SRI LANKAN ROBOTICS CHALLENGE

SLRC 2019

UNIVERSITY CATEGORY

TECHNICAL SPECIFICATIONS

Organized by
Department of Electronic and Telecommunication Engineering,
University of Moratuwa

Introduction

Soon after becoming the new king of the seven kingdoms, King Brandon Stark is about to face yet another challenge. After bringing an end to the intense war, it is now King Bran's duty to rebuild Winterfell, King's Landing and Castle Black. Iron Bank has agreed to lend some money to the new king but have warned him about the burglars who are eagerly waiting to steal the money before they are being delivered to the above locations. Therefore, King Bran should now find a way to deliver the money without being deceived by the traps set by the burglars. However, the head of the Iron Bank, who is aware of the risks of this journey, has imposed one more condition for lending money. He must be informed immediately after the funds have been safely delivered to a correct location. Hence, King Bran has summoned a team to build a robot to perform this daunting task.

Robot Specifications

1. The dimensions of robot should not exceed 25 cm x 25 cm (width x length) (It should fit inside a 25 cm x 25 cm box with no height constraint). The robots which do not address these criteria would lead to disqualification.
2. The robot should be completely autonomous without any sort of remote controlling.
3. The robot should be powered by internal power sources. External power supplies are not allowed.
4. Voltage difference between any two points on the robot must not exceed 24 volts.
5. **The robot should have three color LEDs (red, green and blue) lined together to indicate a color and another two white LEDs on either side of the robot in order to indicate the presence of a pillar at that side (left and right). These LEDs should be placed in a place clearly visible to a person outside the arena and should not be removed from the robot during an attempt.**
6. No off-the-shelf Lego kits or any such assemblies are allowed except for the readymade microcontroller boards, sensor modules and other electronic modules.
7. The starting procedure of the robot should be simple and should not involve giving the robot any manual force or impulse in any direction.
8. The robot should be able to operate under the provided indoor lighting conditions.
9. Since the whole arena can't be constructed on a single board, there can be slight differences in height at the boundaries of the 8'x4' boards.
10. Minimum distance between the middle of the lines and the edges of the arena will be 20 cm. The robot should be designed in a way that it won't fall out of the arena.
11. **The robot is expected to leave a secondary robot behind in the Area-1 and Area-2. (Can use the same secondary robot for both Area-1 and Area-2.) After undergoing separation, the part of the robot leaving Area-1 (or Area-2) will be considered the main robot (only one can leave) and the part/s of the robot left in Area-1 (or Area-2) when this main robot exits the Area-1 (or Area-2) will be considered as a secondary robot unless these two combines again to form one robot.**

12. **The secondary robot can only move within Area-1 or Area-2. The boundaries of Area-1 and Area-2 will not marked on the arena. You can assume it to be a square of 80 cm x 80 cm centered on the white square placed to align the robot in the area of concern.**
13. **Robot should not leave any of its components behind in the rest of the arena.**
14. Any communication method is allowed between the robot and the secondary robot. The team must make sure that communication will not be affected by or affect any external devices outside the arena.

Arena Specifications

All the dimensions shown in the figures are in centimeters and these dimensions will be accurate within 5% or 2cm, whichever is less.

Line Grid Specifications

- One square of the grid has the following dimensions,

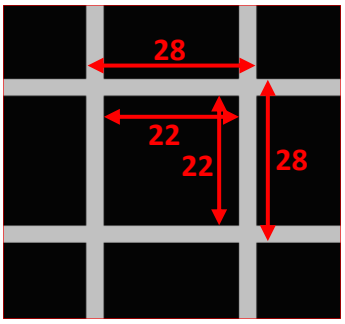

Figure 1.1

- The grid consists of lines of 3cm(±3mm) width on a non-reflective matt black surface. (sample of material will be given to each team at the leaders' meeting.)
- There are 64 squares on the grid (8 squares per side, **see Figure 1.2**.)

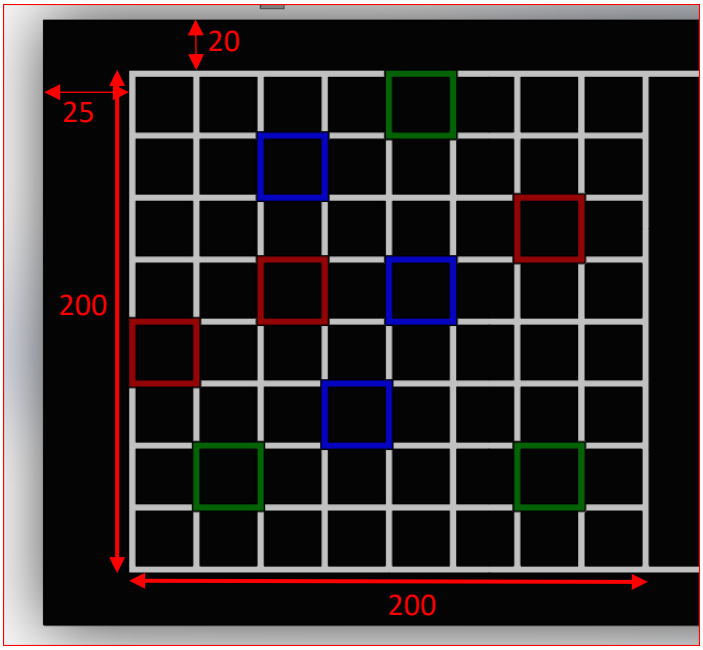

Figure 1.2

- The total length of one side of the grid is 200 cm. The grid is connected to the rest of the arena through two lines coming out of the grid.
- Out of the 64 squares in the grid, **9 will be colored (3 red, 3 blue and 3 green) and the rest will be white.** These 9 squares will be in random and will not be the same as in Figure 1.2.

