WEEDING ROBOT

1. Introduction

To feed its increasing population, already at 1.2B people, India has to increase its agricultural productivity, profitability, and sustainability. e-Yantra Robotics Competition 2013 aims to bring awareness to problems in Agriculture by assigning themes from this vital domain.

Greenhouses have been used to grow plants in controlled environments within a covered space. Greenhouses are recent additions to the Indian landscape, giving Indian farmers opportunities to grow exotic flowers and vegetables all round the year.

As the population densities of cities increase, the phenomenon of "Urban Agriculture" -- where even rooftops of buildings may be used for growing plants -- is becoming increasingly attractive.

Thus, as both (i) a productivity boosting technology for traditional farmers and (ii) a revolutionary technology for growing vegetables and fruits in the cities such that the costs of production and distribution are reduced, greenhouse technology holds great promise.

Today most greenhouse automation solutions available in India are typically imported from other countries. e-Yantra believes that talented engineering college students are capable of developing indigenous automation solutions using Embedded systems and Robotics concepts. e-Yantra Robotics Competition 2013 challenges student teams from across the country to solve technical problems in this domain.

In this theme, we are concentrating on the process of weeding.

A plant is often termed **weed** when it has one or more of the following characteristics:

- Little or no value (as in medicinal, nutritional or energy).
- Very high growth rate and/or ease of germination.
- Exhibits competition to crops for space, light, water and nutrients.

Hence it is important that weeds must be removed early on in order to prevent competition occurring between plant and weed.

In our theme "Weeding Robot" we explore automating this basic task –weeding of small sized weeds while not damaging the structure of bigger plants. The arena for this theme consists of two parts:

1. A black line path on white background.
2. Thermocol sheets on both sides of the path. Weeds and plants are placed on this thermocol sheet. Robot has to detect, uproot, and collect weeds without damaging the plants.

You are free to design the mechanism that detects, uproots and collects the weeds. The challenge is to complete this task in the fastest manner. The robot that performs the task best as per the set rules is the WINNER.

2. Problem Statement

Make an autonomous robot that detects weeds and uproots them, without disturbing the plants. Robot has to deposit these weeds in deposition zones.

3. Arena

The arena for this theme is a simplified version of a greenhouse. It contains a path starting at START point, marked by a black line. On either side of the path there are "troughs" which contain random combinations of weeds (represented by yellow sticks) and plants (represented by green sticks). In our arena, thermocol sheets are used to represent the troughs (as in a greenhouse) in which plants and weeds (represented by yellow and green sticks) are attached. At the four corners of the arena, there are deposition zones into which the robot needs to drop the uprooted weeds. We present the finished arena used for this theme in Figure 1.

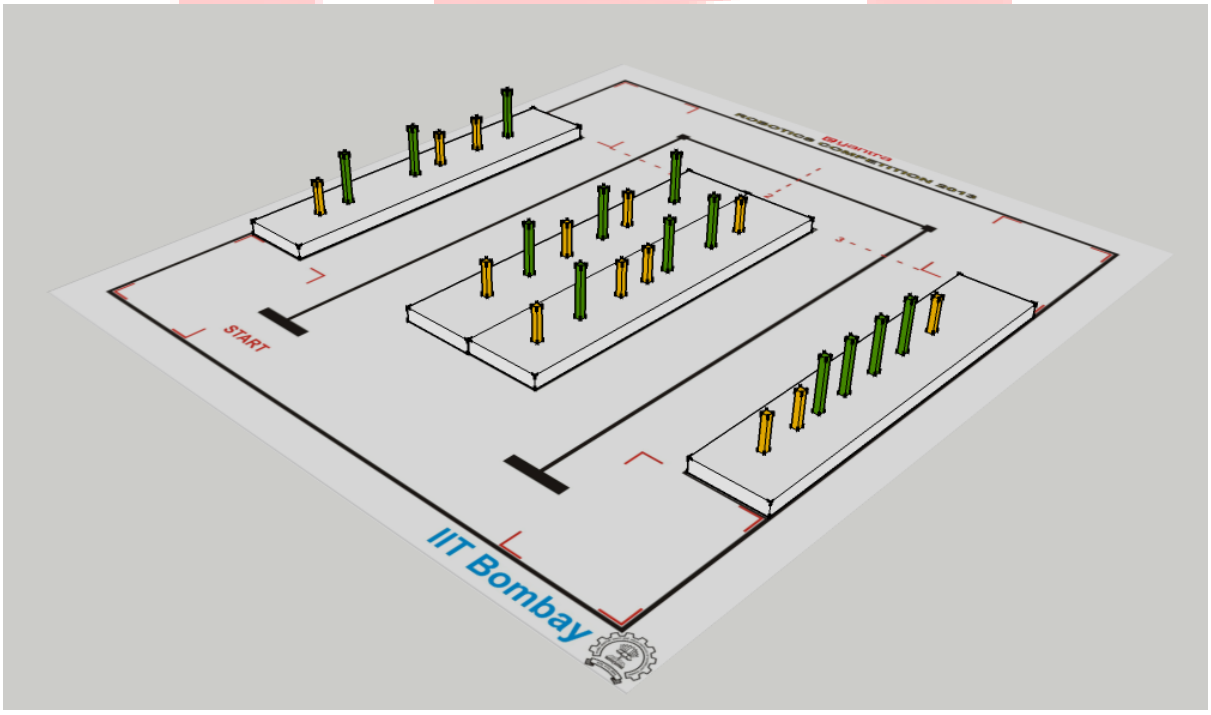

Figure 1: Finished arena

Preparing the arena:

