Sri Lankan Robotics Challenge

SLRC 2021

UNIVERSITY CATEGORY

TASK SPECIFICATIONS

08th Selona 1573 ABY.

Honorable Jedi Master,

It is with great distress; I inform you that the First Order has captured our chief engineer of the 'Anti-Starkiller-Robot' (ASR) project before the project was finished. The Resistance is again in need of help from the Jedi Order in completing the project and destroying the Starkiller. As the masters of the Force, we believe that only the Jedi can do this task in time. I have attached the plans and documents that our engineer was working on. Please, help us to save the millions of Resistance planets.

May the Force be with you!!!

Princess Leia Organa
Leader of the Resistance

University Category
Stage 1

The First Order has captured Mr. Flok, the chief engineer of 'Anti-Starkiller-Robot' (ASR) project of the Resistance. Starkiller is the Order's newest galactic superweapon; a planet turned into super-laser gun powered by absorbing a sun; which can destroy an entire star-system from halfway across the galaxy. In order to save the Resistance planets, the Jedi Order has to step in and use their Jedi powers to quickly learn and finish the ASR project. As a Jedi master, your help is most valuable now.

> Here's the plan; we'll figure out where the Starkiller is along the way, go there, drop the bomb, boom… Starkiller is done for.
>
> - Resistance Pilot Poe

Stage 1 Procedure

1.Virtual Round

The task described in section 1 is given to be completed using a robot in the Webots Open-Source Simulator (https://cyberbotics.com/). You are expected to design a virtual robot, within the limits specified, to complete this task. This round will account for 60% of your total mark for the Stage 1.

2.Physical Round

Five subtasks of the task given for the virtual round will be given for you to complete in this physical round. Your sensor integration skills will be tested here. You are expected to submit codes that can complete these subtasks using the physical robot we design for this round. This round will account for the remaining 40% of your total mark for the Stage 1.

Section 1: Virtual Round

Task Description

- The virtual round will be conducted using Webot2021a.
- A sample arena and a robot chassis will be provided with the task documentation. (Note:
  1. Contestants can either add sensors to the given chassis or build a new robot from scratch.
  2. Complexity of line following paths and wall following areas of the given sample arena and the real arena may differ.)
- Task of the first round is to be completed using a virtual robot which has the following capabilities.
  - Detecting pillars on the sides of the robot
  - Identifying a color patch under the robot
  - Line following and wall following
- First the robot will be placed on the starting square.
- The robot must proceed to the color patch, identify its color, and print that color to the console. (This patch will also give you the color of the destination square).
- Next, the robot should proceed to the next white square. There the robot can either complete the subtask (see Section 1.1), which is optional, or it can skip this subtask.
- In the case the robot chooses to complete the subtask, and successfully do so, the option of using the path on the left, which is the curved line path, will open. With this the robot can either follow the curved line path or the wall following area to approach Junction 1.
- **In the case the robot chooses to skip the subtask or the attempt to complete the subtask fails, it will not have any other option but to go through the wall following area to reach the Junction 1.**
- After reaching the Junction 1, the robot should identify the correct destination square. There are three colored squares at the end out of which only one is the correct destination square. There will be one square of each color (Red, Green and Blue) and each square will have a position number N as follows,
  - Left square $N = 4$
  - Middle square $N = 8$
  - Right square $N = 12$
- If the robot completes the subtask, it will know the position of the correct destination square. But, if the robot chooses to skip the subtask, it will still be able to find the correct destination square by going to all the three squares and comparing its color to that of the color you detected earlier at the beginning of the task.

- Finally, the robot is expected to stop at the correct destination square and display the number N along with its factors (If N = 4, the factors will be $\mathbf{1, 2}$ and $\mathbf{4}$). Finding the factors should not be hardcoded. i.e., A proper algorithm should be used for it.

