NATIONAL ENGINEERING ROBOTICS CONTEST 2020

THEME: INDIGENOUS CATEGORY

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

CHANGE LOG

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

Revision Date	

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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. Robotics is the only field which can add precision while replacing the slow manual labor in the contemporary industrial world. Thus, this field faces enormous pressure from industry to produce all-purpose mobile manipulator robots which can perform simple tasks like grab, navigate and place objects at desired locations autonomously. The future of Pakistan relies heavily on advancement in the fields of engineering and science and events of this nature will encourage and motivate students to improve their technical skills in leaps and bounds.

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.

2.2 MODULAR

Modular/Lego category includes robots that are developed using ready-made kits for example Lego, EV3 kits, EDVON kits or NCRA robotic kit . Modular category is further divided into two subcategories:

2.2.1 Modular School

2.2.1.1 *Lego School*

2.2.1.2 *Ready to Move*

2.2.2 Modular University

This document describes the theme for Category 1 – Indigenous Robots.

3 CONTEST STRUCTURE

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 team. 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 teams (with non-zero score) from the qualifying rounds will go on into the final rounds for head to head matches. The winners will be decided through a final match. Runners up will be decided based on the outcomes of the semi finals and quarter finals.

4 Contest Theme

The focus of NERC 2020 theme is to create autonomous robots that can simulate Fruit Harvesting tasks. In this theme there will be two robots. One robot is acting as the harvester robot. Its job is to pluck the fruits (ping pong balls) from the trees. The second robot is called collector bot. The collector robot will carry a container and will collect the fruits from the harvester after it finishes harvesting fruits from one tree. After collecting all the fruits from the harvester, the collector bot will reach to a parking spot. The first team to successfully collect all the fruits and reach the parking spot will be declared the winner. 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 solid black lines and the dashed black lines in the Figure 1. Represents the walls on the arena. The walls represented by solid black lines have a height of 4 inch throughout the arena. The walls represented by dashed black lines have a height of 2 inch throughout the arena.

3. The red dashed lines in the Figure 1. Represents the black solid lines on the 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 harvester robot will start at the intersection of grid line (4,5) and (9,10) facing in the direction of the arrow as marked in Figure 1. The collector robot will start at the intersection of grid line (4,5) and (6,7). The starting position and orientation of the harvester and the collector bot is fixed.

6. The harvester robot may follow the wall marked in the arena as black solid lines to reach the location of trees. The tree T1 has 2 fruits (ping-pong balls), T2 has 3 fruits and T3 has 4 fruit hanging with it. The harvester robot will pick these fruits from the trees in a fixed ascending order (i.e first from T1, then T2 and then T3).

7. The fruits picked by the harvester will be collected by a second robot called collector bot. The collector robot can be completely autonomous or it can be controlled by a flexible electrical wire. The operator cannot enter the arena.

8. The collector robot may follow the harvester. Both the harvester and the collector are separated by the wall of height 2 inch represented by black dashed lines in the Figure 1. Both robots cannot assist each-other in movement through push/pull.

9. The collector robot will carry a container and will collect the fruits from the harvester. The container of the collector robot should fit in the maximum allowed dimensions of the collector robot. The container can be of any material or shape.

10. After the harvester plucks the fruit, they will be transferred to the collector robot from over the wall. The robot can only move to pluck the fruits from T2 if it has transferred the fruits from T1 to the collector robot and so on.

11. After successful collection of all the fruits from the harvester, the collector robot will move towards the Parking spot as marked in the arena shown in Figure 1. The team to successfully collect all the fruits and reach to the parking spot will be declared the winner.

12. After the start of the match, the team cannot touch the collector bot however it can be controlled via a flexible electrical wire by the team from a distance of atleast 35 inch. The operator cannot enter the arena.

13. The collector robot can only receive the fruits from the harvester robot. The harvester robot cannot have any pre-loaded objects. The use of both the robots is compulsory for this theme.

14. After loading the balls, the harvester bot will transfer the fruits (ping pong balls) to the basket of the collector robot.

15. Each team must bring their own harvester robot and the collector robot.

16. In case of a retry, the team can reset both robots.

17. The fruits are considered to be ping pong balls.

18. The maximum dimension of the harvester robot is 10x 10 inch (LxW), while the maximum dimension of the collector robot is 12 x12 inch (LxW).