Each team prepares the arena. Preparing the arena consists of 2 major steps:

1. Printing the flex design.
2. Preparing and attaching the troughs on the flex sheet.

Details of these steps are given below:

1. Printing the flex design

1. Flex design is shown in Figure 2.
2. A Corel Draw (.cdr) file containing the flex design will be given to the teams. Each team prints the flex design according to the directions given in the .cdr file.

Details of Flex design:

1. Dimension of arena is 160cm x 180cm.
2. Dimension of flex sheet is 180cm x 200 cm. An extra margin of 10cm is given on all sides so that the flex sheet may be stuck on the ground. (Refer to Figure 2)

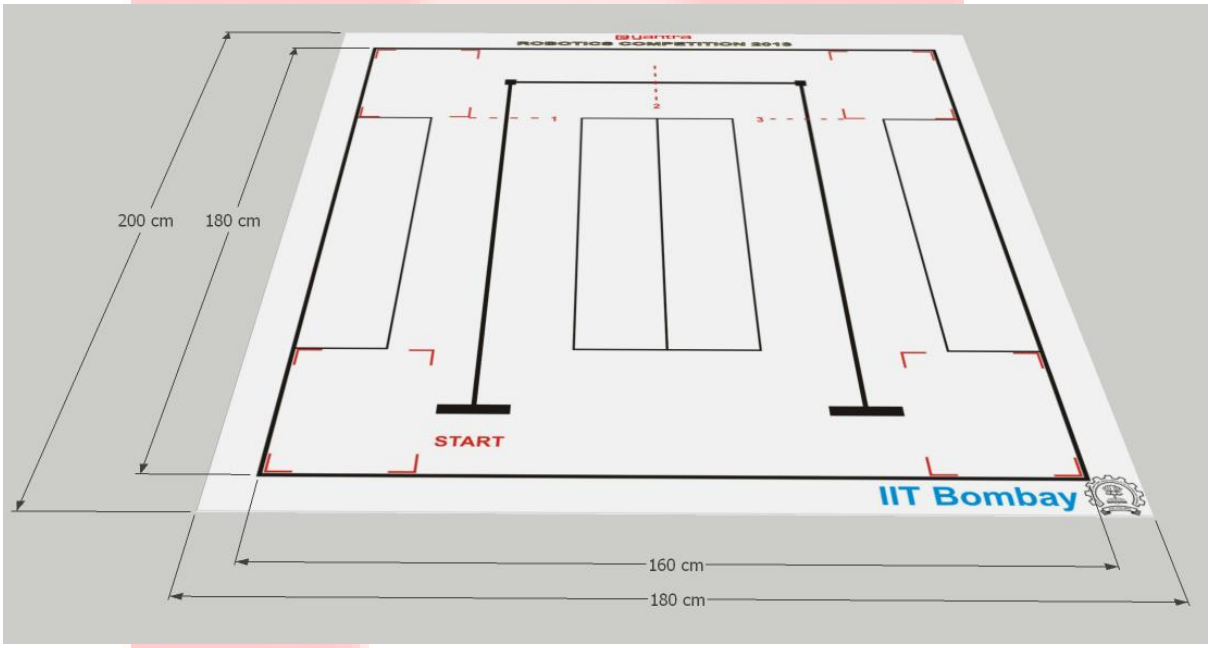

Figure 2: Flex design

3. **START** line is marked on the flex sheet. This is the point from where the robot starts its task execution.
4. **FINISH** line is **NOT** marked on the flex sheet, as the robot can stop after depositing the last weed and give a buzzer as an indication to show that it has finished its task.
5. The arena has a black line of 1 cm thickness. On both the sides of line there are troughs. There are four troughs. On each trough there are a random number of plants and weeds (Details of position and dimensions of plants and weeds and their positions on each trough are given in the next section).
6. There are 3 red dotted lines on the path, which are called "check points". These points are used for "repositioning" the robot. "Repositioning" is explained in Section 6: Theme Rules.
7. At each corner of the flex sheet, red lines bound a square area. These are the four "deposition zones" into which robot drops the uprooted weeds.

8. Teams are not authorized to make any changes in the arena design. Any team making such unauthorized modifications will be disqualified from the competition.

2. Preparing and attaching the troughs on the flex sheet

Thermocol sheets are used to prepare the troughs as explained below.

