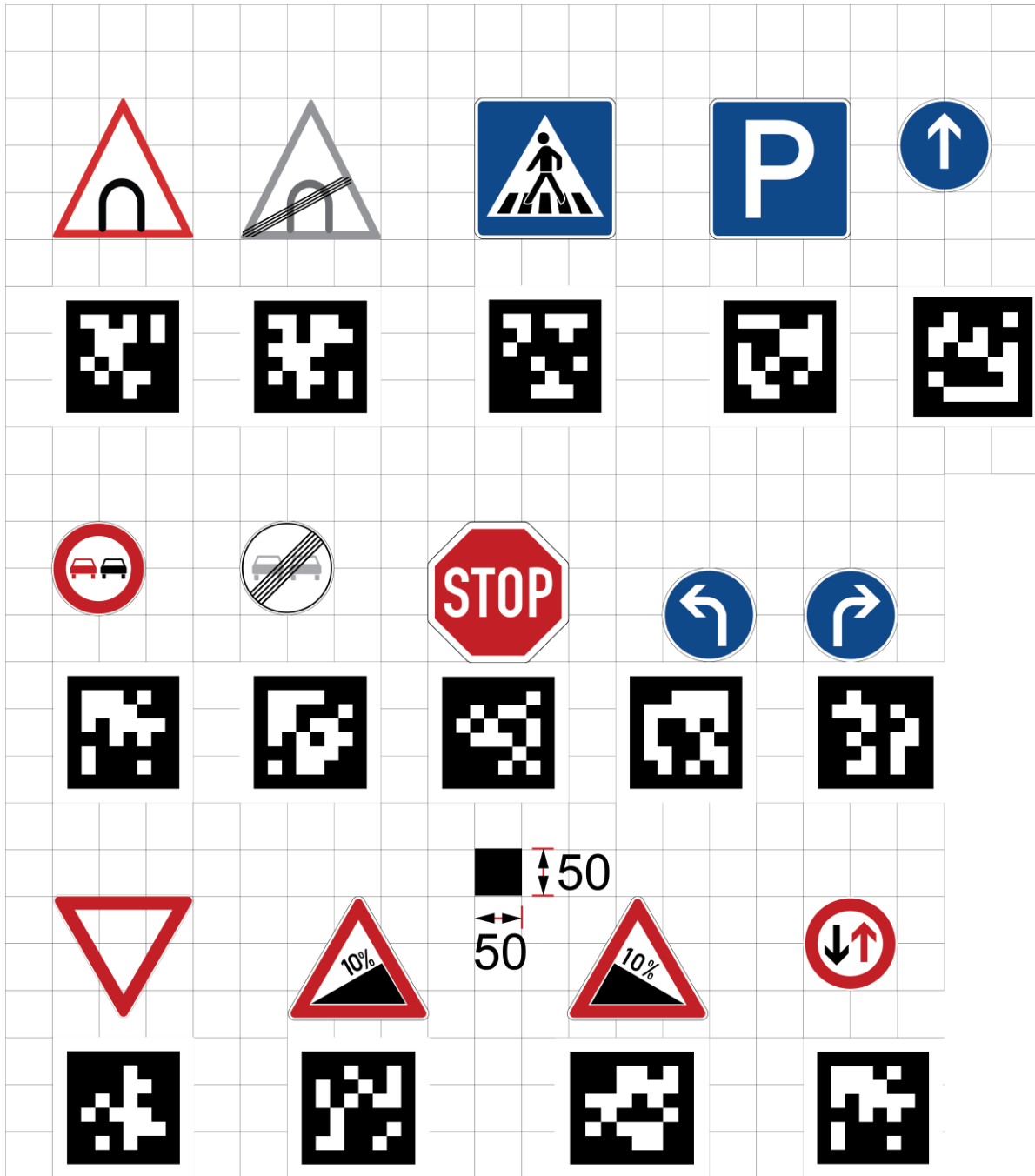

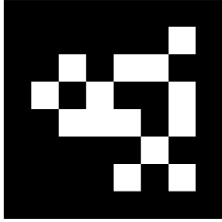

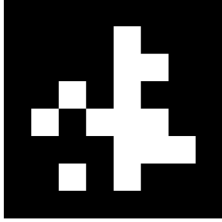

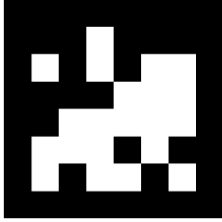

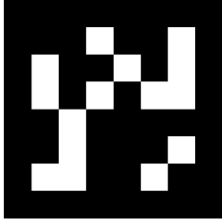

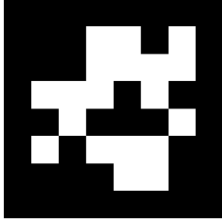

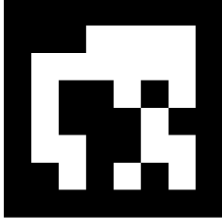

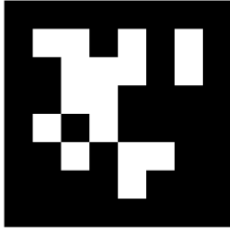

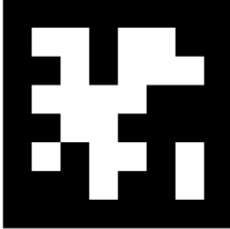

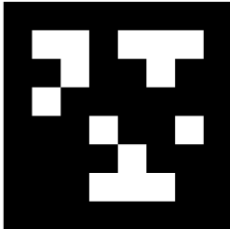

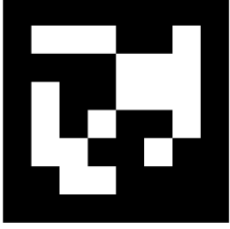




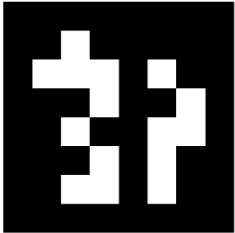


Figure 6

Table 1

<p>Stop</p>		
<p>Priority over</p>		
<p>Barred area</p>		
<p>Steep hill</p>	 <p>uphill grade</p>	
<p>Steep hill</p>	 <p>downhill grade</p>	
<p>Turn left</p>		

<p>Tunnel Beginnig</p>	 beginning	
<p>Tunnel End</p>	 end	
<p>Cross walk</p>	<p>Crosswalk</p> 	
<p>Parking zone</p>	<p>Parking Zone</p> 	
<p>No - passing zone</p>	 beginning	
<p>No - passing zone</p>	 end	

Turn right		
go straight		

2.2.3. Traffic lights

Traffic signs will be present at intersections. As shown below (fig. 7).