19. The harvester robot should be an autonomous and indigenously developed robot. The collector robot can be autonomous or controlled by a flexible electrical wire.

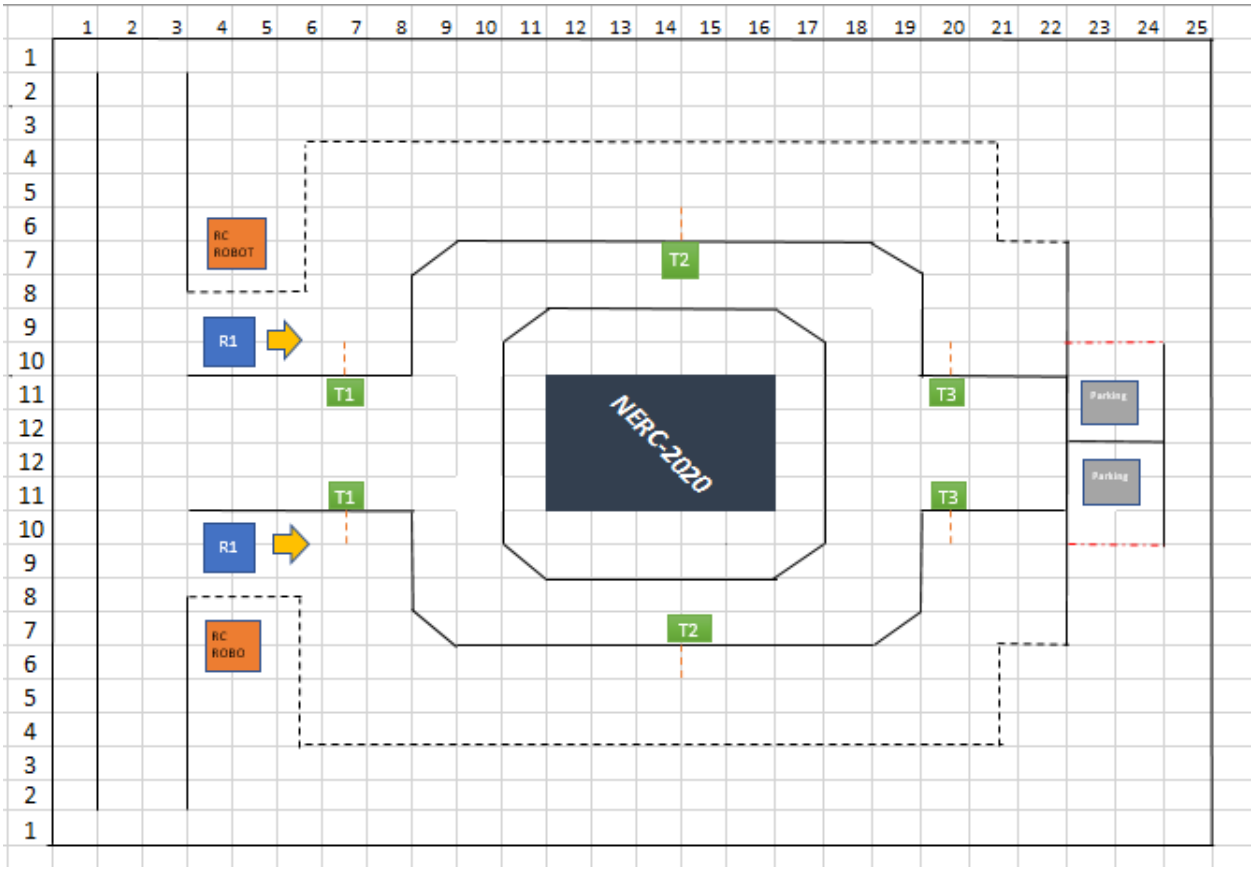

Figure 1 Contest Arena (Top View)

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 harvester robot must be self-controlled without any human intervention. The use of flexible electrical wire is only allowed for the collector robot. 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 harvester robot may navigate through the arena using any suitable technique. The harvester and collector robot may not displace any item in arena. Displacing any item inside the arena will result in a forced retry. 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 but it is not allowed to use any sort of tactile sensor to sense the walls or obstacles. This will result in forced retry or disqualification (as per discretion of judges).