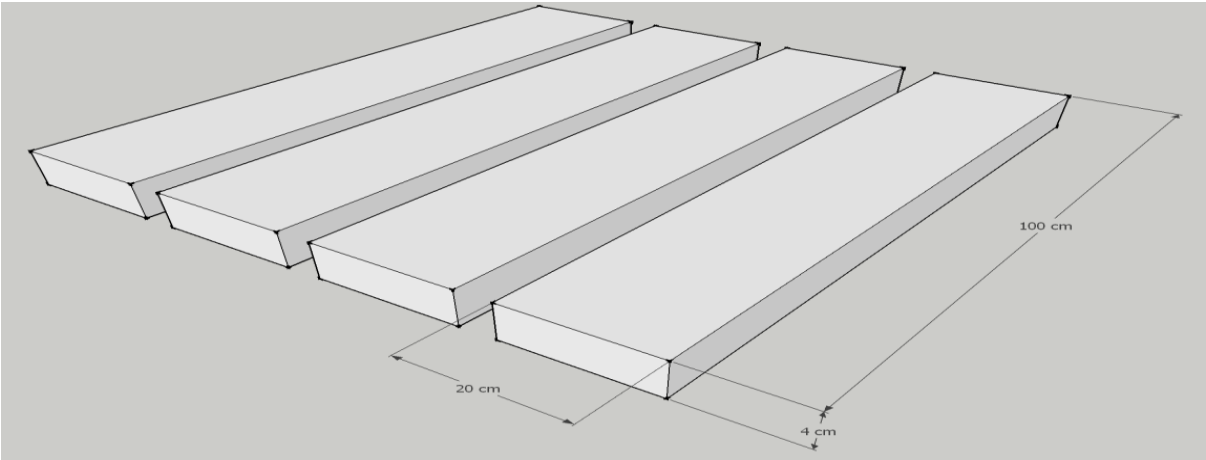

Figure 3: Thermocol

- ✓ 4 thermocol sheets are required each with the following dimensions: 100cm x 20cm x 4cm as shown in Figure 3.
- ✓ Teams purchase four sheets from the market (If sheets of required dimensions are not available then teams can cut or join available sheets on their own).
- ✓ Please purchase a smooth surfaced thermocol sheet for ease of placing on flex.

1. Pick one of the thermocol sheets (say Sheet-1).
   I. Mark a thin line at the center of each thermocol sheet as shown in Figure 4(a). (Note that this line is very light as it is for your reference only)

