TRANSPORTER BOT

1. Introduction

Agriculture is the main source of livelihood for many people in our country. It is also the source of raw materials to major industries, factories which manufacture edible as well as non-edible products.

There is considerable research focused on using robots to reduce human efforts in agricultural activities. Currently there are different equipment available which automate certain repetitive tasks in the farm.

Crops such as fruits and vegetables are produced seasonally but the demands are throughout the year. With the growing demands, a necessity arises to match availability with consumer demands. An important step is to transport the crops to market in a timely manner, as they stay fresh only for a short duration.

This inspired e-Yantra Robotics Competition (eYRC-2017) to introduce a Theme "Transporter Bot" as a means to map the model of a farm, pick up the Crates of different kinds and load them in the vehicle to transport them to market.

The arena for this theme is an abstraction of a farm with various paths to reach the Pick up Points. Different colored Crates representing different types of fruits may be present at the Pick up Points. The robot has to traverse the arena, pick up the Crates and deposit them at designated racks in the vehicle which will then be transported to the market.

In this theme, teams will learn 3D modeling using Blender Animation Tool, Motion Planning, and Communication. The challenge is to synchronize the activities of the robot, vehicle and Blender. The team that performs the task best in accordance with the rules set for this task will be declared the WINNER of the competition.

2. Theme Description:

This theme uses an open source software **Blender** for 3D modeling. The goal of the theme is to transport **Crates** from the farm to the market and to create its animation on the Blender interface.

Make an autonomous robot that performs the following tasks:

- Robot starts from START position of the arena representing a farm (Refer to Figure 1).
  i. Thermocol **Blocks** of Red (R), Blue (B), Green (G) or Yellow (Y) colors are used to represent **Crates** of four different types of fruits in the Blender Interface.
  ii. There are twelve **Pickup Points** numbered 1 to 12 where Blocks are placed randomly.
  iii. **Rotating Structure** having four sections is used to represent a **Truck** having four sections in Blender Interface. Different sections are labeled: Red (R), Blue (B), Green (G) and Yellow (Y).
  Note: In Blender, Blocks are represented by Crates and Rotating Structure is represented by Truck.
  iv. **Deposition zone** is marked on the arena where the Rotating Structure is placed.