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 1 Point Scoring

Tasks	**Score**
Loading the balls from T1 (5 points per ball)	10
Transfer balls of T1 to collector robot (each ball carry equal marks)	5
Loading the balls from T2 (5 points per	15

ball)	
Transfer balls of T2 to collector robot (each ball carry equal marks)	10
Loading the balls from T3 (5 points per ball)	20
Transfer balls of T1 to collector robot (each ball carry equal marks)	20
Reaching the Parking	20

6.1 Deduction of Points

The deduction of points is show below in Table 2 Deduction of Points

Table 2 Deduction of Points

		Deduction/Penalty
1	The harvester robot fits in an area of 10x 10 inch square	No Penalty
2	Oversize harvester Robot (12x12 inch square)	5 Points
3	Oversize harvester Robot (exceeding 12 x 12 inch cm square)	Disqualification
4	Oversize collector robot (exceeding 12 x 12 inch square)	Disqualification
5	Robots (harvester and collector) weighs less than 12 kg*	No Penalty
6	Overweight Robots (Weight between 12 and 14 kg)	5 Points
7	Overweight Robots (Weight exceeding 14 kg)	Disqualification
8	Damaging the arena/wall/sites/ramp	Disqualification

*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 All Electronic Circuitry must be designed and fabricated by the Contestants themselves.

7.1.3 Maximum effort in the design and fabrication of the robot should be generated by contestants themselves.

7.1.4 Contestants are allowed to use only certain electronic components, list for which is attached at the end.

7.1.5 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.

7.1.6 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).

7.1.7 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.

7.1.8 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.

7.1.9 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:

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

7.1.10 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 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 harvester robot must fit within 25.4 cm X 25.4 cm square at the time of the measurement. If the area of the harvester robot base is more than a 25.4 cm X 25.4 cm square, but less than a

30.48 cm X 30.48 cm square, then points will be deducted. There is no restriction on maximum permissible height of the harvester robot. Any harvester robot which does not fit in 35.56 cm X 35.56 cm square will be disqualified. All robots will be carefully measured. The collector robot must fit in a box of 30.48x 30.48 cm square at the time of measurement. Any collector robot which does not fit in 30.48 X 30.48 cm square will be disqualified. 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 the each robot excluding decorations must not exceed 12 kg. Penalties as detailed in 6.1Deduction 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 ELECTRONICS

7.6.1 All electronic circuitry must be designed and fabricated completely by the participants themselves. Circuits should not be fabricated by the help of any professional developers. Only the modules specified in the components list may be bought directly.

7.6.2 The participants must not use any pre-fabricated board or electronic circuitry. Any type of the electronic board or circuit must be etched by the students themselves. Circuits should not be fabricated by the help of any professional developers.

7.6.3 Any type of the electronic board or circuit must be etched by the students themselves. Circuits should not be fabricated by the help of any professional developers

7.6.4 Microcontrollers specified in the component list must be used for controlling your robots. You can also use Microcontroller development boards specified in the list only. Microprocessors and Single Board Computers are not allowed.

7.6.5 Motor drive circuits should be designed and fabricated by participants themselves and made from discrete components like Transistors and logic circuitry. H-bridge IC's like L297 or L298 are not allowed. However you may use Gate driver IC's e.g. IR2101/IR2110 etc.

7.6.6 No prefabricated modules are allowed, unless listed in the components list or allowed by the NERC coordinator. If a component needs to be added then all of its specification (datasheet, picture, location to purchase, price) MUST be emailed for formal permission.

7.6.7 All other components can be used in your circuitry. In case of any query, questions shall be emailed to NERC Coordinator at nerc@ceme.nust.edu.pk . The FAQs section on the website shall be considered part of the theme.

Note: Only the theme documents and the questions in the FAQ section of the official website (www.nerc.com.pk) shall be considered as official notifications.

7.7 Power Supply

7.7.1 The robot must be battery-powered.

7.7.2 The robot must not have any wired connections with its surroundings.

7.7.3 Voltage of the machine's electrical power source must not exceed 48 volt DC. **Power banks may be used.**

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

7.8 Duration of Match

7.8.1 Each match will be of maximum 3 minutes.

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

7.8.3 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.

7.8.4 Once the Robot moves, team members will not be allowed to touch the Robot or enter the Contest Arena.

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

7.8.6 Time would be stopped as soon as collector bot reached the parking spot D. 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.