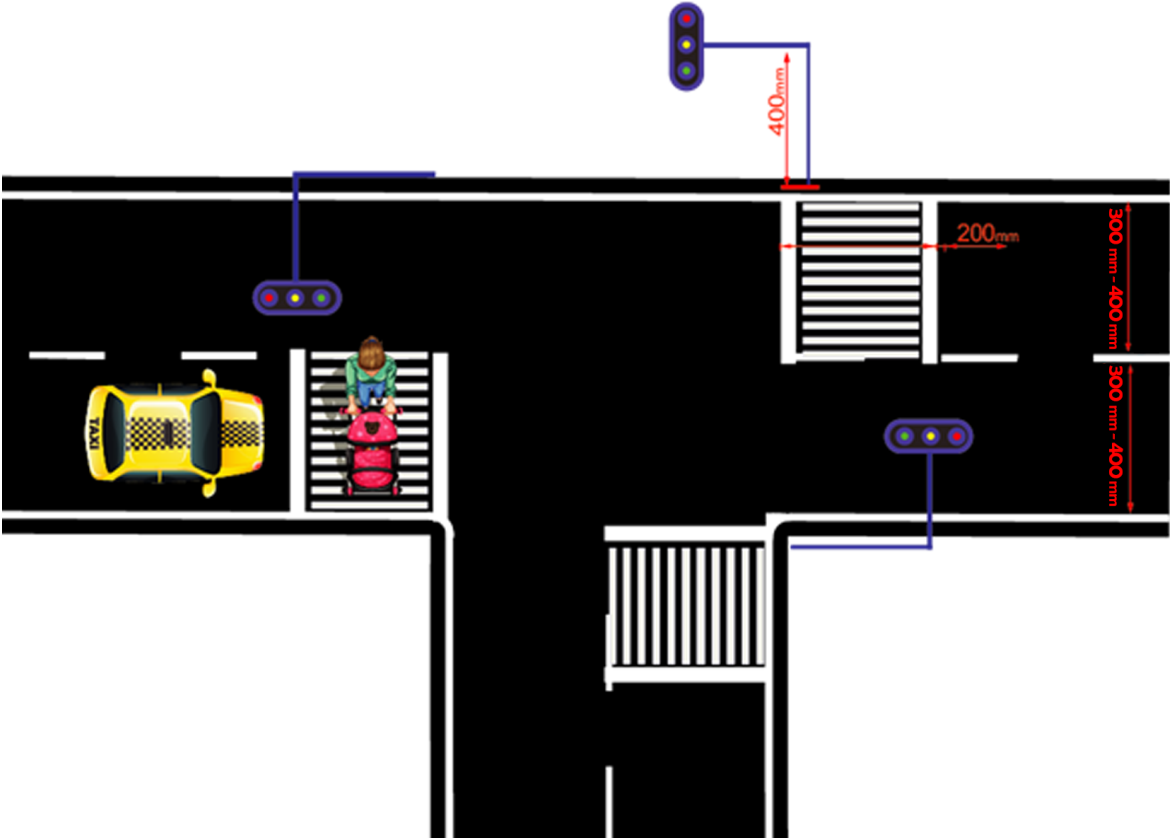


Figure 7

2.2.4. Tunnels

There will be a tunnel along the race track that may have lighting or not. The tunnel will be on the straight track, and indicates by tunnel sign 10 cm before tunnel.

2.2.5. Buildings

It is possible that buildings or building-like structures are set up adjacent to the road.

2.2.6. Plants

It is possible that trees or other plants are set up adjacent to the road.

2.2.7. Static Obstacles

Static obstacles may be anywhere on the racecourse. These obstacles may be cars, dolls or rocks.

2.2.8. Bridge

There may be a bridge with a 50% slope on the race track.

2.2.9. Dynamic Obstacles

There will be dynamic obstacle on the track. Its shape resembles the static obstacles. Dynamic obstacles will act like human driving.