Indication Line and Indicating Pillar Specifications

- There will be 4 white lines (Indicating lines) of 23 cm length spaced 20 cm apart from each other prior to the grid area.
- There will be white pillars (Indicating pillars) with 5 cm x 2 cm (length x width) base and 10 cm in height on either side of these 4 Indicating lines.
- These Indicating pillars will be spaced 8 cm away from the edge of an Indicating line.
- An Indicating line has at least one Indicating pillar on its side (either the right or the left). It can also have Indicating pillars on both sides.

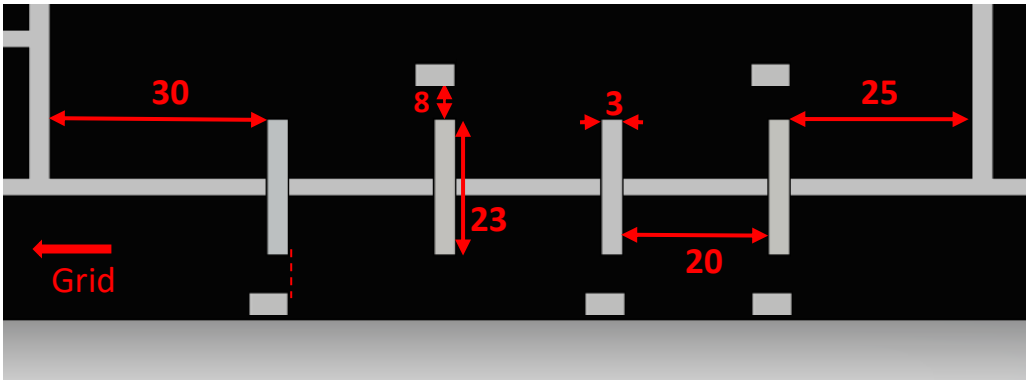

Figure 2.1

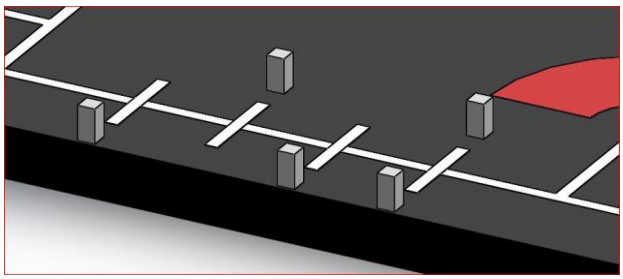

Figure 2.2

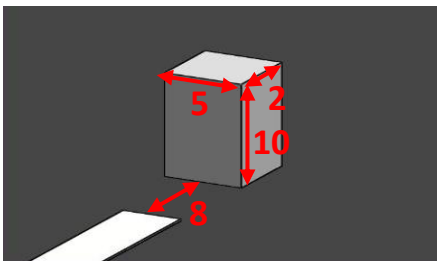

Figure 2.3

Area-1 and Area-2 Specifications

- The dimensions of the Area-1 is shown in the Figure 3.1 and Figure 3.2.

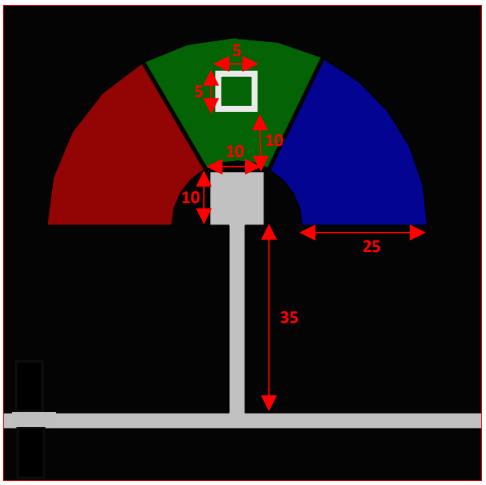

Figure 3.1

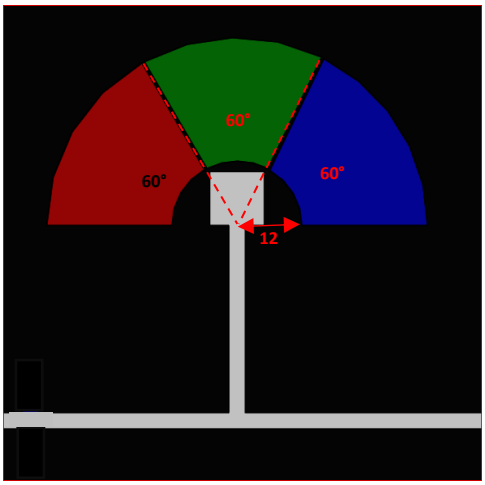

Figure 3.2

- The dimensions of the Area-2 is shown in the Figure 3.3 and Figure 3.4.