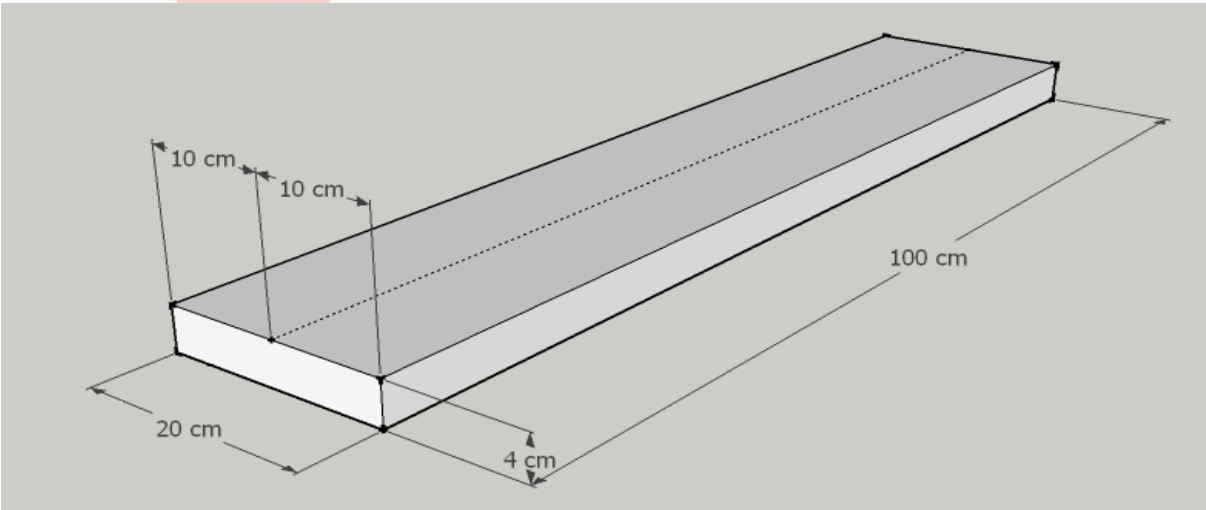

Figure 4(a): Marking a reference line

II. Mark the yellow and green dots as shown in Figure 4(b).

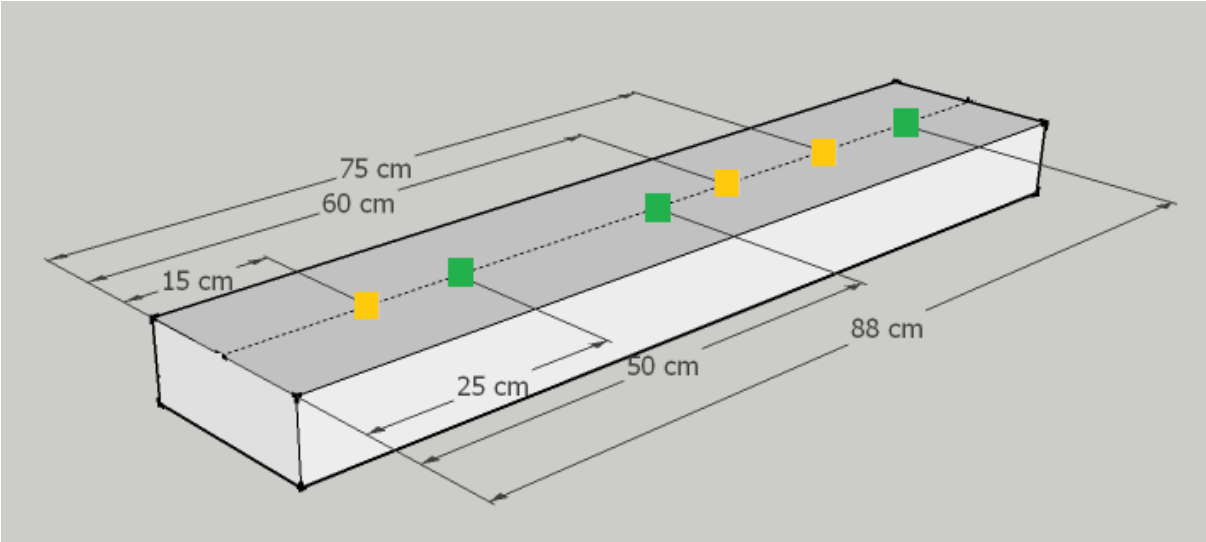

Figure 4(b): Marking center of holes

- ✓ Make sure that these points lie on the marked reference line.
- ✓ Yellow dots indicate the position of weeds and Green dots indicate the position of plants.

2. Procedure explained above should be repeated for the remaining three sheets (Sheet 2, Sheet 3 and Sheet 4). Positions of weeds and plants for these sheets are shown in Figure 5(a), Figure 5(b) and Figure 5(c) respectively.

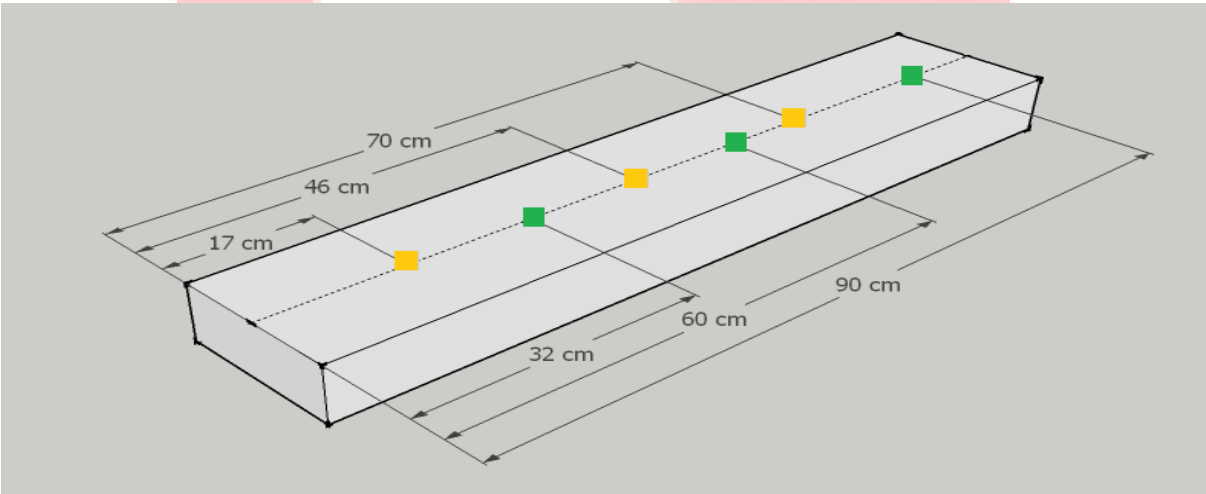

Figure 5(a): Position of weeds and plants in Sheet 2.

