Rules for Embedded Technology software design robot contest 2013

for Developers

Embedded **T**echnology software design **ROBO**t **CON**test 2013 for Developers (ET ROBOCON 2013 for Dev.) is a robotics competition with autonomous line tracing applications on a race track. The race track has two black lines (called in-lane and out-lane) and a competition has two distinct race trials (one for in-lane and other is for out-lane). It competes total time of the two trials. In ET ROBOCON 2013, the robot is constructed of LEGO® MINDSTORMS® NXT.

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1. Robot

It needs to build a robot which is constructed of LEGO MINDSTORMS NXT and it should be built according to the building instructions document provided from ET ROBOCON technical committee. Figure 1 is the self-balancing two wheeled robot used for ET ROBOCON and it is called NXTway-ET. There is no restriction for sensor/motor ports configuration. In case of brick parts connectivity of the robot gets loose due to ageing; it is allowed to tighten up the parts by using rubber band or glue.

Figure 1 NXTway-ET

1.1. Robot decorations

It is allowed to add a few parts to the robot for decoration purpose. For example, attach LEGO mini figure or LEGO flag on the robot. However, it is prohibited to add some parts which impact on the performance the robot in the race or change the size of the robot.

1.2. Prohibited things for the robot

Following things are prohibited for considering the fairness of the competition
- Dirty the race track (e.g. grease the robot)
- Modification of LEGO parts (includes disassemble of NXT brick, sensors and motors)
- Connect a cable between a Sonar Sensor and a NXT brick of the robot on the out-lane
- Decorate the robot with commercial advertisement
- Teams which participated as personnel are prohibited to decorate the robot with advertisement of organizations which the teams belong to

2. Software

2.1. Software used for the competition

Software used for the competition means both of software for the robot (Robot software) and software for Bluetooth Communication Equipment (BCE). In the both cases, the software should be reflected to the models to be submitted for the competition.

2.2. Robot software

2.2.1. Platform software

ET ROBOOCN technical committee provides nxtOSEK (ver. 2.15 or later) as a reference of platform software for the robot. ET ROBOCON technical committee supports the following portion of the platform software via e-mail to be shared by all participants:

- TOPPERS/ATK1(ex. TOPPERS/OSEK) RTOS in nxtOSEK
- ecrobot C library (libecrobot.a) in nxtOSEK
- Robot balancer C library (libnxtway_gs_balancer.a) in nxtOSEK
- Enhanced NXT firmware

It needs to use ecrobot C library (libecrobot.a) to control the devices of the robot. Besides with that, it needs to use robot balancer C library (libnxtway_gs_balancer.a) to balance the robot. In case of modifying or not using the above software (includes a case uses other software); following rules should be applied:

- Modifications should be able to be easily re-used by other participants
- Contents and instructions of the modifications are disclosed to all participants
- Approved by ET ROBOCON technical committee by the deadline for modification

Furthermore, in case of using other firmware except for the enhanced NXT firmware and the NXT BIOS which is included in the nxtOSEK, the above rules are also applied.

2.2.2. Download of robot software

Download of robot software to NXT brick can be done whenever it does not affect the race management even after robot inspection. It is allowed to download different robot software which is specialized for each lane.

3. Bluetooth communication

ET ROBOCON allows teams to use Bluetooth communication between the robot and Bluetooth Communication Equipment (BCE) in the race. Detailed information is described in ET ROBOCON rules for Bluetooth.

4. Race track

Race track is made of cloth called Viscotecs and it is produced by SEIREN Co.,Ltd (http://www.seiren.com/). The size of the race track is 5460mm x 3640mm and it is mounted on the same size of flat foundation. Some part of the race track might have creases due to the structure of the track (just putting the cloth on the foundation). Creases would be removed only if it was admitted to seriously affect the race. On the race track, black lines are drawn on the white base field. This black line is called lane. Each color used in the race track is: White color is #FFFFFF in 24bits RGB and black color is #000000 in 24bits RGB. There are two lanes on the track and these are called in-lane and out-lane. There is no lane crossing on the track. Width of the lane is 20mm and the minimum distance between the lanes is 230mm.

Figure 2 Race track

The race track consists of basic stage and bonus stage. The basic stage is for time trial competition and the bonus stage is the competition to get the bonuses within given time. Acquired bonuses (time) are subtracted from the time trial result.