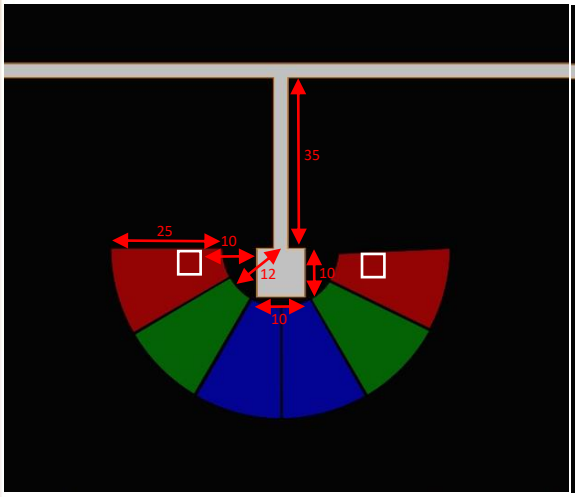

Figure 3.3

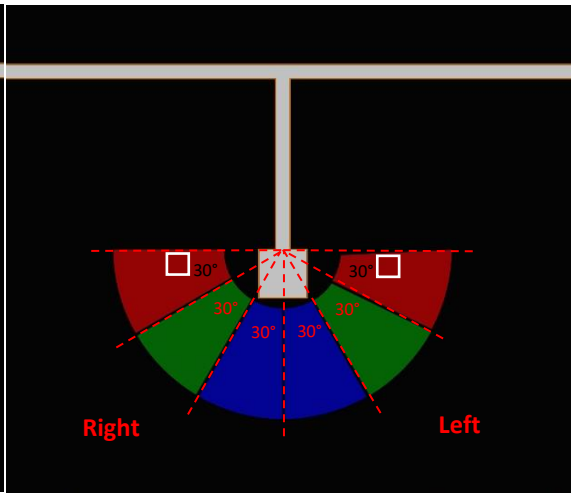

Figure 3.4

- At the beginning of an attempt a 5cm x 5cm x 5cm white cube is placed on the green sector of Area-1 (refer Figure 3.5) and two such cubes are placed the two red sectors of Area-2 (refer Figure 3.6). These cubes are not fixed and can be moved.

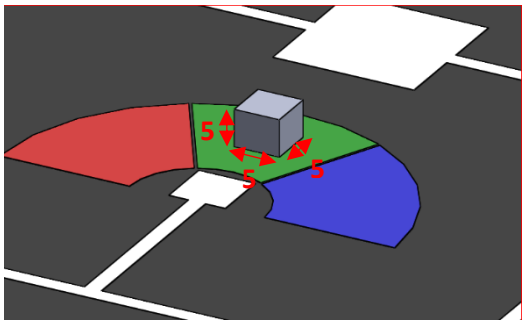

Figure 3.5

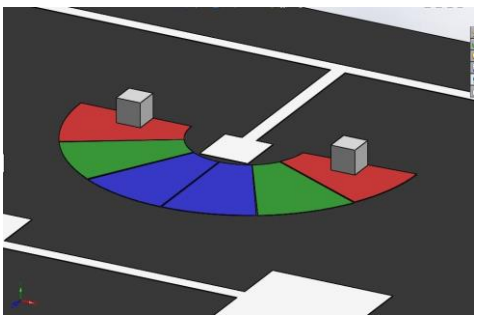

Figure 3.6

- In the first round only Area-1 will be there in the arena. In the second round both Area-1 and Area-2 will be present in the arena.

- To perform the task of **"Color indicating"** (described in detailed in the "**Task**" section) the robot must move the relevant cube into the correct color-sector.
- The colors in each sector of the diagrams of Area-1 and Area-2 will not change in the final arena. Therefore, no color detection is needed here.

Box specifications

- The box is made by pasting white color sticker papers on all six sides of 5cm x 5cm x 5cm cube. The weight of the cube will be less than **150 g.**

Coin specifications

- Coins are made by pasting colored sticker papers on both flat sides of 2-rupee coins issued in 2013.

Second round ending area specifications

- Both Line-1 and Line-2 will be 60 cm long and will be of two different colors (the colors in the figure will differ from the colors used in the arena).
- The line separating Line-1 and Line-2 will be 23 cm long and 3 cm thick.
- The ending square will be a 25cm x 25cm white square.