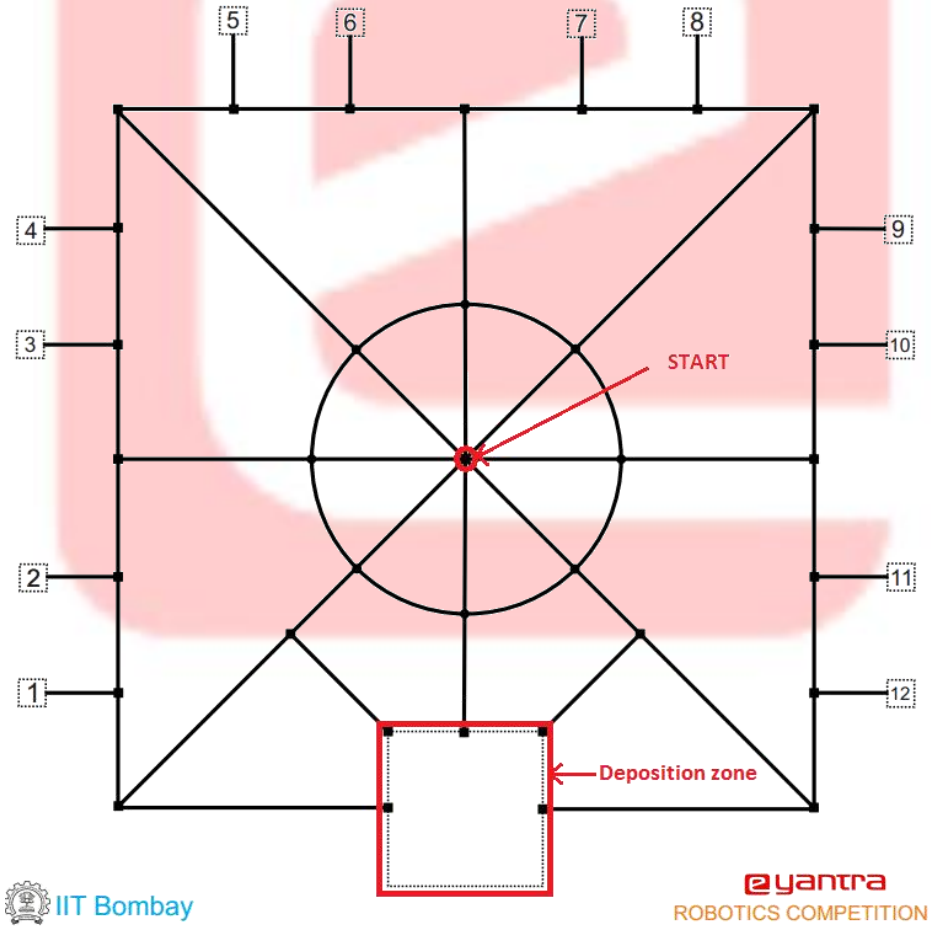

Figure 1: Arena Design

- Figure 2 shows the arena with Blocks and Rotating Structure.

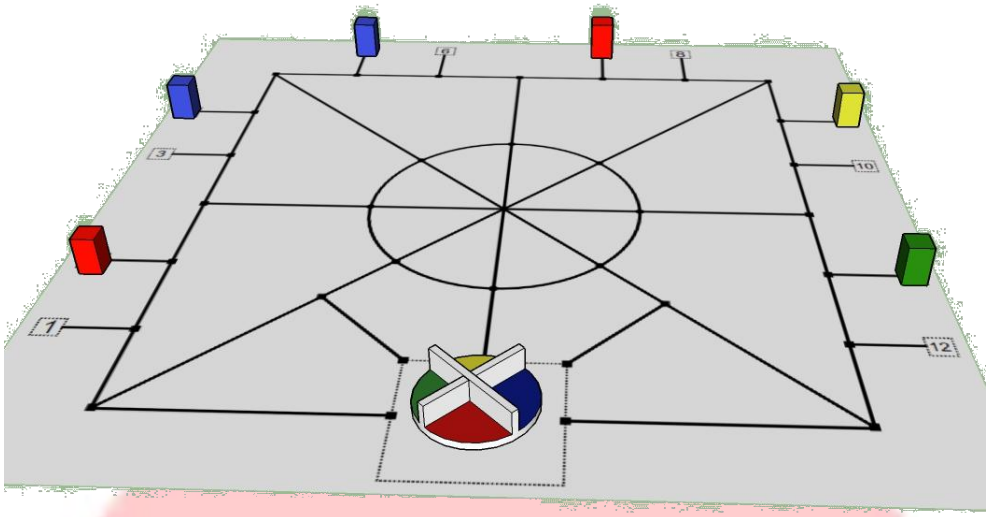

Figure 2: Arena with Blocks and Rotating Structure

- **Placement Sequence** defines position of Blocks on Pickup Points and **Structure Sequence** defines placement of different sections of the Rotating Structure.
- The robot starts from Start position and does the following:
  i. Traverses the arena according to the Placement Sequence given.
  ii. Picks up the Block/s from the Pickup Point/s.
  iii. Communicates this information to Rotating Structure and Blender Interface so that:
    a. Rotating Structure moves according to the Block/s to be deposited.
    b. Blender Interface simulates the picking up of the Crates.
  iv. Deposits the picked Block/s in the corresponding sections of the Rotating Structure.
  v. Communicates deposition completion information to Blender so that Blender Interface simulates deposition of the Crates at the appropriate sections of the Truck.

- **FINISH** line is **NOT** marked on the arena; the robot stops when all the Blocks are deposited in the Rotating Structure and sounds a continuous buzzer.
- In Blender, a 3D model is created at run time. As the robot traverses the arena, all actions are depicted in the Blender interface. Once all the Crates are deposited in the Truck, Truck moves from farm to the market.

Note: You have already completed the modeling and the animation part in Blender in Stage 1. You may integrate these to complete the Theme.