4.1. Specifications of the race track

4.1.1. Marker line

Gray colored lines called "marker line" are placed on the lanes of the race track. The gray color is #888888 in 24bits RGB.

4.1.2. Green area

Green area on the race track is the area where some regional specific objects and sponsor name plates are assumed to be placed. Locations of those are not determined prior to the race and these are placed at the race day.

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4.1.3. Clear gates

Clear gates are virtually placed lines between pairs of the red dots on the race track and each clear gate has to be passed along with the specified direction by the blue arrows in the Figure 3. Even if a part of the robot passed a clear gate, it would be recognized as a clear of the gate.
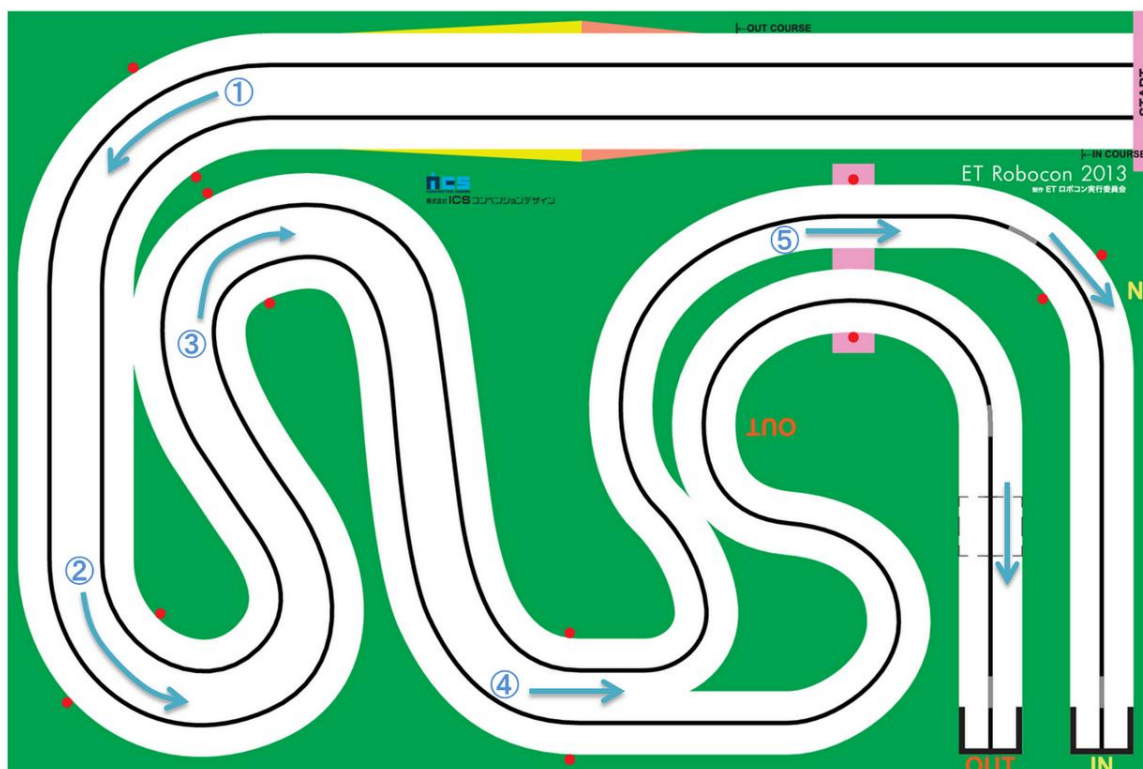

Figure 3 Directions of clear gates

4.2. Basic stage

Basic stage is the time trial to compete the time from start position to goal position and the robot must pass the gates 1, 4 and 5 (the goal gate) with the specified order and direction. Other gates (2 and 3) are optional for additional bonus points to be described in later chapter.

4.2.1. Start position

Figure 4 is an enlarged view of the start position. "←OUT COURSE" is the start position of the out-lane and "←IN COURSE" is the start position of the in-lane. The position of the robot on the each lane should be behind (right side of) the start positions.