7.8.7 The team which harvests all the fruits, delivers them to the collector robot in the correct order and then reach the parking spot will be declared the winner of the match.

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

7.8.9 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.

7.9 RETRY

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

7.9.1 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.

7.9.2 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

7.9.3 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.

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

7.9.5 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.

7.9.6 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.

7.9.7 Changing the microcontroller or reprogramming the robot is **Not Allowed.** A team may change the batteries of the robot if required by taking permission from refree.

7.9.8 If the contestants enter the arena during the match, it will automatically be counted as a retry.

7.10 DISQUALIFICATION

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

7.10.1 Attempting to damage the game field.

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

7.11 PROTEST PROCEDURE

The protest procedure is as follows:

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

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

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

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

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

7.11.6 The judges will decide on the protest's validity and render their decision.

7.11.7 The judges' decision will be final.

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

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 COMPONENTS LIST

Please see the components below. In case of any query, questions shall be emailed to NERC Coordinator at nerc@ceme.nust.edu.pk . The FAQs section on the website shall be considered part of the theme.

Table 3 Components List

Sensors	*Allowed Parts*
Wall Sensor (Proximity Sensors)	*1) IR Sensors: Sharp GP2Dxx & GP2Y0xx series sensor*
	2) Sonars: MaxbotixMaxsonar Range Finder series (XL,LV) Parallax PING))) Ultrasonic sensor, HC-SR04
	3) Self-made from discrete components
Colour Sensor	*1) ADJD-S371-QR99 RGB sensor* *2) Self-made from discrete components* *3) TCS230 or TCS3200*
Other Sensors	*1) Compass/Magnetometer: HMC5883L* *2) IMU: MinIMU-9 v3 Gyro Accelerometer and Compass (L3GD20H and LSM303D), MPU-6050 Accelerometer + Gyro* *3) IMU: GY-80 ADXL345 Accelerometer* *4) Accelerometer : ADXL345* *5) Gyro: LPR550AL Dual-Axis (Pitch and Roll or XY) Gyro ,LPR550AR Dual-Axis (Pitch and Roll or XY) Gyro*
Microcontroller	*1) PIC16F/PIC18F family*
	2) AVR ATTiny, ATMega,
	3) 8051, 8052, 8055
Development Boards	*1) Arduino Mega, Uno, Nano, mini, Pro Series, Leonardo, Esplora, Due*
	2) Pinguino 26j50
	3) Amicus 18
External Shields	*Only SD card shield allowed*
Motor driver	*Self-made from discrete components*
Motor	*Maximum 2 motors are allowed for the drive purpose* *There is no limitation of number of motors in mechanism.* *Encoders may be attached externally.*
Battery	*Any type (Power Banks are allowed)*
Wheels	*Meccanum/Omni wheels are not allowed*

Annex B PROTEST FORM

Protest Form

Team Name:	
Team ID:	
Team University:	
Team Members:	
Match finish time (to be filled by Head Jury)	
Launch time of Protest (to be filled by the head jury)	
Protest fee Payment (to be filled by head jury)	

Reason of Protest: _____

_____

_____

_____

_____ _____

Signature of Team Leader Signature of Head Jury

Decision of Judges: _____

_____

_____

_____

_____

Signature of Head Judge

Annex C TREE DIMENSIONS AND COMPLETE DIAGRAM

Figure 2a. Side View (4 branches)

Figure 2b. Front View – facing the wall (4 branches)

Figure 3a. Side View (3 branches)

Figure 3b. Front View – facing the wall (2 branches)

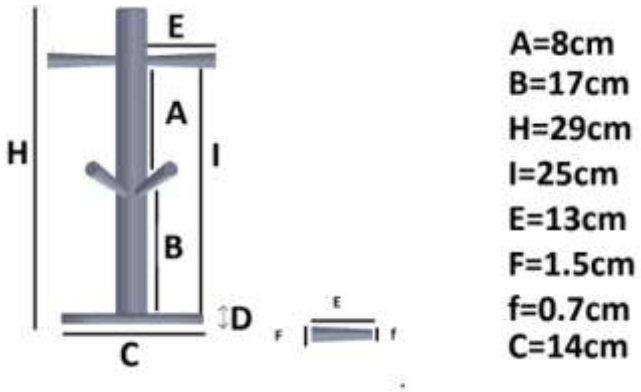

Figure 4. Tree Dimensions