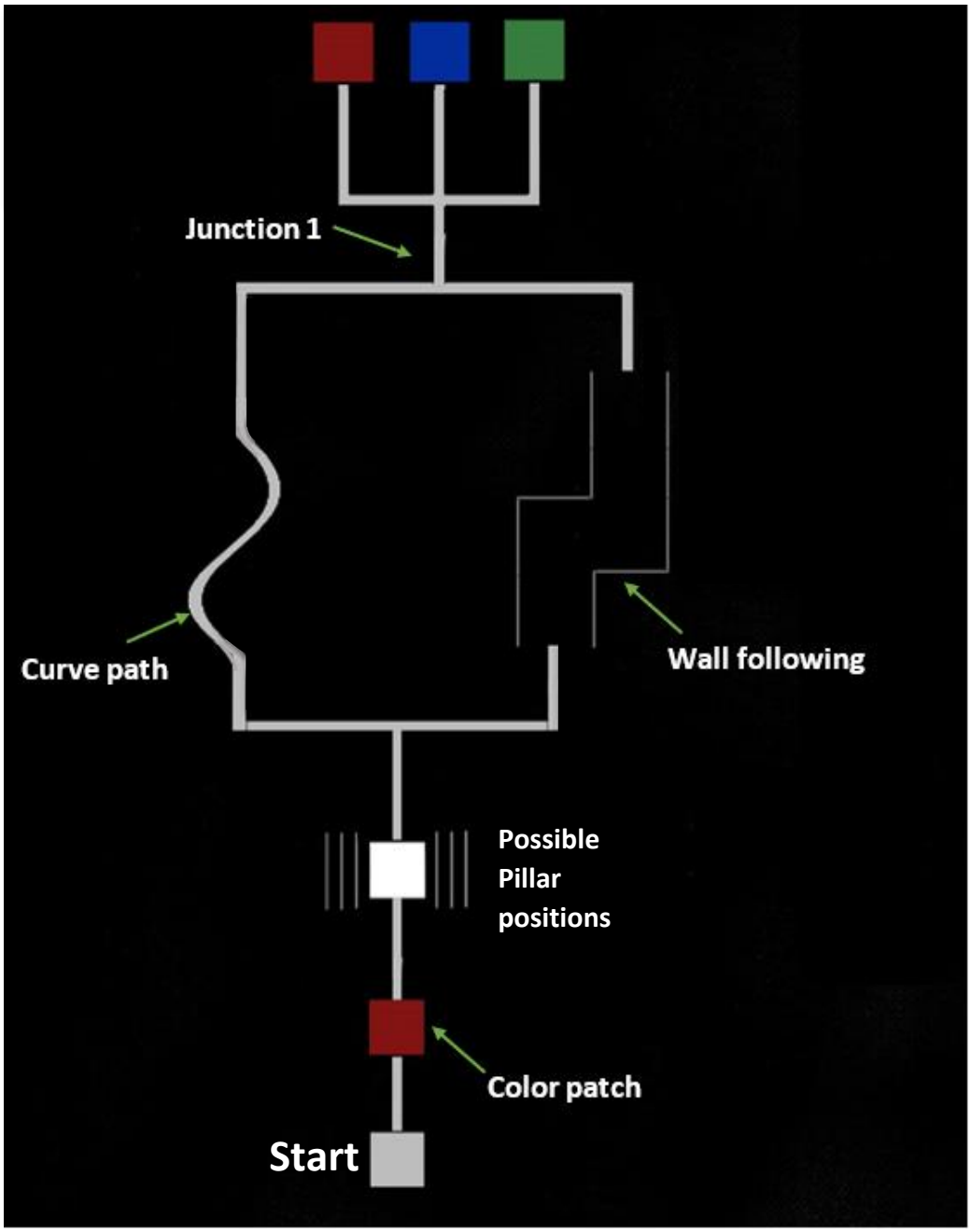


Fig 1. Sample arena for the virtual round. ***(Note: The colors of the RGB squares and the pillar placement of the evaluation arena will be different from what is shown here.)***

Section 1.1 - Subtask (Optional)

A friend of Finn, who is a deserted stormtrooper, is hiding at the planet of Felucia. He holds some secrets that the robot can use to takeout the Starkiller easily. Should we find him and get the clues or should we proceed with the mission, is up to you to decide.

This subtask is optional, and it will reveal the exact position of the matching color patch (destination color patch).

- Robot will arrive at a white square. In line with the square, there are two pillars, one on each side, which can be either tall or short.