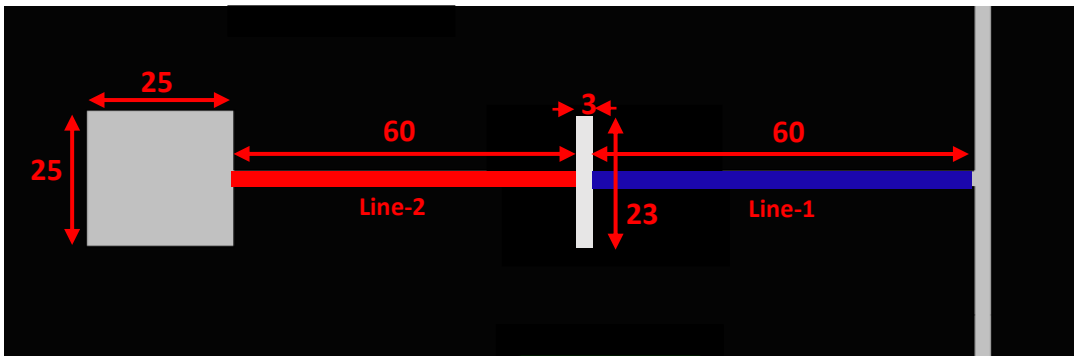

Figure 4

Task

The competition task should be achieved using one autonomous **mobile** robot. It should be capable of leaving behind a **secondary** robot (as defined in the 'Robot Specifications') in Area-1 and Area-2 (can be the same robot).

First Round

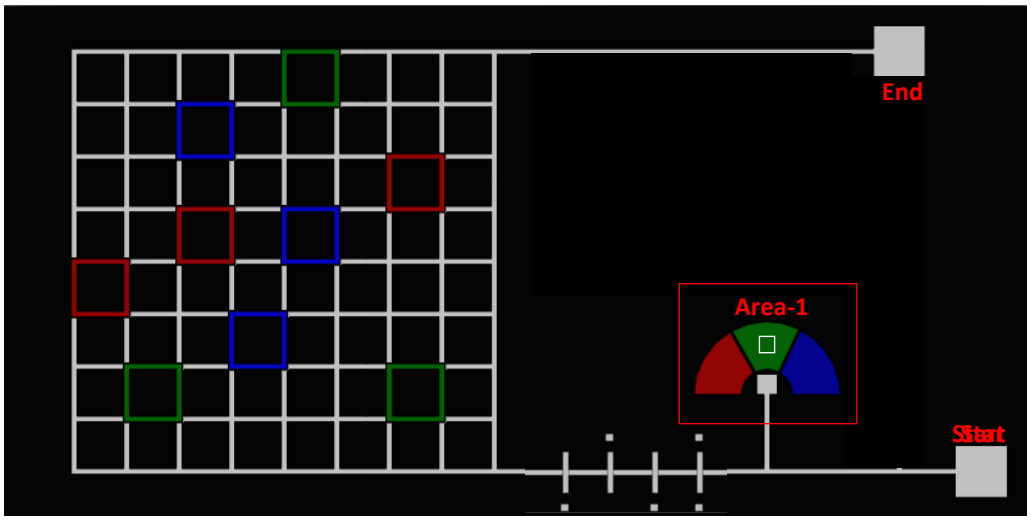

Figure 5: Round 1 arena

NOTE : Before reading the task please read the 'Arena Specification' section. All new terms used in the Task description is defined in that section.

- Before placing the robot on the arena, each team is given three coins of three different colors (Red, Blue, Green). Each of which should be inserted into the robot in whichever way they like and must be dropped into the correct colored square while in the grid.
- At the beginning, the robot should be placed on the **starting square**.
- The robot must start from the starting square and proceed to the Area-1 where they should leave its secondary robot.
- Then it should scan the Indicating lines and Indicating pillars and proceed to the line grid.
- While scanning for the Indication pillars, the robot should clearly indicate the side in which it detects the Indication pillar using two white LEDs on either side (left and right) of the robot. The pillar indication should be completed while the robot is still on the respective Indication line.
- While in the grid the robot is expected to do the following tasks and it can be done whatever sequence it wants.
  - The robot should scan the whole grid and assign numbers to all the squares as defined in the 'Grid Numbering Sequence' section. Displaying the grid number of each square is not necessary. This is needed for the calculations.

- In the grid, out of the 3 squares for each color, only 1 of them is correct. According to instructions given in the ‘Calculations’ section below, the robot should find this correct square using the data it gets from the Indication lines and Indication pillars.
- The robot should calculate the correct color order in which it should drop the coins (according to the instructions given in the ‘Calculations’ section).

- While scanning the whole grid, the robot should indicate the color of the colored squares it meets using the color LEDs. Indicating the color once when it travels over one of the sides of the colored square is enough.
- Then the robot should drop the three colored coins into the three correct squares in the correct color order. The coin should be dropped into the empty space of the colored square and not onto the colored border of the colored square.
- While the coin dropping is done by the main robot, the secondary robot should indicate the color of the coin that the main robot drops. This process is called ‘Color indication’. It should be done as follows,
  - After the main robot drops the first coin, the secondary robot should move the box in the Area-1 to the same colored section as the dropped coin. This box moving should be complete before the main robot drops its second coin.
  - After dropping the second coin, a similar color indication should be done before dropping the third coin.
  - After dropping the third coin, the color indication should be done before the main robot exits the grid.
- The robot finishes the task when it reaches the Ending square.