Figure 4 Start position

4.2.2. Slope

There is a slope between the start position and the first corner. Up slope is 10% steep and down slope is 5% steep.
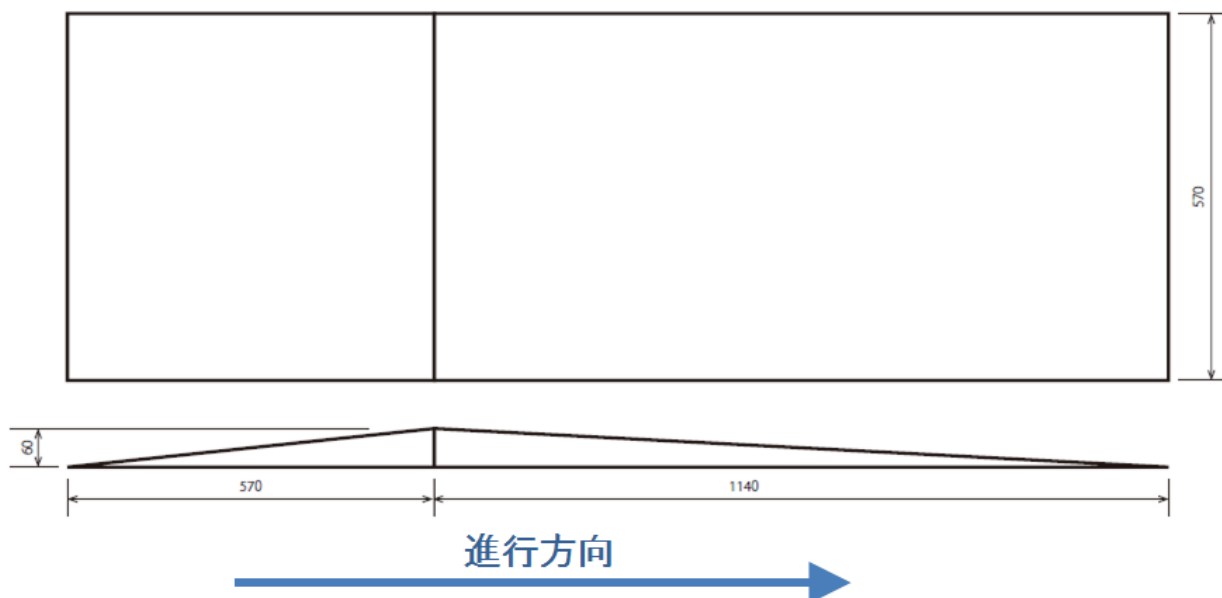

Figure 5 Slope shape

4.2.3. Goal position

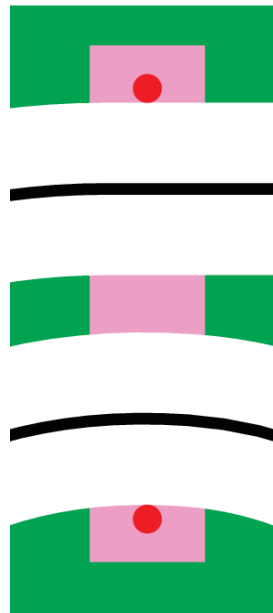Goal position of the basic stage is the virtually placed line between the red dots in Figure 6.

Figure 6 Goal position

4.3. Bonus stage

Bonus stage has several bonuses for each of in-lane and out-lane. Bonus time is given by passing the bonuses within the maximum race time (2 minutes) after the race began.