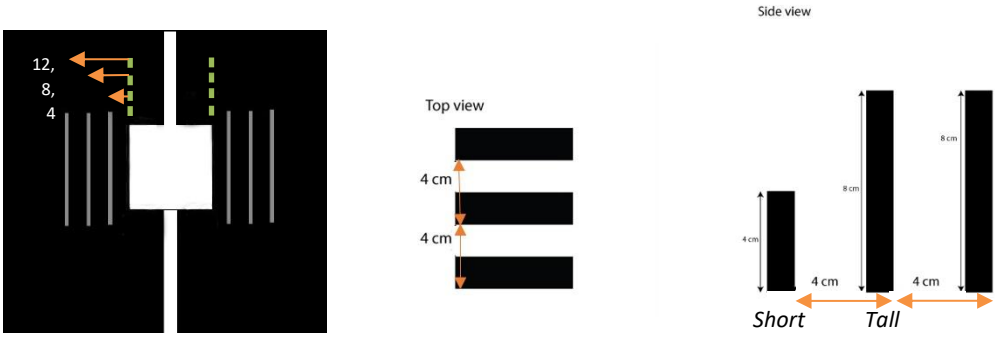


Fig 2. Few possibilities for pillar placement at the right side. **Note: There is only one pillar on each side. It can be any of the above positions.**

- Next the robot should identify the following.
  - Whether the pillar is tall or short?
  - The distance to each pillar from the robot.
- According to the above two parameters following calculation should be done.

$$Right\ Value = Distance\ to\ the\ right\ pillar\ (4\ or\ 8\ or\ 12)\ x\ k_{right}$$

$$Left\ Value = Distance\ to\ the\ left\ pillar\ (4\ or\ 8\ or\ 12)\ x\ k_{left}$$

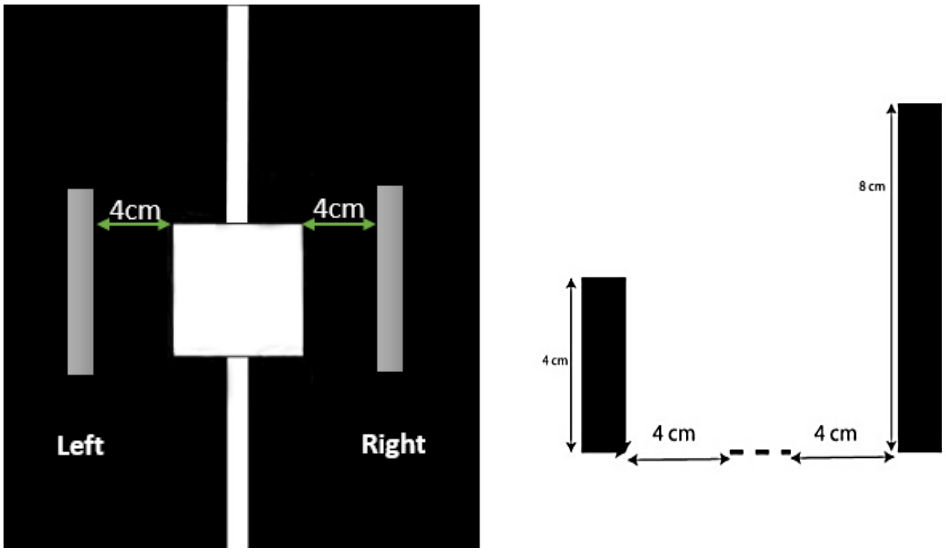
$$k_{right} = k_{left} = \begin{cases} 1; & if\ the\ pillar\ is\ short\ in\ the\ right/left\ side \\ 2; & if\ the\ pillar\ is\ tall\ in\ the\ right/left\ side \end{cases}$$

- To mark the completion of the subtask, you have to print the Right Value and the Left Value to the console. This will not carry marks since the subtask is optional but if the values displayed are correct, the robot will get permission to use the curved line path on the left.
- In addition to that with the information gained through this subtask, N can be calculated as $N = |Right\ Value - Left\ Value|$; *Absolute value*
- With the value you get for N, you will know the position of the correct destination square.

Note: We ensure that the pillar placement will result in one of the above numbers (4,8 or 12) for *N*.

- Then the robot can choose a path and reach Junction 1 and complete the rest of the task according to the above information.

Sample calculation for the subtask:



Top view Side view

Fig 3. Sample arrangement of pillars

$$Right\ Value = Distance\ to\ the\ right\ pillar\ x\ k_{right} = 4 \text{ x } 2 = 8$$

$$Left\ Value = Distance\ to\ the\ left\ pillar\ x\ k_{left} = 4 \text{ x } 1 = 4$$

$$N = |Right\ Value\text{-}Left\ Value| = |8 - 4| = 4$$

According to the found value of ***N***, the robot's destination square is the leftmost one (refer Fig 1).