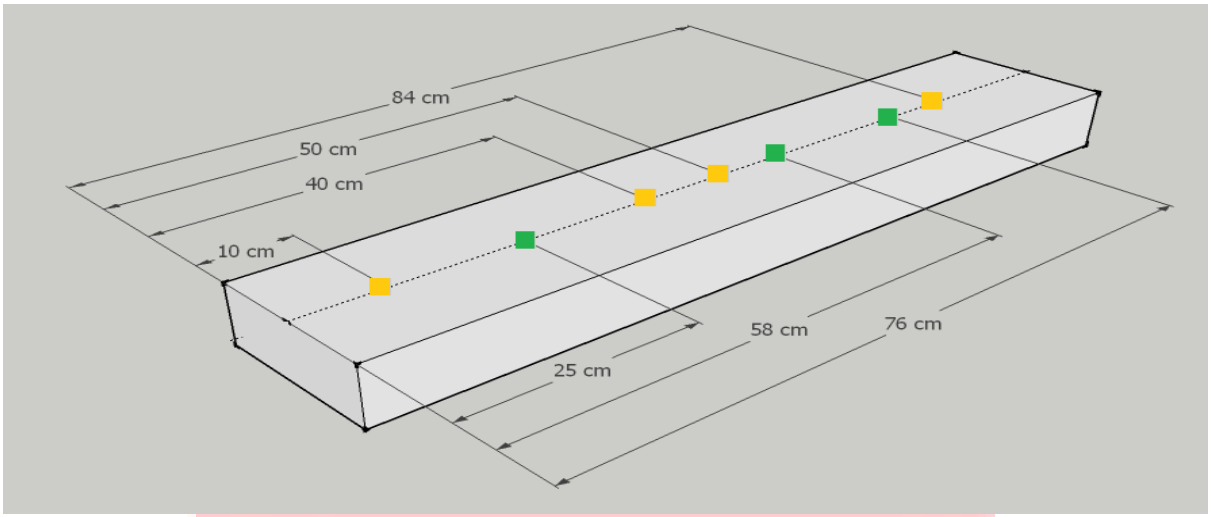

Figure 5(b): Position of weeds and plants in Sheet 3.

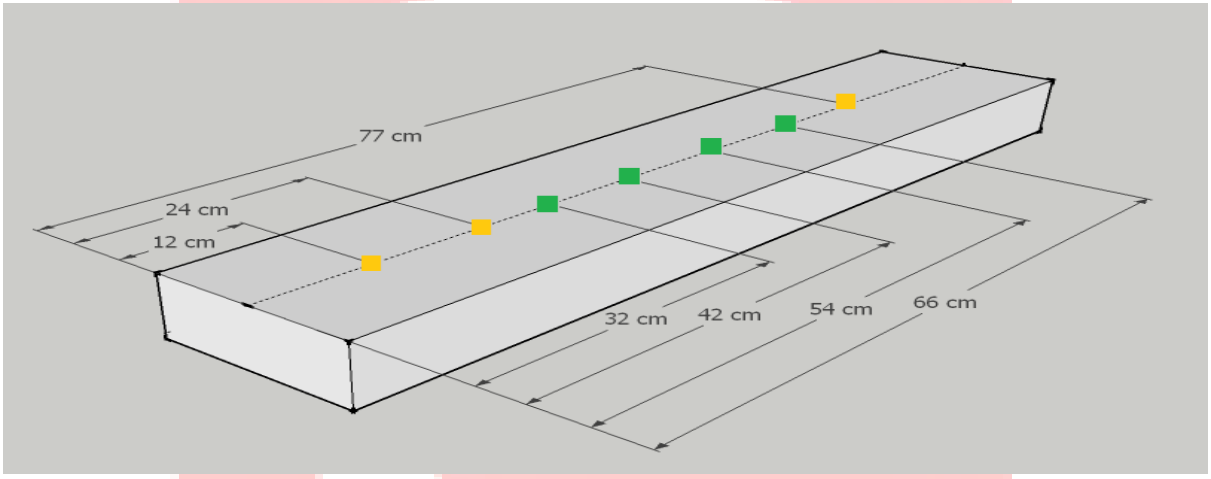

Figure 5(c): Position of weeds and plants in Sheet 4.

3. You are now ready to assemble the thermocol sheets on the printed flex. Place the thermocol sheets on the respective troughs as shown in Figure 6. Take care to align the sheets such that each sheet lies on the bounding box (marked on the flex sheet).

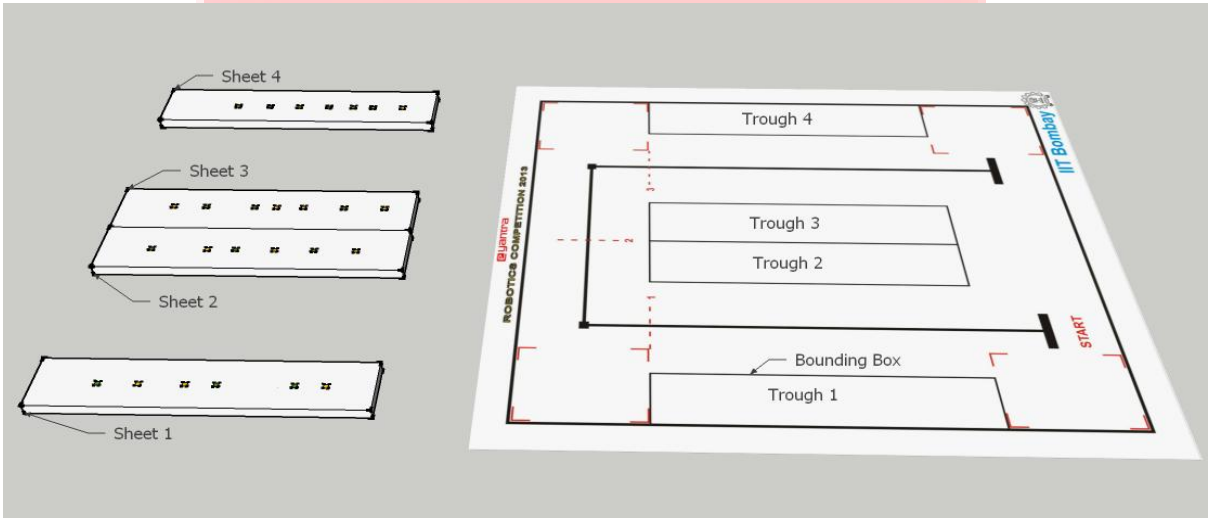

Figure 6: Placing of thermocol sheets in respective troughs

- ✓ If you have space to store the arena for the entire duration of the competition, you can stick the thermocol sheets on the flex sheet using Fevicol. Otherwise, you can use double tape to stick the thermocol sheets on the flex – this way, you can store the thermocol sheets and the flex sheet separately.