Grid Numbering Sequence

Color	Increment
Red	2
Green	3
Blue	4

- Grid numbering is done in a zig zag manner. Numbering starts from 1 and is numbered one by one until it reaches the first colored square. The next squares will be numbered with an increment relevant to the color of the square you meet. This will go on until you meet another colored square where you will have to change the increment. Using this way, the whole grid should be numbered.

(Eg : In the Figure 6, you find a green square at 10, the next square will be 13 because the increment value of green is 3. The next few squares will be numbered three by three and will not change when you meet the green square at 25 because it’s the same color. When you meet the blue square at 43, from there onwards numbering will be done four by four because the increment value of blue is 4. This will continue until the whole grid is numbered.)

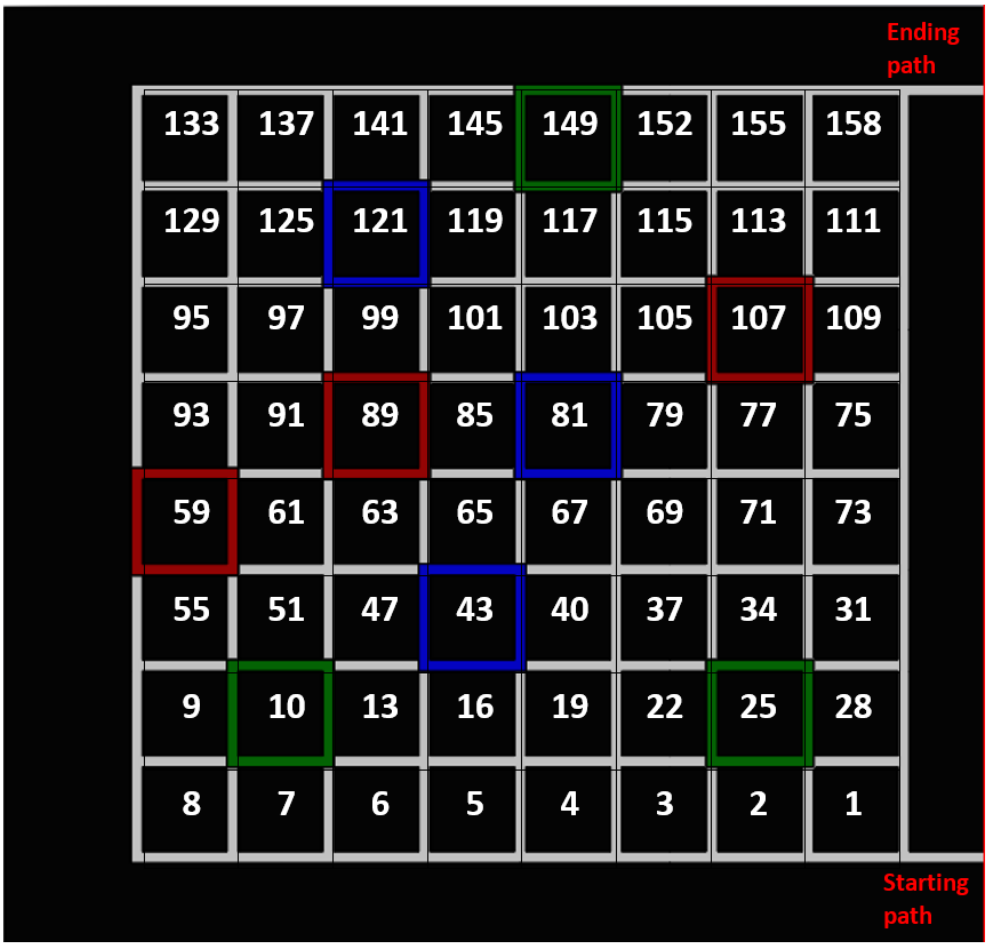

Figure 6: Grid numbering sequence

Calculations

- The position values of the Indicating lines and Indicating pillars are given in the table below.

Indicating Lines	
Indicating line position	**Value**
Indicating line-1	10
Indicating line-2	20
Indicating line-3	30
Indicating line-4	40
Indicating Pillars	
Indicating pillar position	**Value**
Left	1
Right	2
Left and Right	3

- The robot should scan the **Indicating pillars** on the either side of all **4 Indication lines** and get its combination to drop the coins into the empty space of correct squares in the correct order.