Section 1.2 - Arena Details

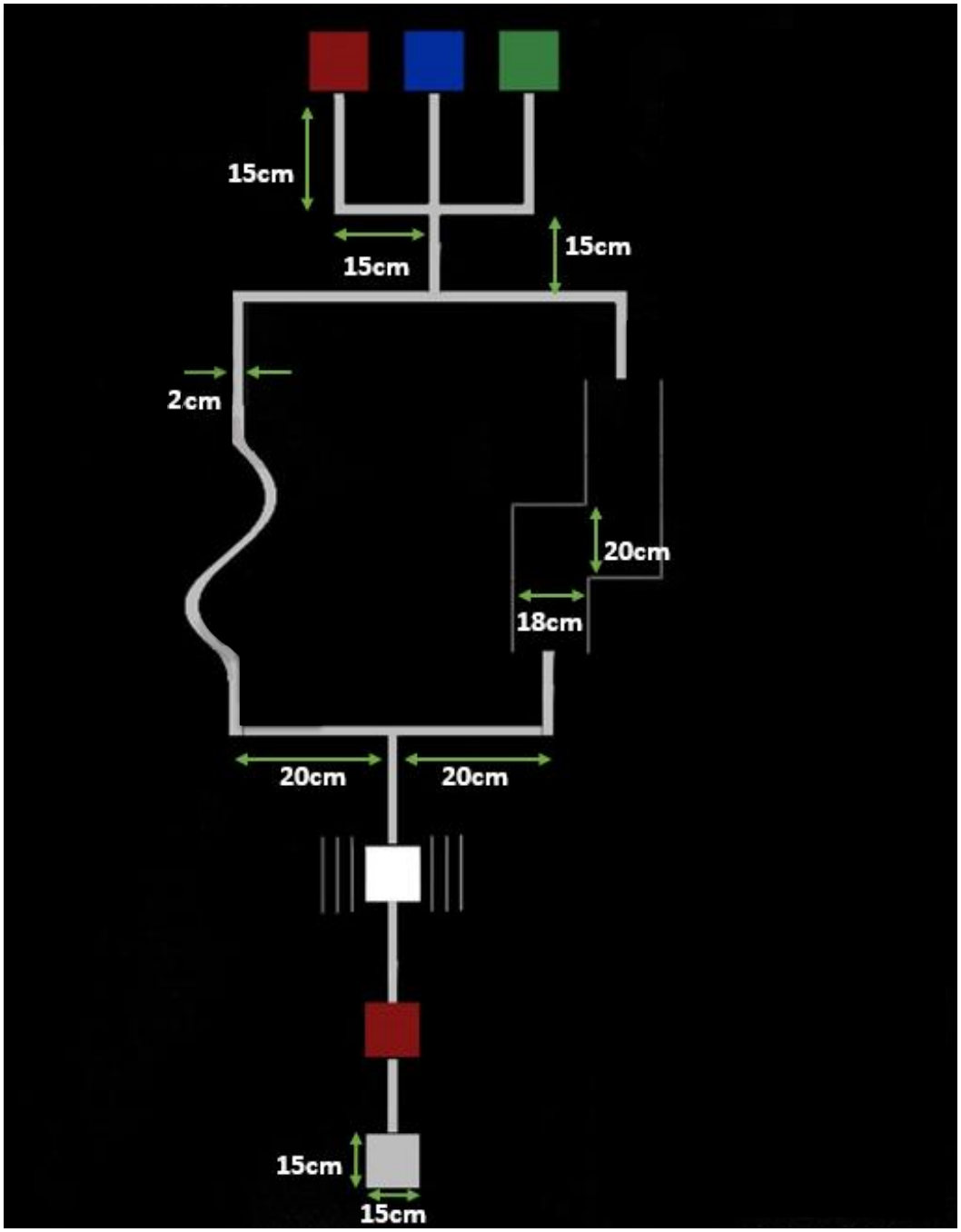


Fig 4. Dimensions of the sample arena

- All the squares in the arena are of size 15x15 cm.
- All the paths are of 2 cm width.

Restrictions

- Maximum speed of the robot: 15 cms^{-1}
- Maximum range for IR sensors: 5cm
- Minimum dimensions allowed for the robot are 10x10 cm and the maximum dimensions are 15x15 cm.
- Contestants are not allowed to use built-in Proto Robots. We expect them to build their own robots. We have provided a sample robot chassis. A contestant can either use it or built their own chassis from scratch.
- C++ is the only allowed language for coding.
- Each team is given 3 attempts within 15 minutes to complete the task. Code changes will not be allowed after submission.

Sensors

In the virtual round, the sensors in Webots Simulation Platform that we need for the task is given a monetary value in US dollars. You are given $40 (not real money) to buy the necessary sensors for your robot.