4. Dimensions for weed - 1.5cm x 1.5cm x 10cm and that of plant - 1.5cm x 1.5cm x 15cm as shown in Figure 7.

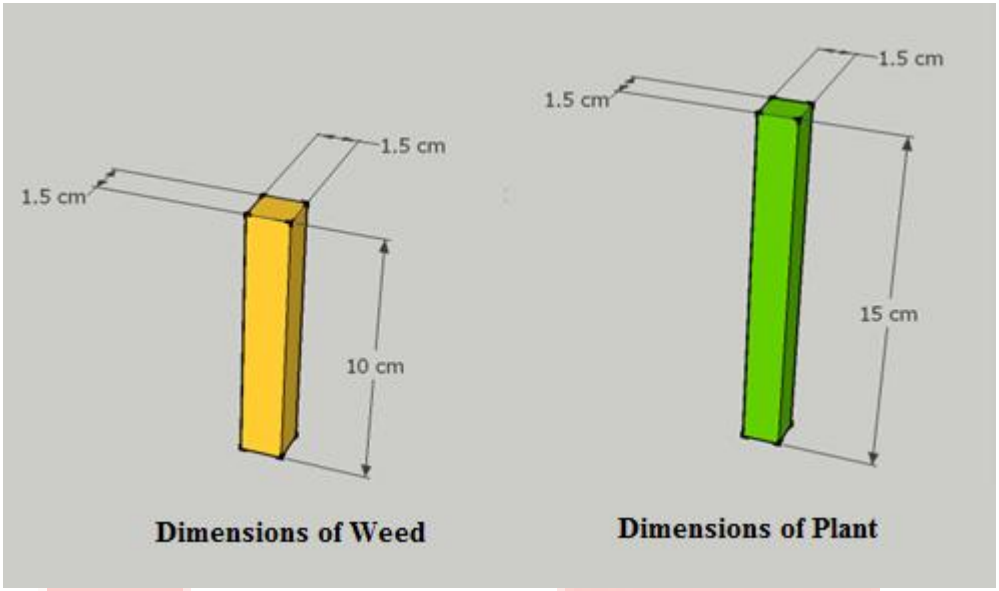

Figure 7: Dimensions of Weeds and Plants

- ✓ Team should prepare wooden sticks (15 each) of required dimensions (If sticks of required dimensions are not available then team can make them by cutting or joining available sticks).
- ✓ 5% error in dimensions can be tolerated.
- ✓ Paint the shorter sticks representing weeds yellow and the longer sticks representing plants green.
- ✓ Any available shade of yellow and green is OK – Note that these colors are for identification purpose; for example, weeds and plants should be distinguishable in a demonstration video of your solution.
- ✓ Pick smooth surfaced wooden sticks for ease of placing on thermocol sheet.

5. Insert each weed and plant into buffers provided with the kit for support (Refer to Figure 8).
6. Make sure that weeds and plants are easily removable from the buffer:
   a. If too tight, file the wooden sticks at the lower portion- then insert.
   b. If too loose, you may use some sand to fill the gap.

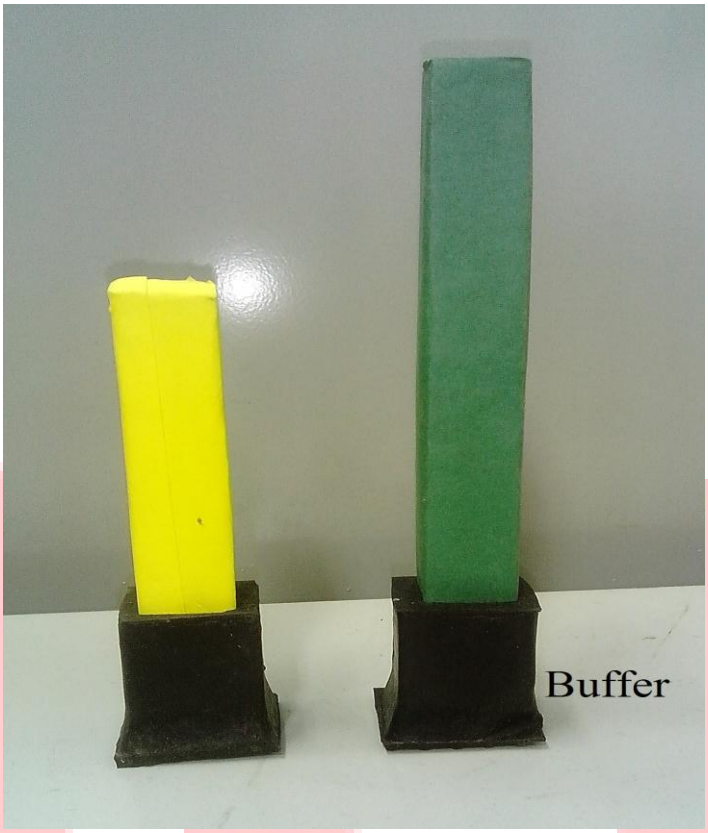

Figure 8: Inserting buffer into Weeds and Plants

7. Now keep the weeds and plants on yellow and green marked dots respectively on all the four troughs. You may stick the buffers on troughs (with double tape).
8. Robot should uproot the weeds without uprooting the buffers.
9. The completed arena at this point should look like Figure 9.