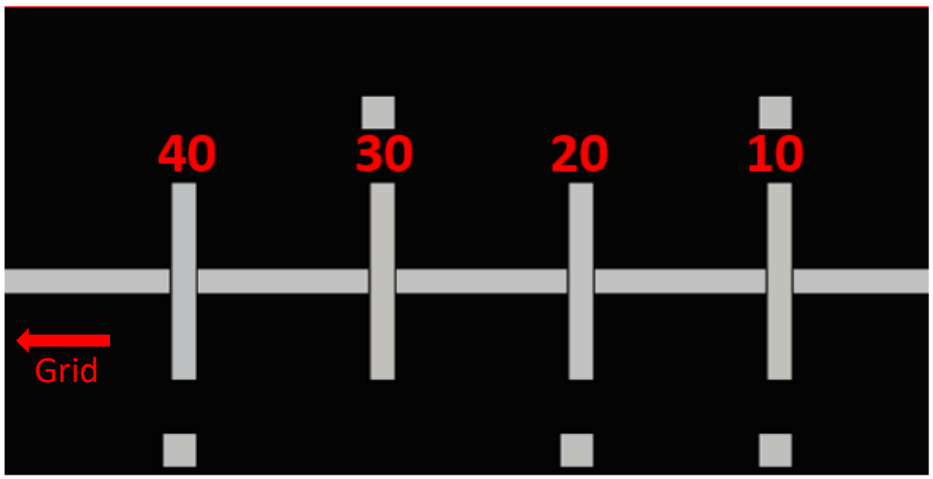

Figure 7: Indicating line position value

- **The correct squares in which the coins should be placed can be identified in the following manner**. (Examples given are with respect to Figure 6 and Figure 7 which will not be the same in the arena)

For Red Coin

The position values of the indicating lines are multiplied by the respective position value of indicating pillars and their sum should be obtained (Eg : (10*3) + (20*1) + (30*2) + (40*1) = **150).** This sum is in the range 100 -300. This range is split into the three sub-ranges (100-166, 167-233, 234-300). The sub-range to which the sum belongs, maps to the index of the red square in which the coin should be unloaded.

- **100-166** : The Red square with lowest index.
- **167-233** : The Red square with medium index.
- **234-300** : The Red square with highest index.

(Eg : Since 150 is between 100 and 166, the red coin should be dropped in the first red square)

For Green Coin

Similarly, use the sum calculated using the indicating lines and indicating pillars and obtain the Fibonacci value of the calculated sum (Eg: If the sum is 150, the 150^{th} value in the Fibonacci Sequence is obtained). Take the 3^{rd} digit from the Right-hand side of the obtained Fibonacci number. The digit so-considered is in the range 0 – 9. This range is split into the three sub-ranges (0-2, 3-6, 7-9). The sub-range to which the digit belongs, maps to the index of the Green square in which the coin should be unloaded.

- **0-2** : The Green square with lowest index.
- **3-6** : The Green square with medium index.
- **7-9** : The Green square with highest index.

(Eg: -Sum of the indicating lines and indicating pillars= 150

-150^{th} Fibonacci number = 9969216677189303386214405760200

-Third digit in the Fibonacci number (from right) = 2

-Since 2 belongs to the first category (0-2), the green coin should be dropped in the first green square)

For more details about Fibonacci numbers refer,

https://en.wikipedia.org/wiki/Fibonacci_number

For Blue Coin

Now consider the 3rd digit from the Left-hand side of the previously obtained Fibonacci number. The digit so-considered is in the range 0 – 9. This range is split into the three sub-ranges (0-2, 3-6, 7-9). The sub-range to which the digit belongs, maps to the index of the blue square in which the coin should be unloaded.

- **0-2** : The Blue square with lowest index.
- **3-6** : The Blue square with medium index.
- **7-9** : The Blue square with highest index.

(Eg : -Sum of the indicating lines and indicating pillars = 150
-150th Fibonacci number = 9969216677189303386214405760200
-Third digit in the Fibonacci number (from left) = 6
-Since 6 belongs to the second category (3-6), the blue coin should be dropped in the second blue square)

- **The correct color order in which the coins should be unloaded can be identified in the following manner.**

For instance, consider the three red colored squares. The grid number of the first red square is raised to the power three, grid number of the second red square is taken to the power two and the grid number of the third red square is taken to the power one. Next, the three values are added together. A similar sum is calculated for the green and blue squares as well. Then, the three sums are arranged in the ascending order and that is the same order in which the three coins should be unloaded. The sums will not be equal.

(Eg : According to Figure 6,
Red : $59^3 + 89^2 + 107^1 = 213407$
Green : $10^3 + 25^2 + 149^1 = 1774$
Blue : $43^3 + 81^2 + 121^1 = 86189$
Ascending order of sums: 1774, 86189, 213407
Hence the coins should be unloaded in the color order **green, blue and red)**

Second Round

- In the second round, the arena will be changed as shown in the Figure 9. In addition to the tasks present in the first round, Line-1, Line-2 and Area-2 will be added to the arena. The ending square will also be different and there will also be a line separating Line-1 and Line-2. The colors of Line-1 and Line-2 will be chosen at random and will only be revealed on the day of the competition.