4.3.1. Look-up gate (in-lane)

Look-up gate is a bonus and it is located between the red dots in Figure 7 (surrounded by yellow dotted line) and Figure 8 shows the dimensions of the look-up gate.
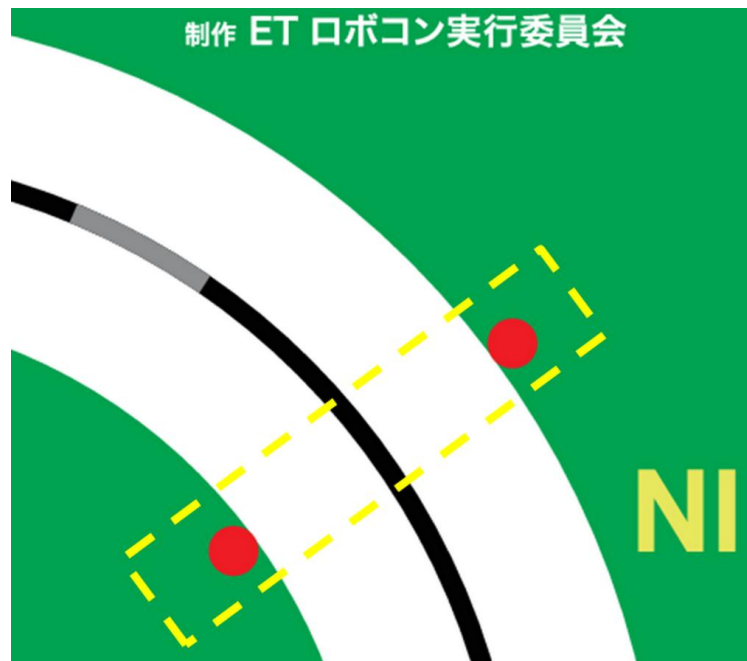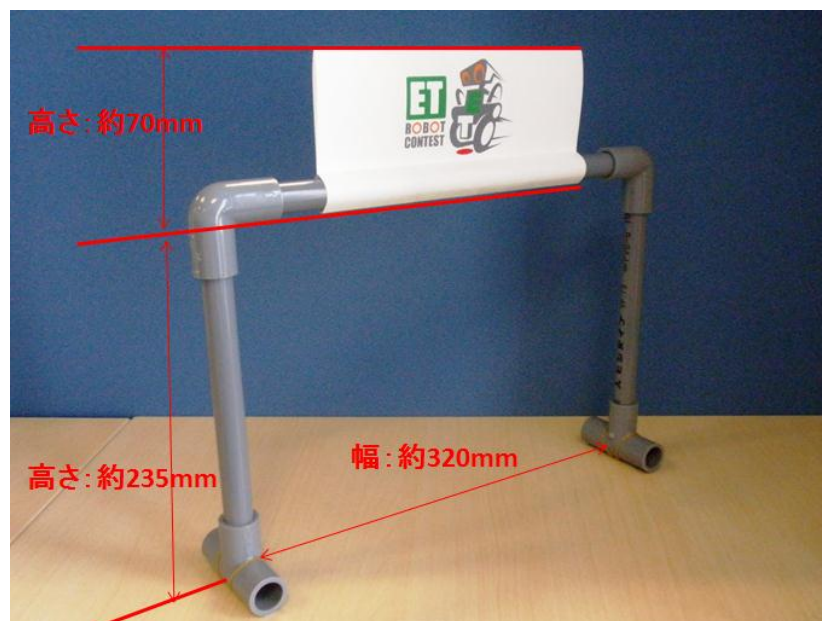
Figure 7 Location of the look-up gate

Figure 8 Dimensions of the look-up gate

4.3.2. See-saw (out-lane)

Figure 10 shows an enlarged view of the see-saw bonus and the see-saw is placed on the oblique lined area. The clear gate of the see-saw is the virtually placed line between the pair of the red dots.
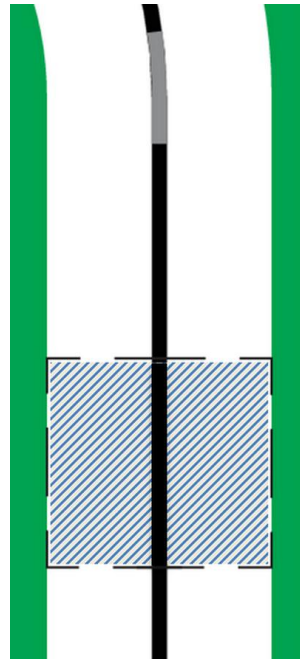

