2025 IEEE R5 CONFERENCE STUDENT ROBOTICS COMPETITION RULES

MARCH 29, 2025

Venue: Wichita State University

Version history log

The following document contains the rules for the 2025 IEEE R5 student robotics competition. As in the past, the rules document will be updated as necessity arises. Major changes or clarifications added to the document will be notated in the table below.

Date	Version	Comment
08/05/2024	V0	Initial draft
08/12/2024	V0.1	Modification to hose release and fixing typos
09/16/2024	V1	Initial release

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1. Eligibility

The competition is open to teams of no more than 5 and no less than 2 undergraduate students who are enrolled in a college or university within the IEEE Region 5 boundaries. The competition encourages a multidisciplinary approach to robot development and recognizes the participation of students who may already be members of SAE, ASME, EEGS, etc. Therefore, only one team member will be required to be a current IEEE Student Member. Teams should not include any non-undergraduate students.

2. Intent to Compete and Registration

Each team MUST complete the online Intent to Compete form provided on the 2025 Student robotics Competition website to declare their intention to participate. This is ***not*** the same as registering for the IEEE Region 5 conference. In addition to this each student in the team must do the following.

Each student on a team planning to participate in the competition must register on the IEEE Region 5 Conference website. When you register, you will be asked whether you are a member of a team competing in a Student Competition; if so, which competition, and which team. Please use the team's name that was submitted on the intent to compete form.

3. Competition Description

This year's contest will preserve the tradition of compact mobile and autonomous robots operating on a predefined playing field. The theme of the contest is based on the robot that can assist in firefighting. In addition to the general autonomous ground robot capabilities such as maneuvering the game field, obstacle avoidance etc., the robot would need to be equipped with the ability to spot the location of fire within the game field and lay the fire hose from a prescribed location to the location of fire. More information is provided in the following subsections.

3.1. Robot requirements

- The dimensions of the robot must not exceed $1.0 \times 1.0 \times 1.5\ ft$ in length, width and height respectively, including the spool mounting with the firehose. The robot is allowed to have any retracting parts, and the dimensions apply to the rest/start posture of the robot.
- The weight must be under 30 pounds including the spool mounting with the firehose.
- The robot should not extend beyond 2 $inches$ to the rear wheel. This will hinder the placement of the robot at the start position (refer section 3.4, placement of robot at the start).
- The robot must be started with an on-board switch/push button and not remotely.
- The exact material to be used to emulate the firehose will be updated by September 30, 2024. The length of the hose required will be 10 feet.
- The robot must be capable of surveying the game field, spotting the location of fire and navigate from the designated start point to the designated location to start the hose lay, then to the location of fire and finally back to the starting point. The robot must also be capable of avoiding obstacles while navigating the game field.

3.2. Competition structure

This year's competition will be carried out in three rounds, with increasing order of difficulty. In every round only one robot will be in the game field at any time.

***Round 1**: Surveying the field and spotting the location of fire*

In this round the robot is tasked with surveying the game field to spot the location of fire. The robots will be assessed based on the following criteria.

- ability to avoid obstacles (no terrain challenges)
- closeness of the robot to the location of fire
- closeness of the robot to the starting region at the end of the trip
- time taken to complete the trip

***Round 2**: Navigating to the location of fire*

In this round the robot is tasked with navigating to the location of fire. This will be the location spotted by the robot in round 1. The difference in this round is that the fire setup will be removed, and the robot should still be able to navigate to the location based on the gained knowledge of the game field. In addition, terrain challenges will be introduced only in round 2. The robots will be assessed based on the following in round 2,

- ability to avoid obstacles with terrain challenges
- closeness of the robot to the location of fire
- closeness of the robot to the starting region at the end of the trip
- time taken to complete the trip

***Round 3**: Fire hose laying from designated the location*

In this round the robot is tasked with navigating to designated location to start the firehose release and start laying the hose from there till the location of fire and return to the starting region. The game field will be set up in the same manner as round 2 but with the addition of the location to start the fire hose laying. The assessment criteria for this round are given below,

- ability to avoid obstacles with terrain challenges
- ability to latch the firehose loose end to the notch at the designated location
- closeness of the end of fire hose to the location of fire
- closeness of the robot to the starting region at the end of the trip
- time taken to complete the trip

3.3. Competition timeline

The robotics competition ***check-in*** will be open from ***8:00 am to 8:45 am*** on the day of the competition. During check-in the robot will be tested for meeting the dimension and weight requirements. The robot is allowed to have any retracting parts; however, the dimension requirements must be satisfied at the rest/start posture of the robot. Any robot that does not meet these requirements will be disqualified and will not be allowed to continue after Round 1. The overall event timeline is given below.