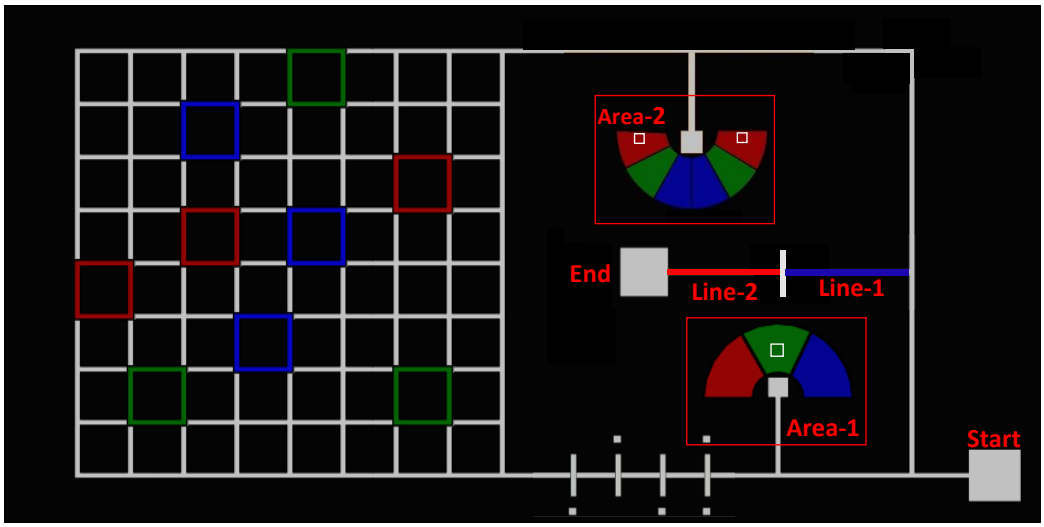

Figure 9: Round 2 arena

- After completing the coin unloading and color indication as per given in the first round, the robot should make its way to the Area-2 where it should leave a secondary robot. The same secondary robot used in Area-1 or a different secondary robot can be used for this purpose.
- If the team choses to use the same secondary robot used in Area-1, the main robot should combine with the secondary robot to form one robot and that one robot should go from Area-1 to Area-2 and separate again at Area-2 because the secondary robot is not allowed to move outside Area-1 and Area-2 on its own.
- In Area-2, the color sections are divided into two parts as the left and right. Each part has three colored sections (red, green and blue). The color of Line-1 should be indicated in the left part and the color of Line-2 should be indicated in the right part (left and right parts are shown in Figure 3.4 in 'Arena specifications')
- Then the robot should proceed to Line-1 where it should identify its color. The main robot should display this color using the color LEDs and the secondary robot should display this color in the left side of Area-2 using the same color indication process used in Area-1. The box moving should complete before the rear end of the main robot passes the line between Line-1 and Line-2.
- A similar color indication should be done by the color LEDs of the main robot and in the right side of Area-2 when the main robot goes over Line-2.
- The task is considered to be complete only when the robot reaches the ending square and the color indication for the Line-2 is over (box moving has stopped).

Rules

1. The robot should not cause any damage to the gaming platform. Any kind of damage to the gaming platform would lead to disqualification.
2. **Robot should not leave any of its components behind in the arena except in the Area-1 and Area-2.**
3. Prior to both 1st and 2nd rounds all the robots are collected and placed on the stage and a robot will be given to the relevant team only during their attempts of the round.
4. In the **first round**, a total time of 17 minutes will be allocated for a team.
5. The first 2 minutes is given for any kind of calibration and hardware changes of the robot. The robot is only allowed to use the arena from the starting square until the last indicating line for their calibrations.
6. Software changes are not allowed after placing the robot on the stage until the first attempt is over. Before the second and third attempts software changes are allowed but there will be a **penalty of 50%** of the total points collected in the attempts that follow. The clock will not be paused for this and you are not allowed to feed in any data regarding the positions of the Indication pillars and the positions of the colored squares during the software change.
7. A team can take up to **3 attempts** within the next **15 minutes**.
8. The team can request the start of their first attempt even within the 2 minutes given for calibration, but this remaining time will not be added to the 15 minutes given for the 3 attempts.
9. If they fail to finish calibrating within this 2 minutes, the extra time taken will be deducted from the time allocated for the three attempts.
10. There won't be any arena changes once the round has started. All teams will have the same arena.
11. When a team is called to compete for the task, they must report within five minutes.
12. During any parts of the task, if a robot deviates from a line and fails to return within 20 seconds, human intervention would be allowed, and the next trial has to be taken as a new attempt. You can also take a new attempt before the 20 seconds with the permission of the judges.
13. In the **second round**, a total time of 22 minutes will be allocated for a team.
14. The first 2 minutes is given for any kind of calibration and hardware changes of the robot. The robot is only allowed to use the arena from the starting square until the last indicating line for their calibrations. Software changes are not allowed after handing over the robot for the second round.
15. A team can take up to **3 attempts** within the next **20 minutes**.
16. The team can request the start of their first attempt even within the 2 minutes given for calibration but this remaining time will not be added to 20 minutes given for the 3 attempts.
17. Any kind of calibration and hardware changes are not permitted between attempts.
18. If they fail to finish calibrating within this 2 minutes, the extra time taken will be deducted from the time allocated for the three attempts.
19. The clock will not be paused during attempts in both first and second round.
20. Decision of the panel of judges will be final.

21. The main robot or the secondary robot/s can move the box at Area-1 and Area-2 using any means without damaging the arena.
22. Players cannot manually alter the orientation of the main robot or the secondary robot/s during an attempt. Players are not allowed to communicate with the main robot or the secondary robot/s by any means (i.e. button presses, radio communication and optical communication). Such actions will result in immediate disqualification.
23. No timing bonus will be given unless robot complete the task.
24. **There will NOT be checkpoints anywhere in the arena. Therefore, in each new attempt, the robot will have to start from the very first task and continue.**

Full View of the Arena

Game field will be built using four, 8'x4' boards.