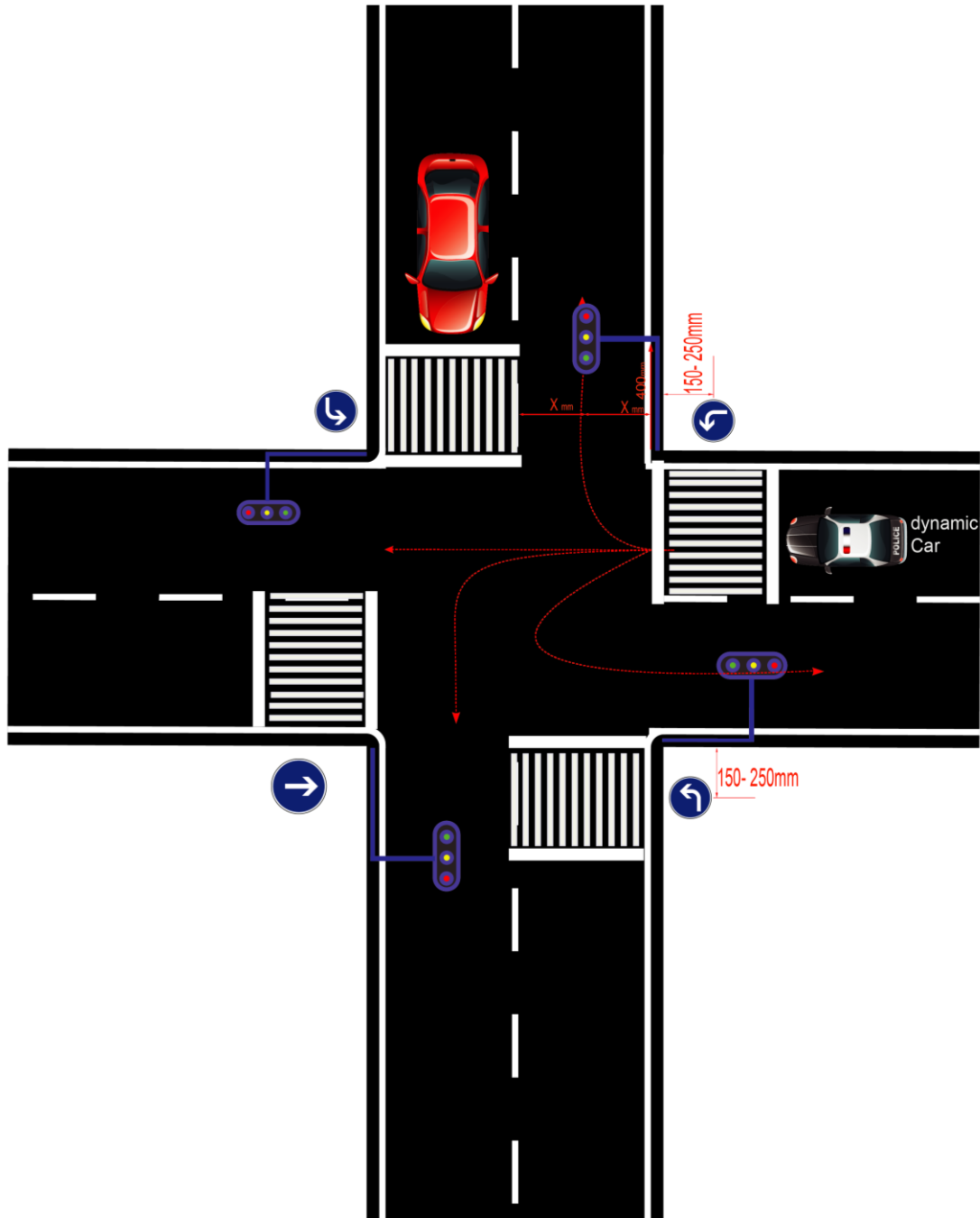


Figure 7

2.2.10. Crosswalks

There will be crosswalks on every junction that is described in the pictures as well as crosswalks may be present in the track. Crosswalk in the track other than intersections is indicated by a corresponding traffic sign. On the roadside, at each crosswalk, a pedestrian may wait to cross the road. The cars must stop on both sides whenever a pedestrian steps onto the crosswalk. If there is no pedestrian on a crosswalk, the car must stop for three seconds and then pass.