9:00 am to 11:00 am **- Round 1**

11:30 am to 12:15 pm **- Lunch**

12:30 pm to 2:00 pm **- Round 2**

3:00 pm to 4:00 pm **- Round 3**

3.4. Game field

The game field will be a $8\ ft \times 8\ ft$ grid as shown in the Figure 1. Plywood or similar material will be used to construct boundary walls to represent the ends of the grid. The walls will be at least $5\ inches$ high from the ground. The regions highlighted in red (no such color coding in the real game field) are the potential regions to hold the simulated fire and starting point of the robot. In this document for illustration of the fire setup and starting region the top right corner of the game field is used. This is purely for illustration purposes and does not mean the fire setup or the starting region must be there in the contest.

Throughout the contest one of these four regions in red in figure 1 will hold the simulated fire and one other will hold the starting point of the robot. This designated fire and starting location will remain same across all rounds. In this contest, the simulated fire will be set up using the following,

- Heated mat (product link)
- Heat gun (product link)

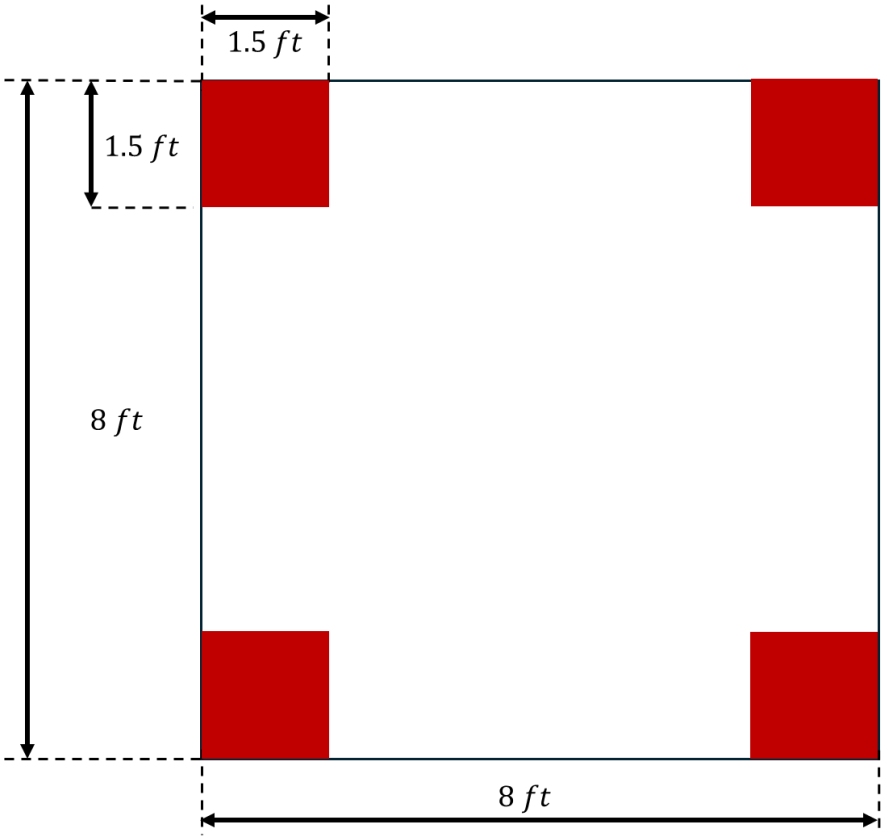

Figure 1. Top view of the game field with colored regions for description

Some of the features not included in Figure 1 are obstacles, challenging terrain, scoring bands for fire detection and latch to hook the loose end of the firehose. These will not be known to the teams until the beginning of the specific tasks during the contest. However, the game field shown above will be available for practice on Friday from 2:00 pm to 5:00 pm.