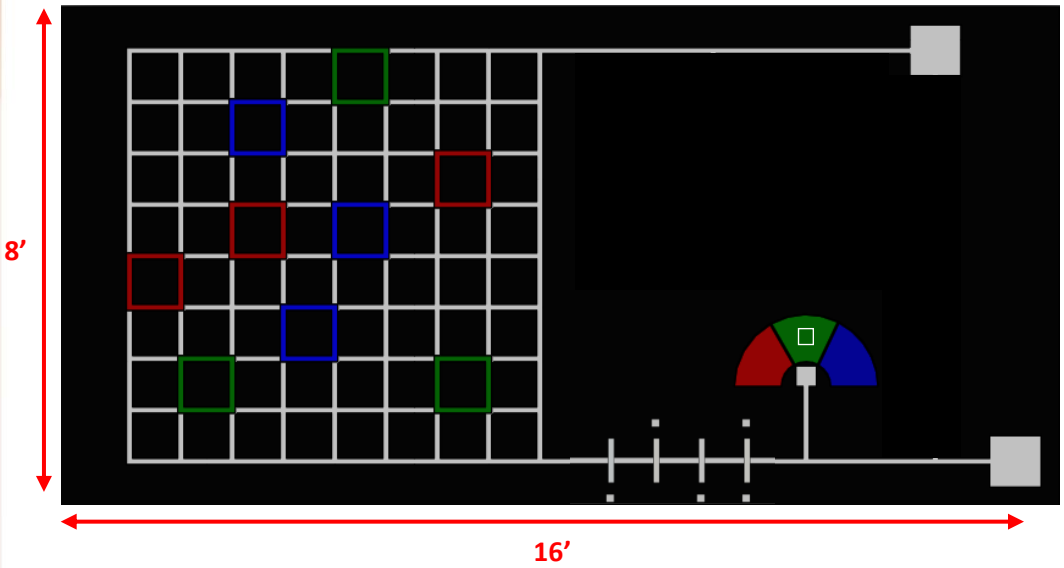

Figure 10: Round 1 arena

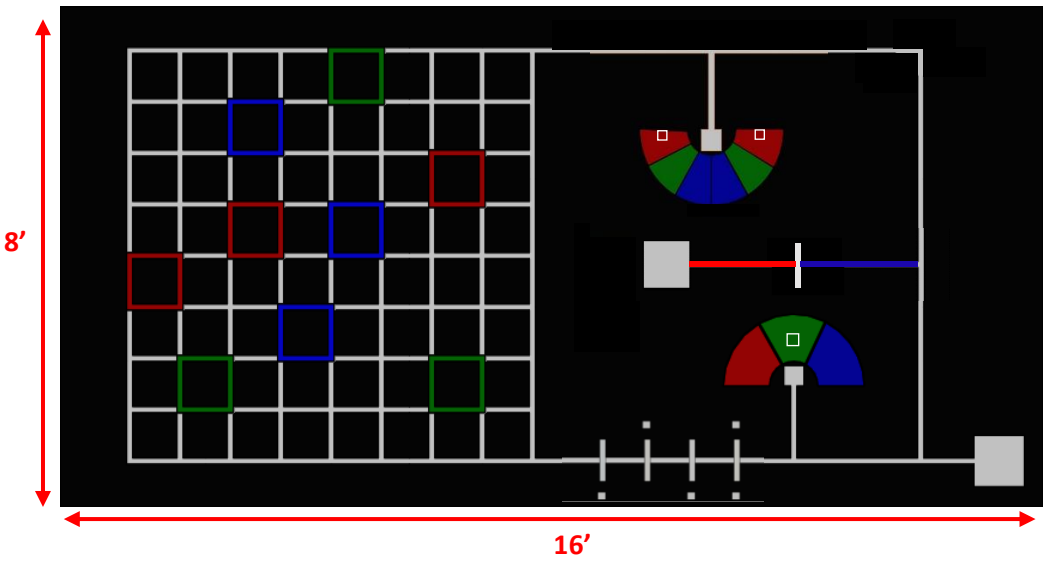

Figure 11: Round 2 arena

Team Specifications

1) Each team can have a maximum of 5 participants. Students from different educational institutes can form a team.
2) All students possessing a valid identity card, issued by the respective educational institute are eligible to participate in the event. All the members of the team should not exceed 28 years of age.

Judging

(1) The judges can ask for an explanation of any mechanism on the bot and there would be an immediate disqualification of defaulters of any kind.
(2) Bot's code will be checked upon request of judges.
(3) Penalties will be mainly given,
   (a) For the coin landing on the line and not the empty space of the correct square.
   (b) For the box stopping on the border of two colors during color indication
   (c) For the box not coming to required color within said time frame.
   (d) For the LED indication not happening in the said time frame.
(4) Final judging criteria will be given on the competition day.

**Any changes will be informed to the team leaders via e-mail.

Contact:

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