3. Arena:

The arena for this theme is an abstraction of a farm as shown in Figure 1.

Preparing the arena:
Each team prepares the arena. Preparing the arena consists of three major steps.

1. Printing the arena
2. Preparing and Placing the Blocks
3. Preparing and Placing the Rotating Structure

3.1 Printing the arena:

1. PDF file containing the arena design is given to the teams in Task 2/Transporter_Bot_Arena.pdf. Each team prints the arena design on a flex sheet according to the instructions given along with the file.
2. Teams are not authorized to make any changes in the arena design. Any team making unauthorized modifications will be disqualified from the competition.

Details of Arena design (Refer to Figure 3):

- ➢ Dimension of arena is 243.84cm x 243.84cm.
- ➢ The arena consists of black lines of thickness 1 cm. Square **Nodes** of dimension 3cm x 3cm are provided at the intersection of two or more black lines.
- ➢ The dimension of Deposition Zone is 40cm x 40cm.

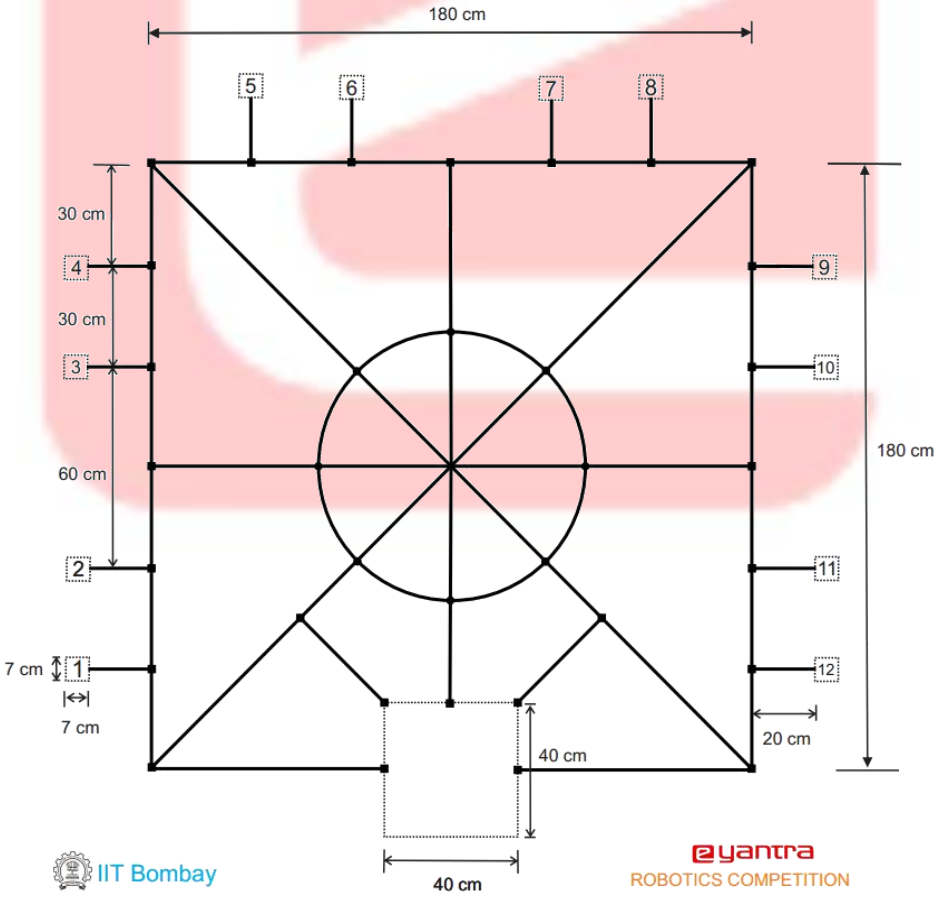

Figure 3: Arena Design

3.2 Preparing and Placing the Blocks:

Preparing the Blocks:
Materials required:

1. Thermocol sheet/s for making the Blocks.
2. Red, Blue, Green and Yellow colored chart paper for covering the Blocks.

- Team prepares 12 Blocks using Thermocol sheets.
- Dimension of each block is 4cm x 4cm x 6cm as shown in Figure 4A. (If the Thermocol sheets of required dimensions are not available then the teams may cut or join the available sheets on their own)
- Team prepares 3 Blocks each of Red, Blue, Green and Yellow by covering the Blocks with the respective colored chart paper. A red Block is shown as an example in Figure 4B.