Obstacles: The game field will contain dowels/ PVC pipes that are attached to the floor as obstacles that represent upright trees. The obstacles will be tightly fastened to the floor to stay upright even upon a collision by a robot. No one of these obstacles will be lying flat on the game field. These obstacles will be no more than 1 $inch$ in diameter and can be placed in a manner to create narrow pathways that are no less than 1.1 $feet$. The intended paths for the robot to navigate will have at least 1.1 $feet$ between obstacles in all directions as shown in figure 2. However, there could be obstacles closer to each other, but they are meant to represent an infeasible path. The game field will not have sharp turns. The robot must be able to make the turns such as the ones illustrated in example 1 and 2 in figure 2, ideally without hitting obstacles. (*Note: compact robot design to meet this turn radius is recommended*)

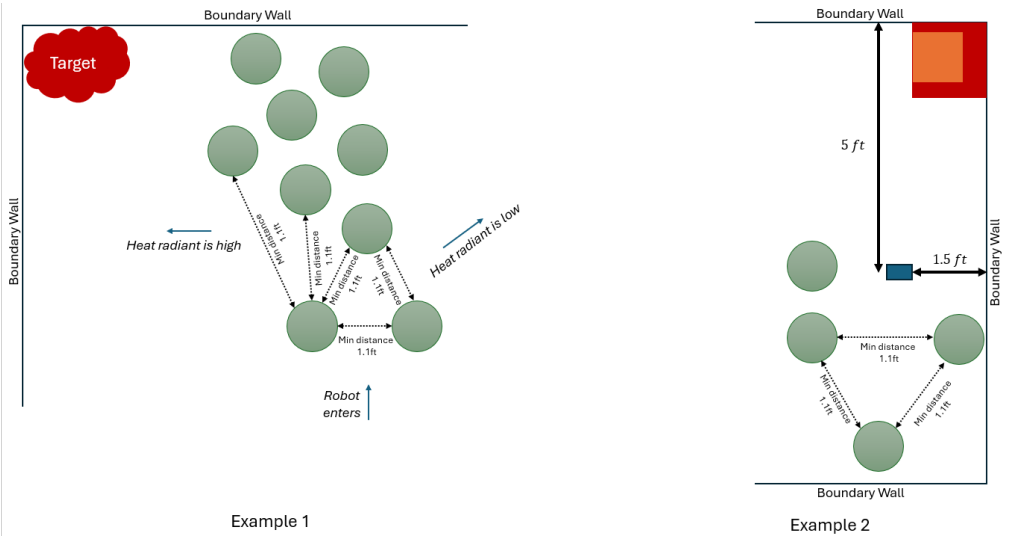

Figure 2. Illustration of obstacle placement in the game field (top view)

Challenging terrain: The game field will also feature simulated challenging terrain in the form of unevenness in the floor and friction variation at certain parts of the game field. These will be simulated using materials such as, but not limited to, sandpapers, sand and gravel. However, none of these materials used will lead to an elevation of more 0.5 $inches$ from the ground. The robots should be able to adjust to these variations and maneuver through the game field.

Placement of robot at the start: The robot would be placed in one of the regions highlighted in red in Figure 1. Figure 3 illustrates the placement of the robot (assuming four-wheel system) within the highlighted region at the start. In this figure, the one foot by one foot orange square represents the robot's position at the start, wherein the rear left wheel will be placed at the yellow point which is represented as $(0.5\ ft, 2")$ in Cartesian coordinate with the respect to the edge of the game field represented by the green point and corresponds to the coordinate $(0,0)$.