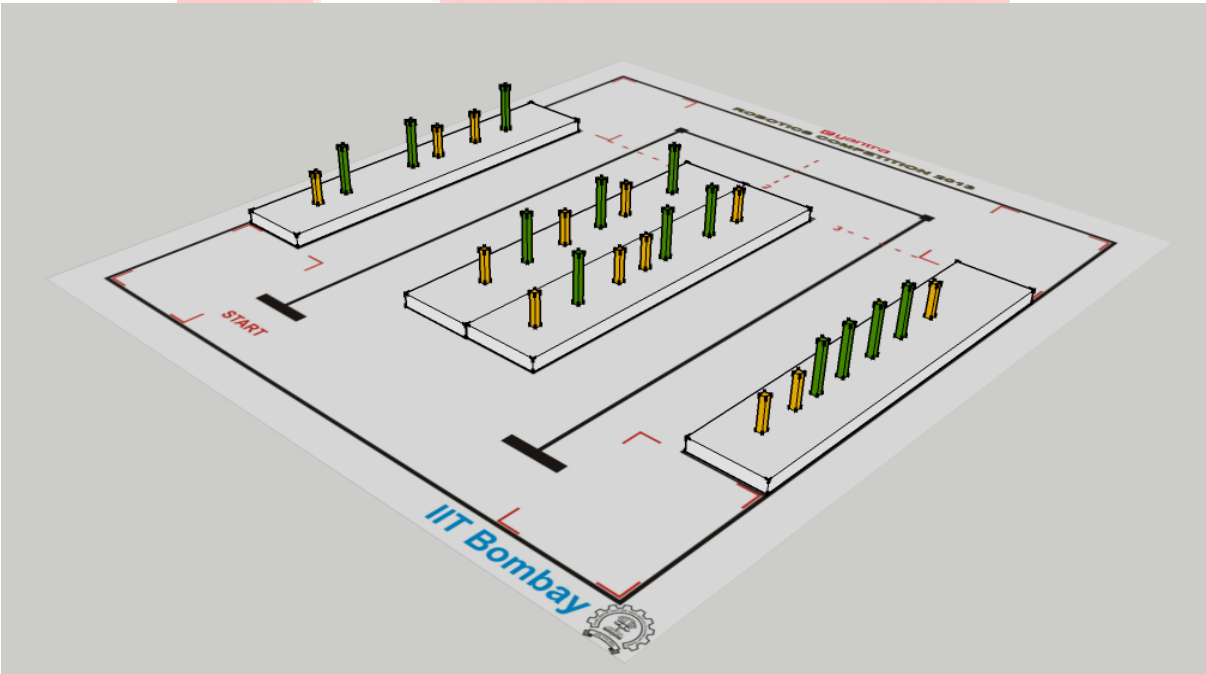

Figure 9: Final Arena

Now we are ready with the arena. Please maintain the arena in 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.**

WARNING: Please be careful while handling the flex sheet – avoid folding it at any stage like a bed-sheet since the resultant folds will cause you 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.

4. Hardware Specifications

Machine:

1. Only one robot is allowed per team.
2. All participating teams must use **only** the Firebird-V robot sent to them in the kit.
3. No other microcontroller-based board can be attached to the Firebird-V robot.
4. Team cannot dismantle the robot. However a team is allowed to attach any **self-designed** mechanical assembly and external motors needed for the work. **The design of this mechanical assembly/structure should be documented in the report along with its cost. A manual on how the mechanical assembly was constructed along with precise drawings and measurements should be provided.**
5. The participating team is not permitted to use any readymade mechanism such as Lego kits or other off-the-shelf readymade components to design the structure on the robot.
6. The robot should be **completely autonomous**. The team is not allowed to use any wireless remote or any other communication protocol or devices such as a camera while the robot is performing the task. The team is also not allowed to use any other sensors apart from those provided in the kit.
7. During the run, the robot can expand itself provided it does not damage the arena in any manner. However, it is not allowed to make any marks while traversing the arena. All robots found damaging the arena will be immediately disqualified. **The final decision is at the discretion of the e-Yantra team.**

Power Supply:

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

Controls

1. The robot must be completely autonomous.
2. It should not receive any extraneous input.

5. Software Specifications

1. 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.
2. As per e-Yantra policy, all your code and documents is open-source and maybe published on the e-Yantra website.

6. Theme Rules

1. The robot must be self contained, and not externally operated by wire or by remote radio control during the competition.
2. The robot must be started by only one switch. The starting procedure of the robot should be simple and should not involve giving robot any manual force or impulse in any direction.
3. Robot should be kept at the **START** line with the castor wheel of the robot positioned on the line.
4. The team should S**witch ON** the robot when asked by reviewer. This is the start of a RUN. The timer will start at the same time.
5. Once the robot is switched on, human intervention is NOT allowed.
6. The maximum time given for completing the task is **8 minutes**. A maximum of **two runs** will be given to a team. A maximum of **two repositioning** (explained below) will be allowed in each run.

