National Engineering Robotics Contest
A joint venture of NUST and STEM Careers Programme (HEC)
Organized by:

- Department of Mechatronics Engineering,
- College of Electrical and Mechanical Engineering,
- National University of Sciences and Technology Islamabad, Pakistan
And
- National Centre of Robotics and Automation

Theme: Ready to Race
CHANGE LOG

The table below will list the pages on which changes have been made to the theme.

<table>
<thead>
<tr>
<th>Revision Date</th>
<th></th>
</tr>
</thead>
</table>

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NOTE:

1. Any correspondence with the NERC officials via e-mail, telephone or any other means will not be considered as part of the rules (unless uploaded as an FAQ on official NERC website).

2. In all matters of interpreting the rules before and during the Contest and in any issues not covered by these rules, the decisions of the Contest Judging Committee will be final.
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1 INTRODUCTION

The National Engineering Robotics Contest is a joint project of the National University of Sciences and Technology and STEM Careers Programme HEC to promote research in robotics and its related fields in Pakistan. We, from the Department of Mechatronics Engineering welcome you all to participate in 18th National Engineering Robotics Contest (NERC 2020). This competition will provide a common platform for the integration and evaluation of various electromechanical designs, control and path planning algorithms, and agent architectures.

Over the years, NERC has grown increasingly popular among students as well as engineering departments across the country. Engineering students from all over Pakistan participate in this competition. Many students participate in this contest in their final years of undergraduate degree and take the contest theme as their Final Year Project thus becoming a part of human resource required in field of robotics and automation. This not only adds value to the competition but also resolves our pledge to bring exciting new challenges every year for the advancement of robotics community at an increasingly wider scale. Robotics is a buzz word at today's technology forefronts. Due to exponential advancements in fields like high performance computing, computer vision, computer networks, material sciences and power electronics, the growth experienced by robotics in past few years is unprecedented.

The National Centre of Robotics and Automation is a consortia of 11 labs over 13 universities of Pakistan with its centre headquarter at NUST College of E&ME. The centre will serve as a leading technological hub within the domain of Robotics and Automation, it also deals with different thematic areas one of them is agriculture robotics

2 CATEGORIES

There are two categories of the contest: Indigenous Robot category, and Modular Robot Category. The purpose of this contest is to develop a sense of problem-solving, project-based learning, team-based learning, technical design and ingenuity among the contestants.

2.1 INDIGENOUS

Indigenous category includes robots that are constructed from scratch. Their mechanical structure, controls etc. are designed and fabricated by the teams themselves. The electronic control modules (including all electronic boards and motor drivers etc.) should be designed and manufactured by the students.

This category is only for university students.
2.2 **MODULAR**

Modular category includes robots that are developed using ready-made kits. Modular category is further divided into two subcategories:

2.2.1 **Modular School**

The category is for students for grade IV to XII/A-Levels. This category is further divided into 2 subcategories based on readymade kits used.

- **2.2.1.1 Lego School**

  This category includes robots that are developed using readymade kits for example Lego NXT and Lego EV3 Only

- **2.2.1.2 Ready to Race**

  This category includes robots that are developed using readymade kits for example EDVON, NCRA Robotic Kit etc. This category cannot use Lego Kits

2.2.2 **Modular University**

This category is only for first and second year under graduate university students.

*This document describes the theme for Ready to Race*

3 **CONTEST STRUCTURE (Ready to Race)**

The contest will consist of two stages:

1. Heats/Qualifying Rounds
2. Head to head matches.

3.1 **QUALIFYING ROUNDS**

Each robot will participate in the qualifying rounds (heats). There will be no head to head matches in heats. For qualifying rounds following rules will be observed:

3.1.1 There will be NO head to head matches. Each team will individually run their robots.

3.1.2 Seeding chart will be based on points scored by teams. If the points of both teams are equal, decision will be made based on time taken by both teams. The team with shortest time will be placed on higher seed position. If time of both teams is also same the decision of the higher seed will be based on the shortest distance from the next objective from the current position (as per discretion of judges). If all of the above criteria are the same, coin toss by judges will decide higher seed position.