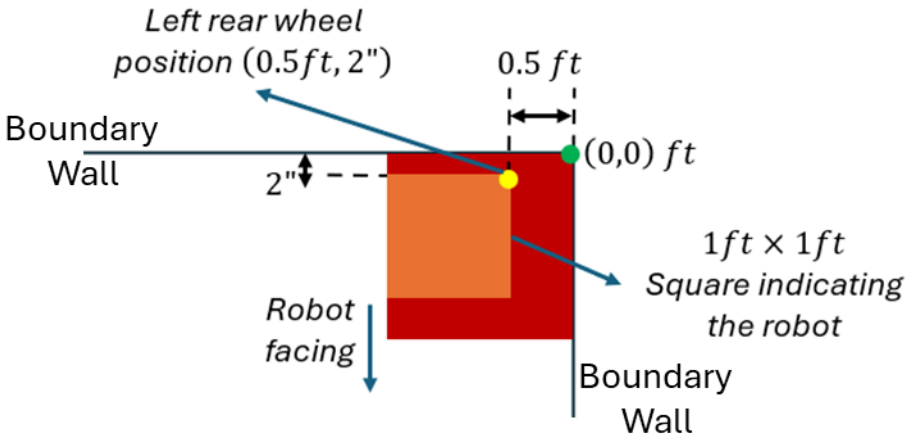

Figure 3. Illustration of robot placement at the start of each round (top view)

Scoring bands for fire detection: There will be bands as shown in Figure 4, around the region colored in red which is set up as location of fire. The robots should not enter the fire region, but rather come closer to the fire region. The judges will use these bands to score the robot's closeness to the fire region. This will be used as the performance metric to score the robots in concerned rounds, please read section 3.5 for more details on judging. The bands 1 and 2 are circles of radius 1.5 ft and 2.5 ft respectively, that are drawn with the green dot (edge of the 1.5 ft × 1.5 ft fire region in red) in Figure 2 as center.

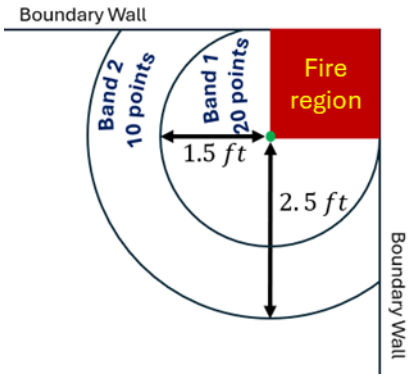

Figure 4. Example fire set up in the top right corner of game field to illustrate scoring bands (top view)

Placement of firehose latch: One of the contest requirements is that the robot be capable of navigating to a set location to start the firehose release. For this purpose, a latch/loop as shown in figure 5 will be placed in the game field. The robot should be capable of latching the loose end of the fire hose on to this to start the firehose release from the spool. Ideally, the robot should drive till the location of fire such that the other end of the firehose ends up in Band 1 next to the fire location. Furthermore, the location of this latch with respect to the potential robot starting location is illustrated in Figure 6 with cartesian coordinates to help teams plan. As shown in this figure the latch will be in the direction the robot faces at the start. Although the obstacle placement is not given in this document, there will be at least 2 $feet$ of straight-line path when the robot is approaching the latch from the start. It is to be noted that this a

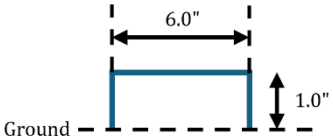

Figure 5. Fire hose latch (front view)

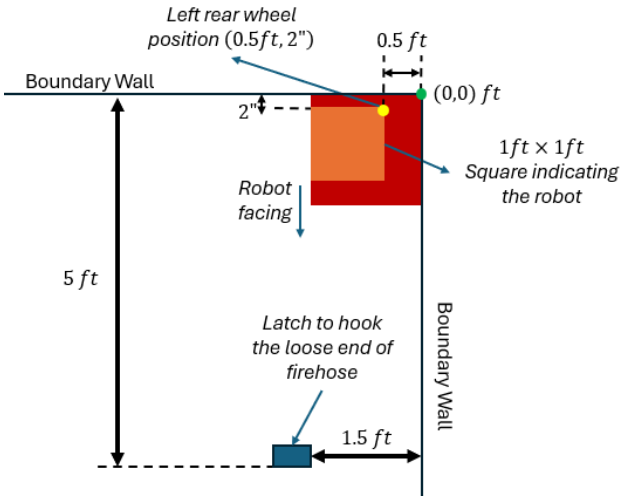

Figure 6. Placement of firehose latch (top view)