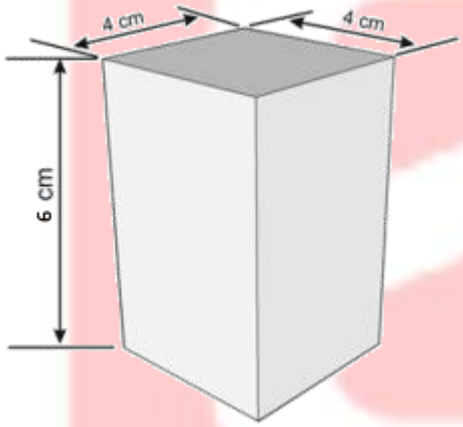

Figure 4A: Block Design

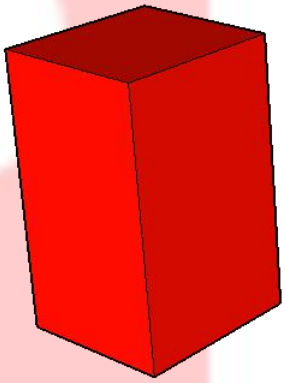

Figure 4B: Red Block

Note: If chart paper of the required color is not available in local stationery shops, the teams can paint white chart paper with the respective colors and then cover the Blocks.

Note: Color coding of Blocks is used only to represent different types of fruit Crates. Teams are not expected to detect the fruit Crates using color detection techniques.

Placing the Blocks:

- Placement of Blocks is given as a sequence of tuples (groups) defined as a **Placement Sequence**.
- Tuple specifies type of Block and Pickup Point number. Example: If the given is tuple is (red, 3), place the red Block on Pickup Point number 3.
- One example Placement Sequence is given as follows:
  (red, 2) (blue, 4) (blue, 5) (red, 7) (yellow, 9) (green, 11)
- Final arena after placing the Blocks according to the example is shown in Figure 5.

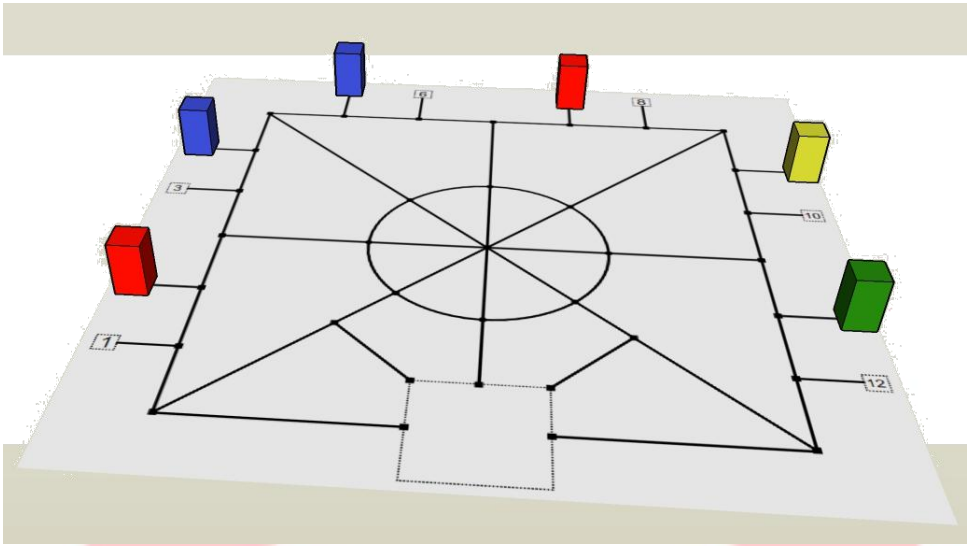

Figure 5: Example Arena with Blocks

3.3 Preparing and Placing the Rotating Structure:

Preparing Rotating Structure:

Components provided for preparing the Rotating Structure:

- Arduino nano
- Stepper motor
- L293d - motor driver circuit
- Zigbee
- Li-ion Battery

- Team prepares the Rotating Structure using materials of any kind (e.g cardsheet, cardboard, thermocol, plywood, etc.)
- To make it rotate, use the provided components specified above (provided in the kit).
- The dimension of the Rotating Structure is such that it should fit within the marked deposition zone.
- Place the components required for Rotating Structure in such a way that it does not disturb the traversal of the robot.

Placing Rotating Structure:

- Place the Rotating Structure in the deposition zone.
- Rotating Structure should have four equal sections.
- Each section denotes a zone for depositing a particular type of Block.
- Placement of sections in Rotating Structure is given as a sequence of tuples (groups) defined as Structure Sequence.
- Tuple specifies color and direction. For example, if the given tuple is (red, south), attach the red chart paper on the section at south using push pins.

Important: Use the direction compass given in Figure 6 for any placement using Structure Sequence.

- One example Structure Sequence is given as follows:
  (red, south) (blue, east) (green, west) (yellow, north)
- Final arena after placing the Rotating Structure according to the example Structure Sequence is shown in Figure 6.

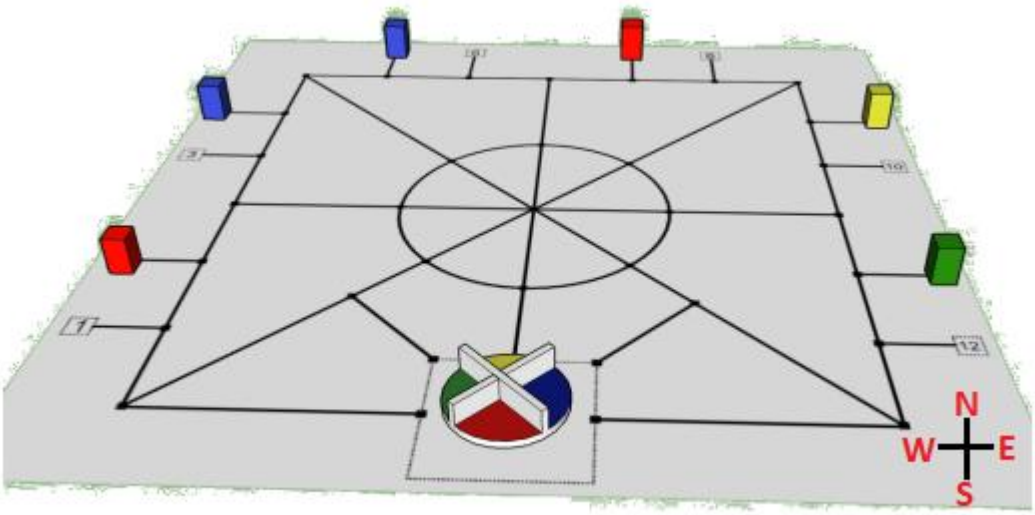

Figure 6: Arena with Blocks and Rotating Structure

Now, we are ready with the arena. Please maintain the arena in a good condition. If the arena is found damaged or in a condition not good enough to properly evaluate the team, e-Yantra has the right to disqualify the team. The final decision is at the discretion of the reviewer.

Note: The arena shown in Figure 6 is specific to the example considered. During the competition, the placement of Blocks and placement of section positions will be different. In Blender interface, create the farm scenario having different pick up points and where the Crates are placed. According to placement sequence , the Crates position on Blender interface should also be varied.

WARNING: Please be careful while handling the flex sheet – avoid folding it like a bedsheet since the resultant folds will cause problems while the robot moves. One way of "flattening" flex if it has been compromised is to hang it for a few hours in the sun -- it tends to straighten out. Never attempt ironing it or applying heat of any kind -- it may be a fire hazard. Best is to store the sheet rolled up.