7. A run ends and the timer is stopped when
   - ✓ The robot stops and sounds the continuous buzzer or
   - ✓ If the maximum time limit for completing the task is reached or
   - ✓ If the team needs repositioning but has used both repositioning options of that run.
8. Buzzer sound for more than **5 seconds** will be considered as continuous buzzer.
9. 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 as the team's score.
10. Robot needs to deposit the uprooted weeds into any of the deposition zones. The deposition zones are shown in Figure 10.

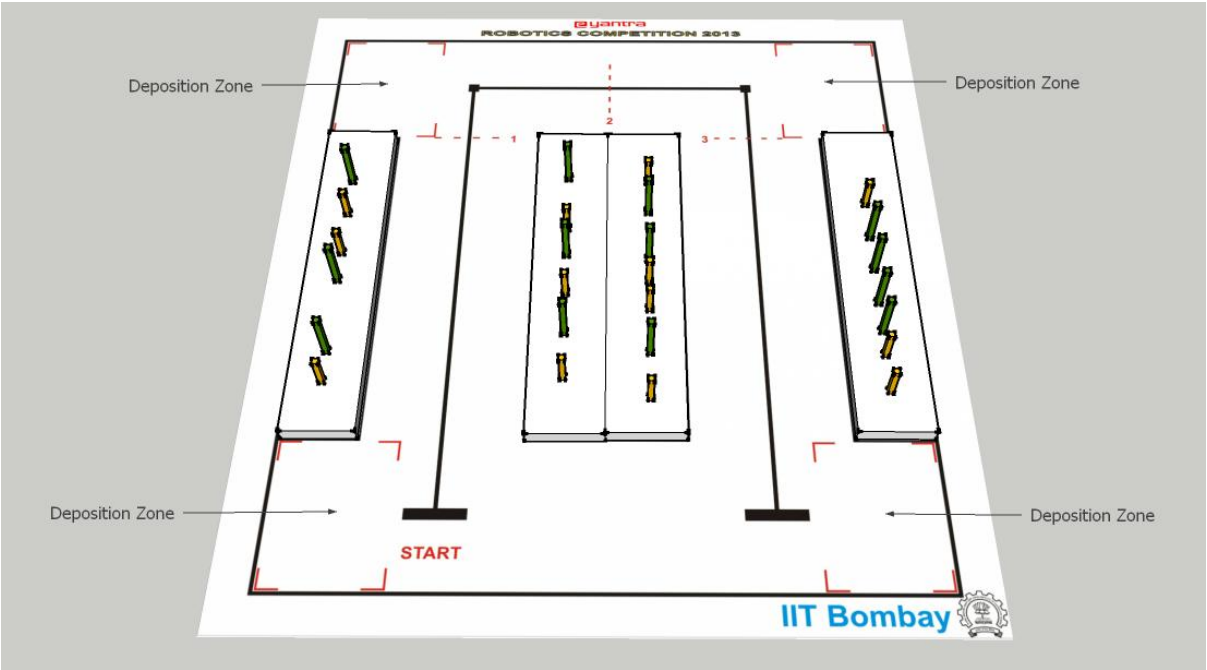

Figure 10: Representing Deposition Zone

11. The weeds are considered as deposited if at least some part of the weed lies inside the deposition zone (Red Box) at the end of the run.
12. The arena is the same for all teams. Positions of weeds and plants will be random in actual competition. There will be a maximum of eight weeds and four plants in a trough and minimum spacing between them is 7cm.
13. Once the robot starts moving on the arena participants are not allowed to touch the robot.
14. If the participant wishes to reposition the robot it will be kept at the previous checkpoint it has crossed (Dotted red lines shown on flex sheet indicate the checkpoints). There are a total of three checkpoints. If participant wishes to reposition in between the START position and first checkpoint then it will be kept on the START position.
15. If robot is found to be displacing or damaging the arena then it will be kept at a previous checkpoint.
16. **In case of any disputes/ discrepancies, e-Yantra's decision is final and binding.**
17. **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 total score is calculated by the following formula:

Total Score = (480-T) + (40 X C1) + (10 X C2) – (10 X I) + B - P

1. **T** is the total time taken by the robot to complete the task in seconds.
2. **C1** is the total number of weeds deposited in the deposition zones at the end of the run.

3. **C2** is the total number of weeds that robot is able to uproot but is unable to deposit.
4. **I** is the total number of weeds that robot is unable to uproot.

Note- Each weed will either have a status of C1, C2 or I

5. **Bonus Points (B):** Sixty (60) bonus points will be awarded, if the robot
   a. uproots and deposits all the weeds in deposition zones and
   b. completes its task in less than 8 minutes and
   c. does not displace or damage any plant.
6. **Penalty (P):** If robot uproots a plant instead of a weed then 15 points will be deducted for each uprooted plant (P)

ALL THE BEST….!!!