3.5. General rules and guidelines

- Only team members are allowed to work on the vehicle, not mentors or supervisors.
- The teams are free to work on the robot before and after each round. However, the teams cannot work on the robot once called to the game field.
- All the robots should be kept at the head judges table at least 15 minutes prior to the beginning of each round. Only one representative from each team should accompany the robot. Failure to follow these instructions would lead to disqualification.
- The team representative with the robot would be escorted from the head judges table to the corresponding game field for each round.
- The field judge present at each game field is responsible for indicating the start position and once the field judge signals the start, the team representative can proceed with the starting mechanism of the robot.
- The robot should start each round untethered from any initialization devices.
- Wireless/wired communication with the robot is not allowed once it is in the game field.
- The robot must carry any connected devices on its own. The team cannot add or touch the robot once it is in the game field.
- The robot can have any mechanism to ensure the firehose ends up close to the fire location to score maximum possible. For instance, teams can design the robot with a feature to cut the hose or drop the entire spool or unwind the remaining hose at the end.
- Each robot should have a "kill switch" to stop all functionality. The kill switch on the robotic system must be the first device powered by the battery.
- The robot will be considered to have failed the round if the robot is stuck in the same position either stationary or with no progress for a continued period of 30 seconds or more. This will be monitored by the field judge.
- In case of any unexpected circumstance the judges' team will decide the course of action.
- All judges' decisions are final and will not be reconsidered.

3.6. Judging

Each round will be scored based on the performance under the corresponding categories mentioned in section 3.2. There will be no elimination until round 3 unless disqualified. The points tally after round 2 will be used to eliminate teams and the top 8 teams will compete in round 3. Round 3 will have a fresh start to the contest, i.e., the points tally after round 2 will not affect the teams who qualify for round 3. The score allotment method that will be used by the field judge is described below.

Obstacle avoidance: $(-5\,points)$ for each obstacle the robot collides with. This also includes the walls, and the fire set up. Multiple collisions with the same obstacle will not lead to additional loss of points.

Closeness to fire location, starting region and firehose lay: The scoring bands illustrated earlier will be used by the field judge to score the performance of the robot. In the following paragraph the mechanism for awarding points for closeness to fire location is explained. A similar method will be used to score the return of the robot to the starting region and firehose laying, both start and end.

If the robot enters Band 1, $20\,points$ will be awarded and if it only enters the Band 2, $10\,points$ will be awarded. If the robot enters the fire set up, it will result in the robot not getting any positive points but minus five points for entering the fire. If the robot did not enter either of the bands then the robot will be awarded $(10 - x)$ points, where x is the distance in feet between the point in the grid which the robot reached while proceeding towards the fire and the line indicating Band 2.

Completion time: The robots which complete the task in under five minutes (300 seconds) will be rewarded with bonus points. The bonus points awarded will be the difference between the time taken to complete in seconds (k) and three hundred, $(300\ - k)$. No negative points for robots taking more than five minutes, however this would be used as a criterion in case of tie break. However, teams can only get this bonus if, (i) the robot lands in either band 1 or 2 in rounds 1 and 2, (ii) the robot is able to latch the loose end and release the firehose in round 3.

Illustration of scoring: Consider a robot that does the following in round 2,

- Collides with one obstacle 3 times and with another obstacle 4 times and avoids all other obstacles
- Goes close to the fire region marked by the front wheel entering Band 2
- Returns to the starting region with one of the wheels still outside the starting region
- Takes 6 minutes to complete the round

The robot will be scored as given in the table below under the corresponding metrics.

Metric	Score	Remarks
Obstacle avoidance	-10	Hits only two obstacles
Closeness to fire	10	Enters the Band 2
Closeness to starting region	20	Enters the starting region
Completion time	0	More than 5 minutes; no bonus
Total	20	

4. Events and Prizes

- The competition will conclude with an awards banquet on Saturday evening.
- Prizes and certificates will be awarded at the banquet.
- Specific award details will be provided on the Robotics Competition page of the Region 5 website.