Figure 9 Positions of the see-saw

Figure 11 shows the dimensions of the see-saw. See-saw is made of natural colored (light brown) wooden board with 14mm thickness and black colored line which made of paper is placed on the center of the board.
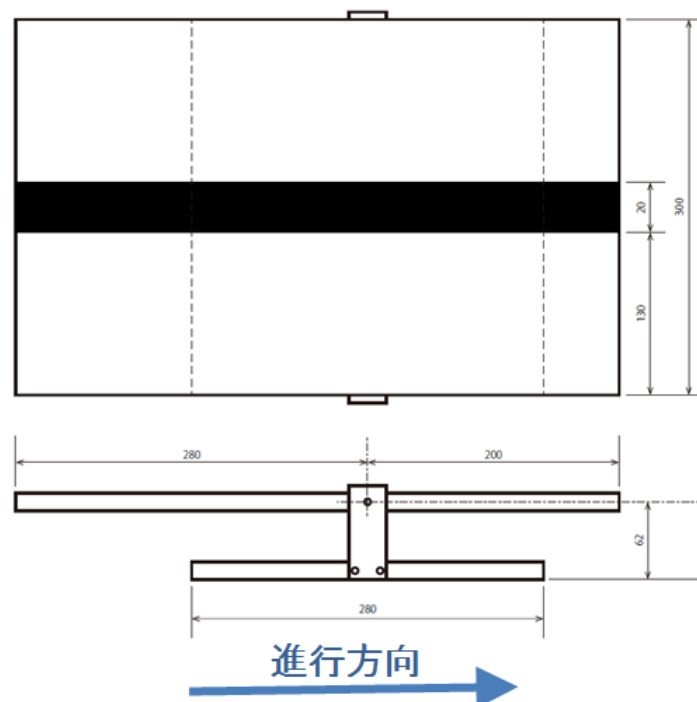

Figure 10 Dimensions of the see-saw

Figure 12 See-saw

Table 1 shows material to assemble a see-saw.

Table 1 Materials of a See-saw

Parts	Material	Remarks
Boards	池内ベニヤ社 シナランバーNEO	Appx. 700g weight
Black line	竹尾社 ラシャ紙 Extra Black	伊東屋で入手可能
Axle	家具用ダボ 直径 5mm、長さ 25mm	ニッケルメッキ
Support part	アルミ引出材 厚さ 3mm	
Bolts	4mm×12 の皿タッピング	

4.3.3. Garages (in-lane and out-lane)

Figure 11 shows garage areas for in-lane and out-lane. The robots are required to stop in the area of the garages with grounding the tails. On the boundary of the garage areas (bold black lines), there are walls with approximately 50 mm height.
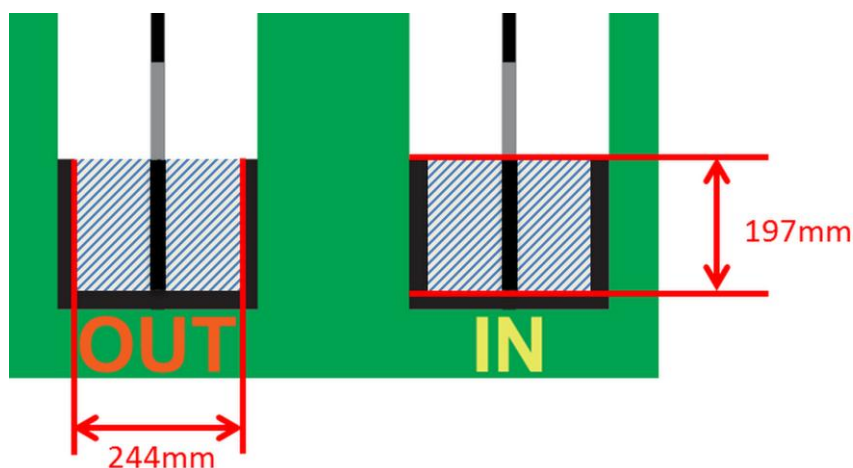

Figure 13 Garages

5. Race

5.1. Race order

Race order is determined by ET ROBOCON committee and it is announced on the race day.

5.2. Practice

On the race day, it is allowed to perform practice to confirm the performance of the robots and the condition of the race track prior to robot inspection.

5.3. Robot inspection

All robots are inspected between the practice and the race. All teams must pass the robot inspection; otherwise, it is not allowed to attend the race. In the robot inspection, it is confirmed that the robot could be built according to the building instructions. If there were something wrong, the team needs to take the inspection after correcting it during the period of the robot inspection. For the teams which could pass the inspection, batteries to be used for the race are provided and the teams have to attach the provided batteries to the robot with observation of ET ROBOCON committee and the committee seals the battery. It is prohibited to remove the seal until the race is over. If it needs to remove the seal to reset the robot due to some reason, it has to be done with observation of ET ROBOCON committee. Even in that case, replacement of the batteries with new ones is not allowed. After the robot inspection, ET ROBOCON committee puts team ID stickers on the wheel motors of the robot as the evidence of the completion of the inspection.