3.1.3 Each team will be provided maximum of 3 minutes to run their robots.

3.1.4 A team can take as many retries as it wants within 3 minutes without any penalty but only the total time taken by the team will be recorded.
3.1.5 When the team takes a retry the score is reset to zero and the entire arena will be reset.

3.1.6 When the team is ready and the whistle is blown, time will be started.

3.1.7 If a robot is not able to successfully complete the task in time then the time when team will call it off will be recorded as the finish time.

3.2 Head To Head Matches

After qualifying rounds, the top 32, 16 or 8 teams (with non-zero score) from the qualifying rounds will go on into the final rounds for head to head matches. A less number will automatically give a by to the leading teams.

4 Contest Theme

The focus of NERC 2020 ready to race brings a competition of autonomously constructed robots pitching teams against one another with wheel to wheel action. The robot that will reach first at finish point will be considered as the winner (see Figure1). The Contest arena is shown in Figure 1.

1. Laminated wooden sheets (lasani) are used for the construction of the arena. The floor of arena will be of white color as shown in the map.
2. The Green lines and dashed red lines in the Figure 1 represents the walls on the arena. The walls represented by Green lines have a height of 4 inch throughout the arena. The walls represented by Red dashed lines have a height of 2 inch throughout the arena.
3. The black lines in the Figure 1 represents the marker (black solid tape on original arena).
4. The entire arena is divided into 8x8 inch grids. Each grid is assigned a row and a column number. This grid is not represented as lines on the arena. It is for reference position only.
5. The starting position of the robot is shown in Fig 1 with blue box labelled as “R1”, in the direction of the arrow. The robot must be completely behind the black marker line located at the intersection of grid line 8,9 as shown in Fig 1.
6. The robots will move through a pre-defined path i.e. check point A, B, C and then finish line; while seeking help from arena walls to reach the finish line.
7. After the start of the match, the team cannot touch the robot.
8. In case of a retry, the team can reset robot.
Note:

* Red lines represent walls with a height of 2 inches throughout the arena
* Green lines represent walls with a height of 4 inches throughout the arena
* The black lines represent the marker (black reflective tape on arena)
5 ROBOT OPERATION

The qualifying teams (those which qualify for the final rounds) will compete with each other in a knockout format. In each match two teams will be pitted against each other, running their robots’ side by side in the contest arena. Teams will be declared as Team A or Team B based on the coin toss before every match. Team A will run their robot in the left side and Team B will run their robot right side.

Once turned on, the robot must be self-controlled without any human intervention. Contestants are NOT allowed to touch their robots. After the blow of whistle, the robot will have 3 minutes to complete the task.

During a retry the layout of the arena shall remain SAME however the point scoring will restart from zero. The robot may navigate through the arena using any suitable technique. If the participating team sees that their robot has lost track of its location and is facing trouble localizing itself, the team can ask for a retry. During its motion, the robot may touch the walls of the arena without damaging them.

In case of a tie, the contestant may be required to run a rematch or winner may be decided on coin toss as per discretion of the judges.

For a particular match, both teams will face the same layout of the arena.

6 POINTS

The point scoring is shown below in Table 1 Point Scoring.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Score(100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Crossing check point A</td>
<td>25</td>
</tr>
<tr>
<td>*Crossing check point B</td>
<td>25</td>
</tr>
<tr>
<td>*Crossing check point C</td>
<td>25</td>
</tr>
<tr>
<td>**Crossing the finish line</td>
<td>25</td>
</tr>
</tbody>
</table>

*Crossing means the front tyres of the robot must have crossed the black marker line present at the mentioned check points as shown in Fig. 1.