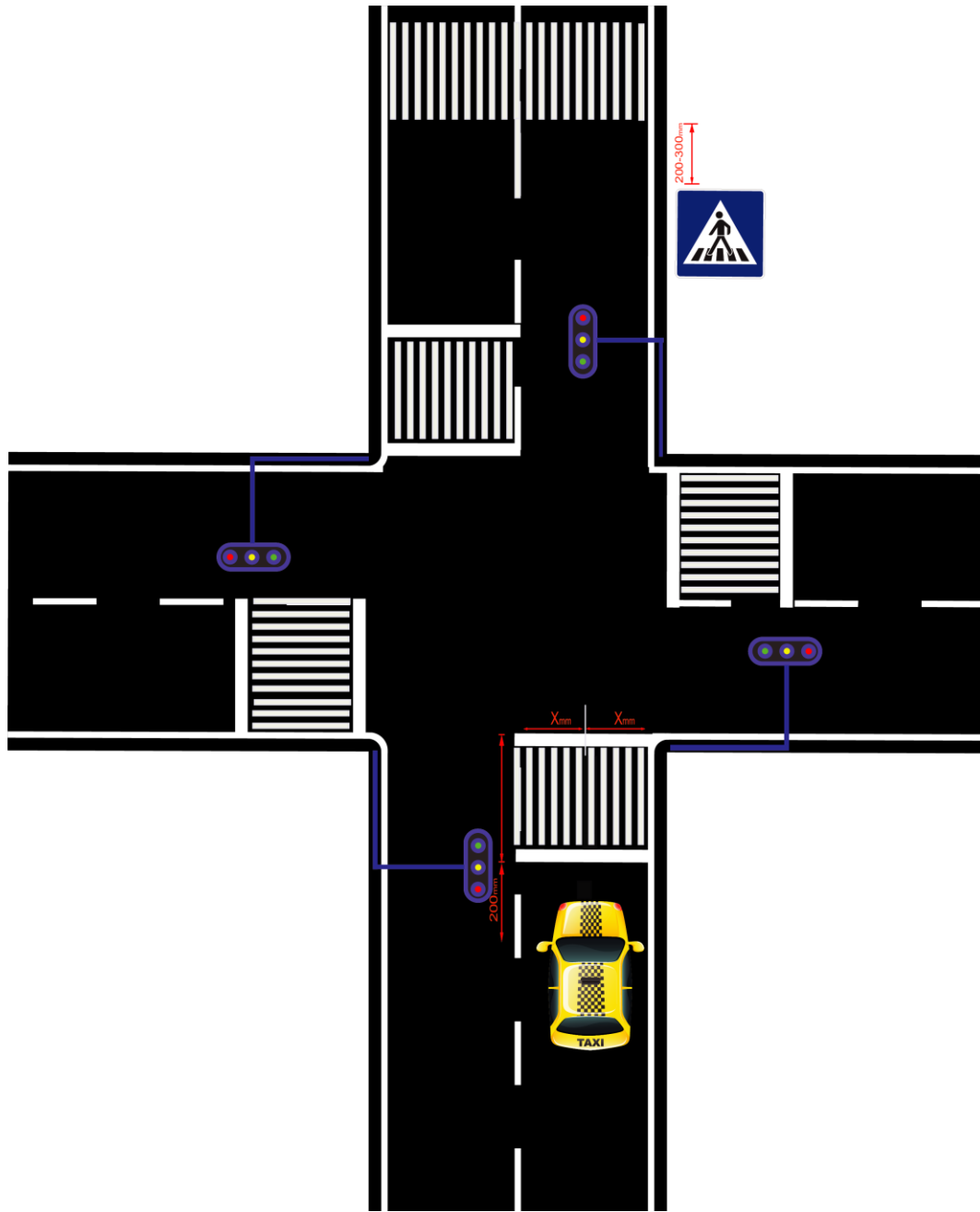


Figure 8

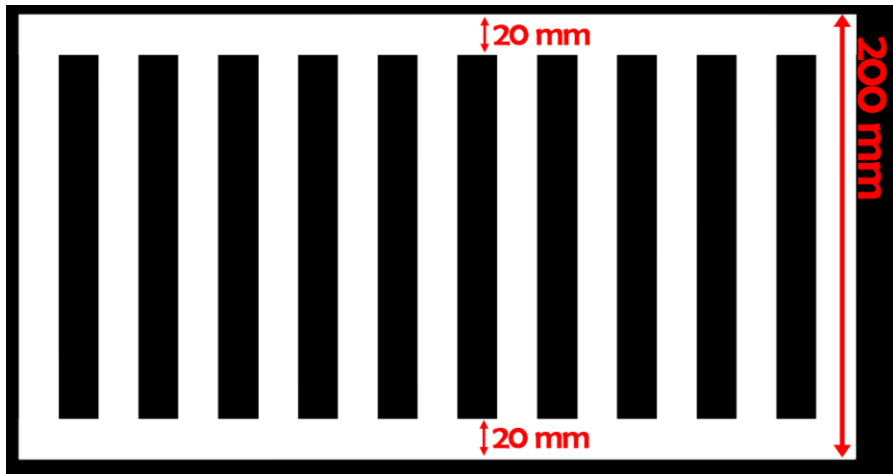


Figure 9

2.2.11. Parking

There will be two parking areas on the track. One cross parking on the right and one parallel parking on the left of the road. After passing the parking sign, the car shall find a parking spot within the parking areas and maneuver into it, without touching the surrounding obstacles.