5.4. Race

A team has two race trials. One for in-lane and other is for out-lane. The race result is total amount of race time for in-lane and out-lane and the race result is subtracted bonus time from race time. Smaller race result (time) is greater. If two of the top three teams had a same race result, an extra race would be performed by the teams which had the same result. In this case, the extra race is considered to determine the final rank of the teams.

5.5. Race start sequences

In the race, only one participant in a team can operate the robot. Preparations for the robot such as program download should be completed by the end of the previous race. There is more than one minute for the final calibration of the robot. During the final calibration time, only calibration (parameter tuning) is allowed and further program update is prohibited. Calibration is ended by notification from ET ROBOCON committee. After the calibration, the robot should be placed on the start position with Static Stop (SS) state which is described in ET ROBOCON rules for Bluetooth document. After all race start sequences completed for the in-lane team and the out-lane team, ET ROBOCON committee announces the start of the race (Say "Go to the start…"). According the announcement of the start of the race, a participant operates either Bluetooth Communication Equipment (BCE) or the robot to start the robot. In case of directly operating the robot, press the Touch Sensor attached on the robot.

Table 1 Race start sequences

	Team	ET ROBOCON committee
①	Place BCE (if it is used)	Check the placement of BCE
②	Calibrate the robot	
③	Place the robot on the start position	Check the placement of the robot
④	The in-lane team places a plastic bottle for ET Tackle bonus	
⑤		Announce"Go to the start, ready…"
⑥		Start the race by announcing "3, 2, 1, Go!"
⑦	Start the robot	

5.6. Basic stage

After the race began, the robots should pass the clear gates 1, 4 according to the specified directions and order, and then, should pass the goal gate of the basic stage with specified direction.

The robot does not need to go along with the lane as long as other rules are not violated.

The tail of the robot must not touch on the ground after the robot started moving (the race began) until the robot got the goal.

5.7. Bonus stage

After getting the basic stage, it is allowed to challenge the bonus stage. The bonus stage is over by one of the following conditions:
- Elapsed 2 minutes after the race began
- Passed garage-in bonus or touch the wall of garage-in
- Either 5.8 Retirement or 5.9 Disqualification were applied

5.8. Retirement

If one of the following cases happened in the race, it would be judged as retirement. Retired team has no chance to retry the race.

- Robot remained stopping and no chance to start after the race began
- Robot felt down on the race track
- Robot was out of the race track
- Robot could not reach the goal of the basic stage after 2 minutes elapsed
- Robot was not possible to run
- Team declared retirement

5.9. Disqualification

If one of the following cases happened, it would be judged as disqualification. Disqualified team has no chance to retry the race.

- Preparation for the race was not completed until the race began
- Battery seals at the robot inspection were removed without declaration
- Robot on the in-lane had cable connection between a Sonar Sensor and a NXT
- Provided energy, force or information to the robot from outside except for using Bluetooth Communication Equipment after the race began
- Interfered with the robot on other lane
- Damaged the race track intentionally

5.10. Retry the race

In case of a robot is interfered by other robot, it is allowed to retry the race.

5.11. Dummy robot

In case of there is no robot on other lane depending on the race order, ET ROBOCON committee provides a dummy robot for the other lane.

6. Time

6.1. Race time (basic stage time and bonus stage time)

Race time is total amount of the basic stage time and the bonus stage time. The basic stage time is measured from the race began until the robot got the goal of the basic stage with 1/10 second resolution. If a robot was retired in the basic stage, 2 minutes would be given as the basic stage time.

The bonus time is calculated from the following bonus time conversion table.

Table 2 Bonus time conversion table

Bonus stages	Bonus time (sec)	Remarks
Remote start	-5	
Clear the gate 1	-5	Valid when the gate 4 was cleared
Clear the gate 2	-5	Valid when the gate 4 was cleared
Clear the gate 3	-5	Valid when the gate 4 was cleared
Clear the gate 4	-5	
Clear the goal gate (gate 5)	-10	
Look up gate (single)	-5	Valid for only in-lane
Look up gate (double)	-10	Valid for only in-lane
See-saw (single)	-5	Valid for only out-lane
See-saw (double)	-10	Valid for only out-lane
Garage	-5	

The bonus stages can be challenged until 2 minutes elapsed since the race began.

6.2. Condition to get a bonus time of Remote start

It needs to make the robot start driving by using Bluetooth without any direct (physical) touch.