4. Hardware Specifications:

4.1 Use of Firebird V:

- All participating teams must use **only** the Firebird V robot. **Only one** robot is allowed per team.
- Team shall not dismantle the robot.
- The robot should be **completely autonomous**. The team is not allowed to use any wireless remote or devices such as a camera while the robot is performing the task.

4.2 Use of additional components not provided in the kit:

- No other microcontroller-based board shall be attached to the Firebird V robot.
- Teams may connect external actuators along with their driver circuits to the Firebird V robot only on the condition that the actuators must be controlled through the robot.
- The team is not allowed to use any other sensors apart from those provided in the kit.
- The teams must use a laptop/computer capable of running Blender.

4.3 Power Supply:

- The robot can be charged through battery or auxiliary power supply. These are shipped with the robot.
- The team cannot use any other power source for powering the robot.
- The team can use auxiliary power during practice but the final demonstration should only be made using the battery powered robot.

5. Software Specifications:

- e-Yantra has provided all teams with ATMEL STUDIO 6, a free software for programming AVR microcontroller. Participating teams are free to use any other open source Integrated Development Environment (IDE) for programming AVR microcontroller.
- Use of any **non-open-source** libraries is **not allowed** and will result in disqualification.
- As per e-Yantra policy, all your code and documents are open-source and maybe published on the e-Yantra website.

6. Theme Rules:

- The maximum time allotted to complete the task is 10 minutes. A maximum of **two runs** will be given to a team (the better score from the two runs will be considered as the team's score). A maximum of **two repositions** (explained below) will be allowed in each run.
- Placement Sequence and Structure Sequence will be given before the start of a run. Only 5 minutes will be given to enter these sequences in your codes.
- The robot should be kept at **Start** position with the castor wheel positioned on the black line and robot facing towards the Deposition zone.
- Before starting the robot, Arduino and Blender program should be started.The team should switch **ON** the robot when told to do so by reviewer. This is the start of a **run**. The timer will start at the same time.
- Once the robot is switched on, human intervention is NOT allowed.

- The following are the steps of the task:
  i. The Robot starts from the Start position.
  ii. Traverses the entire arena and picks up the Block/s from the pick up point/s.
  iii. Communicates the information to the Rotating Structure and Blender using Zigbee Communication.
  iv. Rotating Structure moves according to the Block/s to be deposited.
  v. Blender Interface simulates the picking up of the Crate/s.
  vi. Robot deposits the picked Block/s in the designated section of Rotating Structure and communicates deposition completion information to Blender.
  vii. Blender Interface simulates deposition of the Crates at the appropriate sections of the Truck.
  vi. When the last Block is deposited in the Rotating Structure, robot stops at that position and communicates deposition completion of the final Block to the Blender Interface.
  vii. Robot sounds a continuous buzzer to indicate the end of the Task.
  viii. In Blender Interface, after the last Crate is deposited, the Truck moves from the farm to the market.

- **Blender Output Rules:**
  i. Teams must use Blender Game Engine.
  ii. Teams must not use Keyboard, Mouse or any other communication media other than the Zigbee communication from the robot.
  iii. Team should start the game on Blender before robot is switched ON.
  iv. No human intervention is allowed with Blender once the Robot is switched **ON**.
  v. Depict the arena on Blender Interface showing different Pickup Points. (Scaling /Dimensions are left to the choice of the teams).
  vi. Simulate Blocks by the Crates and Rotating Structure by Truck (already created in Task 1).
  vii. For each section of the Truck, design a counter that displays the count of Crates deposited in that section.
  viii. Once all the Crates are deposited in the Truck, Truck moves from farm to the market.

ix. Modeling of Robot, animation of the robot and Truck, creative visualization of Truck moving to the market, will earn you additional points.

- Buzzer sound for more than 5 seconds will be considered as continuous buzzer.
- A run ends and the timer is stopped when:
  i. The robot stops and sounds the continuous buzzer or
  ii. If the maximum time limit for completing the task is reached or
  iii. If the team needs a reposition but has used both reposition options of that run (reposition is explained below) or
  iv. If team interrupts the Blender game.