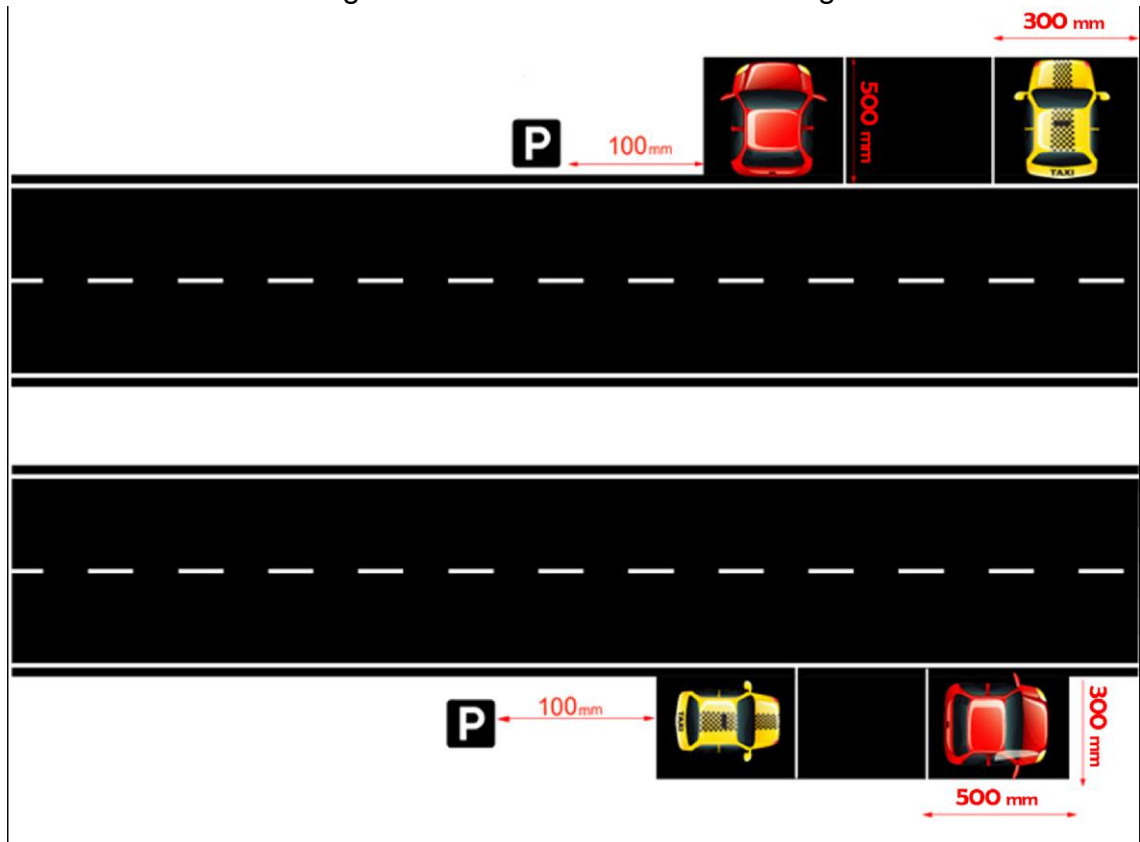


Figure 10

3. Competition procedure

This competition comprises two components: a suburban race and an urban performance competition, each featuring distinct tasks. Each stage is assigned a score, and the final team score is the sum of both stage scores. The start and finish lines are marked by a stop sign (or corresponding April tag). The race begins when the stop sign is removed, and the robot must come to a stop between 10 cm and 1 cm from the sign at the end of the track, remaining stationary for 10 seconds after the stop sign is removed.

Each team is granted one to three runs in both stages, depending on the number of participating teams. During each run, three resets are allowed. Checkpoints are positioned along the designated course, with each crossing contributing positive points. The last passed checkpoint serves as the reference for total run time and scoring calculation. Before the start of each run, all robots will undergo a quarantine.

Key rules regarding resets:

Resets can only be used when the car goes entirely off the race track.

Only the captain has the authority to call for a reset.

In the event of a reset call, only the captain can place the car inside the raceway. The car must be positioned before the last checkpoint. The captain may also utilize a reset button if available.

3.1. Suburban race

In this stage, the objective is for the robots to navigate the race course as swiftly as possible and reach the finish line. The course is free from obstacles, pedestrian lanes, traffic signs, traffic lights, etc. The scoring is based on the time it takes for a robot to cross the finish line or the time recorded at the last checkpoint.

In this challenge, the arrangement of robots may vary depending on the number of participating teams. In instances with multiple teams, two robots can be positioned on the road, each in a designated lane. One robot is placed in the left lane, and another is placed in the right lane. These robots will then compete against each other.

3.2. Urban performance competition

In this stage the main challenge is performance of the robot in urban environment. The race course may have obstacles, traffic signs, traffic lights, tunnel, cross walks and parking zone.

4. Scoring

In general, the criterion for scoring is race completion time and the number of errors. In the following, the method of scoring in the two sections of the speed competition and the performance competition is discussed.

*Teams should pass technical interviews. And this interview has 2000 points.

** To ensure order and a clear chain of communication, objections to the referees must be made solely by the team captain. Any objections raised by other team members will result in a 100-point deduction.