6.3. Condition to get a bonus time of gates 1 to gate 4

It needs to pass clear gate 1 to 4 according to the specified directions and order. The bonus time for each gate is valid only for the first time to clear the gate 4.

6.4. Condition to get a bonus time of goal gate

It needs to pass the goal gate according to the specified direction. The bonus time is valid only for the first time.

6.5. Condition to get a bonus time of Look-up gate single

It needs to pass the look-up gate without felt down the gate. The bonus time is valid only for the first time.

6.6. Condition to get a bonus time of Look-up gate double

It needs to pass the look-up gate without felt down the gate and go back to pass the gate with reverse direction, and then, pass the gate again. The bonus time is valid only for the first time.

6.7. Condition to get a bonus time of see-saw single

It needs to pass the clear gate of the see-saw. The bonus time is valid only for the first time.

6.8. Condition to get a bonus time of see-saw double

The robot needs to go up and down the see-saw until the end edge of the see-saw touches on the race track, and then the robot needs to go backwards until the start edge of the see-saw touches on the race track. After that, the robot needs to go up and down the see-saw until the end edge of the see-saw touches on the race track again to get the bonus. During these actions, the robot should keep getting on the see-saw. The bonus time is valid only for the first time.
Note that the see-saw "double" is derived from the robot goes up and down the see-saw "twice" without getting off.
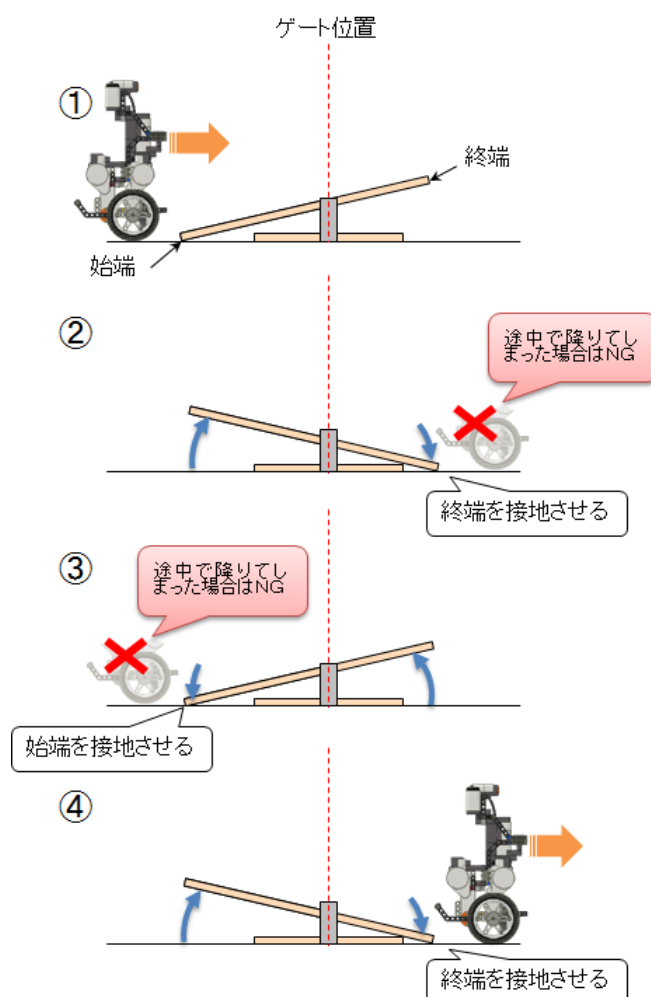

Figure 14 Condition to get a bonus of the see-saw double

6.9. Condition to get a bonus time of the garages

It needs to make the robot is turned into the Static Stop state in the specified area (see Figure 13). The bonus time is given only for the first time. On the black line of the garage-in, there is 50 mm height wall and if a robot touched on the wall, the bonus time of the garage-in would not be given. If a robot is turned into the SS state in the garage-in area, the race is over regardless of the result of the garage-in bonus.

6.10. Race time for retirement

If a robot was retired before getting the goal of the basic stage, the race time is 2 minutes (= retirement time). If a robot was retired after getting the goal of the basic stage, the race time is measured basic stage time + valid bonus time.

6.11. Race time for disqualification

If a robot was disqualified, both of measured basic stage time and acquired bonus stage time would be invalid and the race time is 2 minutes.