- Second run will start once again whilst resetting the score, timer and arena. The score of both runs will be recorded and best of two runs will be considered the team's score.
- Teams are not allowed to keep anything inside the arena other than the robot and Rotating Structure. The time measured by the reviewer will be final and will be used for scoring the teams.
- Time measured by any team by any other means is not acceptable for scoring.
- Once the robot starts moving on the arena, teams are not allowed to touch the robot.
- The robot is not allowed to make any marks while traversing the arena. Any robot found damaging the arena will be immediately stopped; reposition will be allowed as per the rules. The final decision is at the discretion of the e-Yantra team.

Reposition of robot:

Suppose while traversing the arena, robot strays off the black line (Refer to Figure 7), a **member of e-Yantra team** who will be monitoring the task will place that robot on the previous Node (Node already traversed by the robot) in such a way that both the wheels of robot are parallel to the Node and castor wheel is on the black line (Refer to Figure 8). This is termed as a **Reposition**. Note that the timer used for measuring the task completion time in the competition will be continuously running during a Reposition and the robot will not be switched off. **Robot** is given **only two repositions** per run. If the robot has been repositioned twice and requires a third reposition, the run will **be ended and the maximum time for the Task will be considered for that run**.

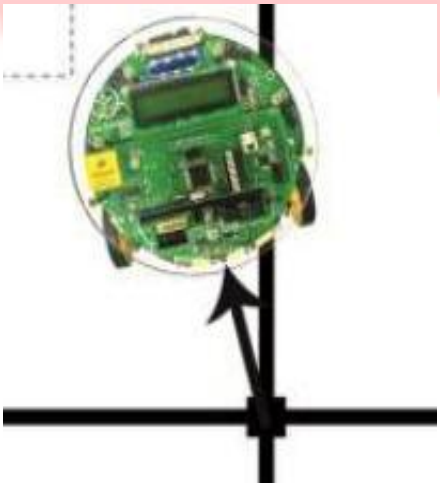

Figure 7: Robot strays off the line

Figure 8: Robot after Reposition

NOTE:

- **You will be given a Placement Sequence and Structure Sequence just before the submission of Task 4: Video submission along with instructions to complete the task.**
- **After completion of all tasks, teams will be selected as finalists based on their cumulative scores across all the tasks. Complete rules and instructions for the finals at IIT Bombay will be sent to those teams that qualify for the finals.**
- **In case of any disputes/ discrepancies, e-Yantra's decision is final and binding. e-Yantra reserves the rights to change any or all of the above rules as we deem fit. Any change in rules will be highlighted on the website and notified to the participating teams.**

7. Judging and Scoring System:

- The competition time for a team starts from the moment the robot is switched ON. The timer will stop as soon as the robot finishes the task.
- Better score of the two runs for a team will be considered as the final score of the team.
- The team's total score is calculated by the following formula:

  Total Score = (600 - T) + (CD x 100) + (CDA x 70) – (ID x 50) - (IDA x 10) + B + BC - P

  CD and ID are related to the actions that are performed on the arena.
  CDA and IDA are related to the actions that are depicted on the Blender Interface.

  - T is the total time in seconds to complete the task.
  - CD is the number of Blocks that are correctly deposited in Rotating Structure.
  - CDA is the number of Crates that are correctly deposited in Truck.
  - ID is the number of Blocks that are: (i) not deposited (ii) not correctly deposited in the Rotating Structure.
  - IDA is the number of Crates that are: (i) not deposited (ii) not correctly deposited in the Truck.
  - P is a penalty where 20 (twenty) points are deducted: (i) for each reposition (ii) for each block that the robot dashes against or displaces during the run.
  - B is a bonus of 100 points awarded, when
    i. the task is completed within 10 minutes,
    ii. no penalty is incurred, and
    iii. all the Blocks are deposited correctly in Rotating Structure as well as in Truck.
  - BC is a bonus of 200 points awarded for creativity – Judges discretion is final and binding. Following will be considered:
    i. Modeling of Crates, Truck, farm and market.
    ii. Modeling of Robot.
    iii. Attractive interface in Blender.
    iv. Animation of the Robot and Truck.

ALL THE BEST…!!!