** Crossing means the robot must have fully crossed the red marker line and completely enter the finish area mentioned in Fig 1. If two robots finish in close proximity then which ever robot’s front tyres crossed the line first will be declared winner (Decision will be as per discretion of judging committee)
6.1 **DEDUCTION OF POINTS**
The deduction of points is shown below in Table 2 Deduction of Points

<table>
<thead>
<tr>
<th></th>
<th>Deduction/Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The harvester robot fits in an area of 10x10 inch square</td>
</tr>
<tr>
<td>2</td>
<td>Oversize Robot (12x12 inch square)</td>
</tr>
<tr>
<td>3</td>
<td>Oversize Robot (exceeding 12 x 12 inch square)</td>
</tr>
<tr>
<td>5</td>
<td>Robot weighs less than 12 kg*</td>
</tr>
<tr>
<td>6</td>
<td>Overweight Robot</td>
</tr>
<tr>
<td>7</td>
<td>Overweight Robot (Weight exceeding 14 kg)</td>
</tr>
<tr>
<td>8</td>
<td>Damaging the arena/wall/sites/ramp</td>
</tr>
</tbody>
</table>

*This is the individual weight of each robot

7 **RULES**
The following are the rules governing the contest.

7.1 **GENERAL**

7.1.1 The Contest judges may stop any robot at any time if they feel that it is performing, or is about to perform, any action that is dangerous or hazardous to people or equipment.

7.1.2 Additional information regarding the contest rules and regulations may be found in the FAQs and will be considered as part of the theme and rules. New FAQs are uploaded frequently so keep watching the FAQ corner for new information.

7.1.3 Any correspondence with the NERC officials via e-mail, telephone or any other means will not be considered as part of the rules (unless uploaded as an FAQ on official NERC website).

7.1.4 If both the teams have scored the same points but are not able to complete the task in allocated time slot decision of the winner will be on judges’ discretion who will determine which robot is closer to finish the task first.

7.1.5 If both teams have scored the same points, have the same time and are at the same distance from the finish point, a coin toss will be used to decide the winner.

7.1.6 If any team wants to launch a protest (of any kind), they must do so within 15 minutes of the end of their match. The procedure is outlined in Anx B.

The following behavior shall be considered for disqualification by the referee and the
team could possibly be disqualified:

Attempting to damage the game field or performing an act that fails to comply with the spirit of Fair Play.

7.1.7 In all matters of interpreting the rules before and during the Contest and in any issues not covered by these rules, the decisions of the Contest Judging Committee will be final.

7.2 Teams
7.2.1 The Robots can be built by teams of currently registered students from Engineering Institutions and Polytechnic Institutions. Each team can comprise of a maximum of 6 members.

7.2.2 If the students from two different Institutes/Universities join hands and form a team in collaboration then the name of the Institute/University with maximum number of students in such a team would be registered or official consent from both institutions will be required at the time of registration before the contest start date.

7.3 Robot Size and Weight
The robot must fit within 10 inches X 10 inches square at the time of the measurement. If the area of the robot base is more than a 10 inches X 10 inches, but less than 12 inches X 12 inches square, then points will be deducted. There is no restriction on maximum permissible height of the robot. Any harvester robot which does not fit in 14 inches X 14 inches square will be disqualified. All robots will be carefully measured. All sensors mounted on the robot will be counted as part of the robot’s total dimensions. If contestants want to add a flag, hat or other purely decorative, non-functional items to the robot, they may do so. The decorations may be removed for measurement purposes. The weight of each robot excluding decorations must not exceed 12 kg. Penalties as detailed in 6.1 Deduction of Points will be levied if the robot does not fulfill the size and/or weight criteria.
7.4 **ROBOT OPERATION**

7.4.1 Any team that damages the arena will be disqualified.

7.4.2 The robot must not use any harmful substances such as oil, petrol etc. in its operation that can damage the arena.

7.4.3 The Robot CANNOT split after the start of the game, only one Robot is allowed to compete at a time.

7.4.4 The robot must not use any destructive or dangerous methods to displace any obstacle or box.

7.5 **SENSORS**

7.5.1 Robot is not allowed to use tactile sensor of any type for sensing the walls.

7.5.2 Ultra-Sonic Range detectors (SONARs) or IR based proximity sensors (models specified in the components’ list attached) must be used for sensing walls.

7.5.3 The team may use any off-the-shelf encoders if they feel the necessity. Self-made encoders from discrete components are also allowed.

7.6 **POWER SUPPLY**

7.6.1 The robot must be battery-powered.

7.6.2 Power sources that are considered dangerous or unsuitable by the contest Officials shall not be permitted.

7.7 **DURATION OF MATCH**

7.7.1 Each match will be of maximum 3 minutes.

7.7.2 Teams will be given 1 minute for setting up the Robot at the start.

7.7.3 Robot can start at the instant when the start signal is given and a whistle is blown. Robot should be constructed so that it can be started in minimum possible steps.
7.7.4 Once the Robot moves, team members will not be allowed to touch the Robot or enter the Contest Arena.