- Distance Sensor (IR) $2
- Camera $5
- Light sensor $3
- LED Display $3

When selecting the sensors for your robot, you must manage from the given $40. You cannot exceed this $40 limit and you can only use the sensors mentioned above.

Marks are Allocated after Considering the Following:

1. Time remaining in the clock after task completion.
2. The amount of money saved by using less sensors.
3. Displaying N and its factors (Hard coding the factors of N will result in a reduction of marks)
4. Displaying the color of the color patch.
5. Accurate curved path or wall following.
6. Proceeding to the correct square.

Section 2: Physical Round

The remaining 40% of marks for Stage 1 will be given for 5 different physical subtasks, which will test your sensor integration skills. **You are required to code for the physical robot we provide for these subtasks. Specifications and pin configurations of the robot will be released soon. Two attempts will be given for each task.**

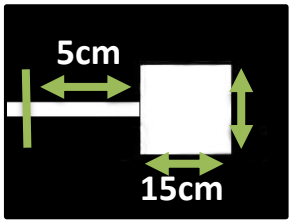


Fig 5. Subtask1

1. **White Square Detection**
   The Physical robot will be placed 5cm before the white square. Contestants should provide a code to move the robot into the square completely.

(**5% marks**)

2. **Color Detection**
   Robot will be placed on R,G,B color patches for calibration, separately. We use the push button to run separate cases. (R calibration, G Calibration, B calibration) Then the robot is placed on a color patch, and contestants should detect the color and print it on an OLED display in words.

(**10% marks**)

3. **Pillar Distance Measuring**
   First, a pillar will be placed 4cm apart from the right bottom Sharp IR sensor, which can be used for calibration. Then we place the pillar at another distance. Contestants should provide a code to measure that distance and print it on the display. The distances are not limited to 4cm, 8cm and 12cm.

(5% marks)

4. **IR Sensor Panel**
   IR sensor panel is placed on a 3cm path of the arena. If the sensor panel has moved towards the right side of the path, the multicolor LED should light up with a shade of red color. If it moves towards the left side, the multicolor LED should light up with a shade of green color. The intensity of the shade of red or green color used should reflect how much the robot has deviated from the line.

(10% marks)

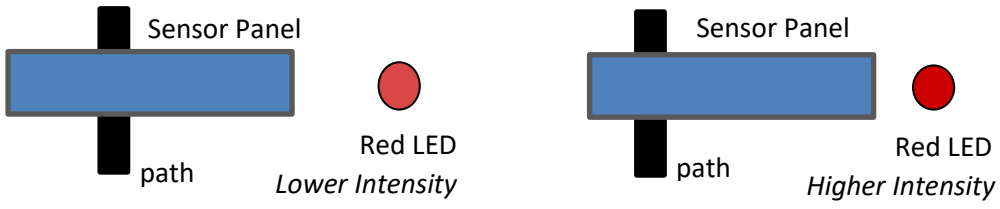


Fig 6. Subtask 4 Description

5. **90 Degrees Turn**

   As shown in figure 7, the robot will be placed 5cm before a junction. Contestants should provide the code for the robot to take a 90° turn either to the left or to the right.

(10% marks)

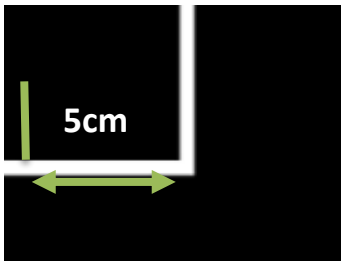


Fig 7. Subtask 5

For calibration and tuning purposes, each team will be given 1 hour on a date prior to the competition. The date and the time schedule will be announced later.

Submissions

If you are importing other files to the Webots environment (e.g. STL files), attach relevant files with your submission. Please double check before submitting whether your submission is working on another computer.

When submitting your codes, please rename your files as follows. You can submit one zip file.

- **<Team_Name>_<Webots>**
- **<Team_Name>_<Subtask Name>**

Section 3: Judging

- The judges have the full authority in giving marks in every round.
- The judges can ask for an explanation about your submissions by arranging a viva examination.
- Decision of the panel of judges will be final.
- Your team can be disqualified at any moment for not following the rules and restrictions stated in the task document.
- Stage 1 is a knockout round. Number of teams qualified for the Stage 2 will be announced at the end of Stage 1.
- Late submissions will be neglected.

Any further changes will be informed to the team leaders via emails.

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