Total score = Total urban performance competition score + Total suburban race score + Technical interviews – Number of team members objections

4.1. Urban performance competition

4.1.1. Crossing task

Car arriving at a crossing must act according to signs, and it must give way at all of the following:

- At give way signs (for 3 seconds)
- At stop signs (for 3 seconds)
- Turning across the path of an oncoming car at an intersection
- Turning from a terminating road onto the ongoing road at a T-intersection
- If you're turning at an intersection, you must also give way to pedestrians crossing the road you are entering.
- Give way to pedestrian crossing in crosswalks in middle of the road.

4.1.2. Parking task

The end of the parking procedure must be signaled by a stop of at least 5 Seconds. Car parking is optional and has positive points.

4.1.3. Tunnel

Crossing the tunnel is optional, and the correct crossing has positive points.

4.1.4. Crosswalks

Skip the crosswalk procedure has negative points.

4.1.5. Obstacles

Each touching an obstacle has negative points.

4.1.6. Track

If the car completely Get off the track, it has negative points, and it can continue the race only if the captain calls for reset.

4.1.7. Traffic signs

Failure to maneuver correctly based on the associated traffic sign or April tag has negative points. Correct maneuvering based on the associated traffic sign has extra positive points. April tags have no such extra points.

4.1.8. Traffic lights

Detection and enforcement of traffic lights are optional and has positive points.

4.1.9. Timing

Each run has a specific time to complete, and it will determine before the race. Each checkpoint reference time is the total time divided by the number of checkpoints. Any extra second it takes to complete the last checkpoint has a negative point.

4.1.10. Scoring table

description	points
Time	((number of passed checkpoints ÷ total checkpoints) × reference time) – Run Time
Each Collision with pedestrian	-300
Each Collision with obstacles	-200
Get completely off the track or wrong turn in junctions	-300
Each correct traffic sign detection (except the signs that indicate the route)	+50
Each false traffic sign or April tag detection	-50
Park the car correctly	+300
Pass the tunnel correctly	+100
Each correct traffic light detection	+100
First checkpoint pass	200
Second checkpoint pass	300
Third checkpoint pass	400
Fourth checkpoint pass	500
Fifth checkpoint pass	600
Cross the continuous lines	-100

Total urban performance competition score = Time + Collision with pedestrian * N + Collision with obstacles * N + completely off the track (or wrong turn in junctions) * N + correct traffic sign detection * N + false traffic sign or April tag detection * N + Park the car correctly * N + Pass the tunnel correctly * N + correct traffic light detection * N + checkpoints pass points + Cross the continuous lines * N

****N: Each times**

4.2. Suburban race

4.2.1. Track

In suburban races, crossing both dashed and continuous lines is prohibited. if the car completely Get off the track, it has negative points, and it can continue the race only if the captain calls for reset.

Missing the stop sign at the end of the lap is considered both a lane-crossing violation and a misidentification of a traffic sign, resulting in penalties for each infraction.

4.2.2. Timing

Each run has a specific time to complete, and it will determine before the race. Each checkpoint reference time is the total time divided by the number of checkpoints. Any extra second it takes to complete the last checkpoint has a negative point.

4.2.3. Collision

In case two robots collide, the faulty robot will face 500 points penalty and the race will start again from the beginning.

description	points
Time	$((\text{number of passed checkpoints} \div \text{total checkpoints}) \times \text{reference time}) - \text{Run Time}$
Collision with rival robot	-500
Get completely off the track	-300
First checkpoint pass	200
Second checkpoint pass	300
Third checkpoint pass	400
Fourth checkpoint pass	500
Fifth checkpoint pass	600
Cross the continuous lines	-100
misidentification of a traffic sign	-50

Total suburban race score = time * 10 + Collision with rival robot + Get completely off the track * N + checkpoints pass points + Cross the continuous lines * N + misidentification of a traffic sign

****N: Each times**

5. Ranking

- there will be a 1st, 2nd, and 3rd place award trophies (first and second place only when the number of teams is eight or less).
- In order to value very specific capabilities required in self-driving cars technical challenges are part of self-driving cars league. technical challenge is separately awarded.
- There will be the best car body design award.

***All numbers may have 10% tolerance.**

*Technical committee has right to change the rules at any time until competition day.