7.7.5 Timing shall start once the start signal is given and the whistle is blown.

7.7.6 Time would be stopped as soon as bot crosses the finish line. If a robot is not able to successfully complete the task then the time when team will call it off will be recorded as the finish time. The team must leave their robots as it is on their current locations when time stop is called by them. They may NOT pick their robots up till the referee announces the end of the match. The team is not allowed to take a retry after the time has stopped.

7.7.7 The team reaches the finish line first will be declared the winner of the match.

7.7.8 If both teams fail complete the task, within the time limit, the team scoring more points will be declared the winner of the match.

7.7.9 If both the teams have scored same points but are not able to complete the task in allocated time slot decision of the winner will be on judges’ discretion who will determine which robot is closer to finish the task first. The distance of the robot’s current location from the Finish Point will be measured in terms of grid units.

7.8 RETRY
If the robot is strayed due to some reason, retries are allowed.

7.8.1 There is no limitation on the number of retries and a team can take as many retries within the 3 minutes duration of the match. No Points will be deducted for retries.

7.8.2 Each team would be provided a flag of their respective team. If a team wants to take a retry, the flag bearer must raise the flag and say clearly “retry”. Once the referee announces a retry, the team shall place its robots at their starting location.

7.8.3 If a team wants to stop their robot during the match, the flag bearer must raise the flag and say “stop”. The team can then turn off their robot but they must not move it. The time at which the robot is stopped would be recorded as the final time.

7.8.4 For each retry, robots must be started again from the Start point. Points will reset to zero.

7.8.5 Arena Management team is responsible to reset the arena, any team member is not allowed to interfere or do the resetting of arena themselves. If such an act is done, referee will call retry.

7.8.6 Separate time for individual retries will NOT be recorded or maintained. When a team takes a retry it is only allowed to restart the robot.
7.8.7 If the contestants enter the arena during the match, it will automatically be counted as a retry.

7.9 **DISQUALIFICATION**
The following behavior shall be considered for disqualification by the referee and the team could possibly be disqualified:

7.9.1 Attempting to damage the game field.

7.9.2 Performing any act that fails to comply with the spirit of Fair Play.

7.10 **PROTEST PROCEDURE**
The protest procedure is as follows:

7.10.1 The team must launch a protest (submit a complete protest form to the head jury) within 15 minutes of the end of their match.

7.10.2 The team must collect the protest form from the head jury on request or use a hard copy of the form in Anx D.

7.10.3 The team must submit a non-refundable protest fee of Rs. 5000/- along with the protest form.

7.10.4 A complete protest form includes submission of the protest fee.

7.10.5 The head jury will forward the case to the judges.

7.10.6 The judges will decide on the protest’s validity and render their decision.

7.10.7 The judges’ decision will be final.

7.10.8 In case of noncompliance of any of points above the protest will not be considered valid.

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**8 TEST RUN**

Contestants will be given time for trial run one day before the contest to calibrate their robot/sensors on the actual arena/game field.
### Annex A  PROTEST FORM

#### Protest Form

<table>
<thead>
<tr>
<th>Team Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Team ID:</td>
<td></td>
</tr>
<tr>
<td>Team University:</td>
<td></td>
</tr>
<tr>
<td>Team Members:</td>
<td></td>
</tr>
<tr>
<td>Match finish time (to be filled by Head Jury)</td>
<td></td>
</tr>
<tr>
<td>Launch time of Protest (to be filled by the head jury)</td>
<td></td>
</tr>
<tr>
<td>Protest fee Payment (to be filled by head jury)</td>
<td></td>
</tr>
</tbody>
</table>

**Reason of Protest:**

Note: I understand if I do not submit this form within 15 minutes of termination of match, I lose my right to protest no matter the authority and that my form will not be accepted by head jury.

**Decision of Judges:**

Signature of Team Leader  
Signature of Head Jury

Signature of Head Judge