Department of Electronic & Telecommunication Engineering

University of Moratuwa

# EN2533

# Robot Design and Competition

# 2023

Task version 1.0

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# 1 STORY LINE

In a bleak and desolate future, where the world had been swallowed by despair and destitution, a faint glimmer of hope emerged on the horizon—the Squid Game. This clandestine competition offered a chance at salvation, but the cost of failure was unimaginably grim. To seize the coveted grand prize and escape the clutches of destitution, participants had to conquer seven grueling trials, each bearing a captivating name and an unfathomable challenge.



Figure 1 — Squid-Game-Logo

Undeterred by the ominous nature of the game, our fearless protagonist ventured forth into the perilous realm of the Squid Game, ready to confront the inaugural trial: "The Shadowed Path." This mysterious challenge tested not only their physical agility but also their cunning wits as they navigated through a labyrinthine maze cloaked in darkness. The only respite from the inky blackness came from fleeting bursts of light, offering mere glimpses of the treacherous path ahead.



Figure 2 — Squid-Game

As the game unfolded and tension mounted, they encountered the second trial, aptly named "The Gauntlet of Peril." Here, a relentless barrage of physical obstacles stood as a formidable adversary, demanding nothing less than lightning reflexes and unwavering determination. With hearts pounding and adrenaline coursing through their veins, they deftly maneuvered through the treacherous course, defying gravity and conquering each challenge that lay in their path.

The third trial, christened "The Summit's Ascent," beckoned them to reach new heights, both literally and metaphorically. Scaling a towering structure, they faced a daunting test of both body and mind, pushing the boundaries of their endurance to reach the lofty pinnacle. With each arduous step, they ascended closer to their goal, conquering their own fears and embracing the intoxicating sense of accomplishment that came with reaching the summit.

Task four, bearing the enigmatic moniker "The Enigma's Puzzle," presented them with a cryptic box, its contents and purpose shrouded in impenetrable mystery. Driven by insatiable curiosity, they unraveled the intricacies of the enigma, assembling clues like pieces of a surreal puzzle. As the final piece fell into place, a concealed passage unveiled itself, leading them further along their mesmerizing odyssey.

Now, standing at the crossroads of their destiny, they confronted "The Fateful Junction." Two divergent paths beckoned them, each cloaked in its own allure and enigma. With a mixture of intuition and calculated risk, they made their choice, sealing their fate and venturing forth on the path they believed would carry them closer to their ultimate triumph.

Embracing their chosen path, they ventured into the sixth trial, known as "The Chromatic Odyssey." Clutching a resplendently hued box, they embarked on a mesmerizing journey through a landscape painted in vivid, kaleidoscopic colors. Each step resonated with the pulsating rhythm of their surroundings, and they danced to the chromatic symphony beneath their feet.

However, In "The Chromatic Odyssey," an additional layer of complexity emerged. As they lifted the vibrantly colored box, an unexpected twist revealed itself. A relentless, unseen force known as the "Buzzer of Fate" loomed over them, poised to disrupt their harmonious progress. This relentless buzzer sounded at unpredictable intervals, compelling the robot to freeze in its tracks when it activated, suspending it in time and space until the all-clear signal allowed it to resume its journey.
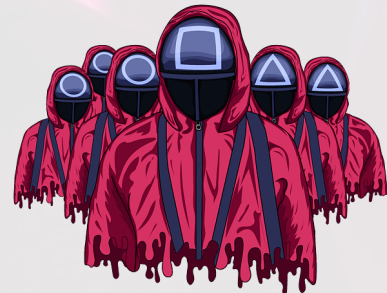


Figure 3 — Squid-Game

With hearts racing and their senses finely attuned, they navigated this challenge with heightened anticipation, inching closer to the box's designated square, matching its hue with the colored line beneath, whether it be a vibrant red or an electrifying blue. The relentless Buzzer of Fate served as a constant reminder of the peril that lurked just beyond their reach.
With the echoes of Mastermind S's voice still resonating in their ears, "Now it's your turn to win this Squid Game. Are you ready?" our valiant champion gazed ahead, knowing that their journey through the Squid Game was far from over. Task 7, "The Guardian's Gambit," lay ahead—a final, formidable challenge.

Before them stretched a narrow corridor, guarded by an imposing, mechanical sentinel. Its relentless, back-and-forth patrol threatened to block their path to the ultimate prize. With bated breath, they analyzed the guardian's movements, searching for the perfect moment to advance.

With a potent mixture of strategy and daring, they timed their advance with precision, slipping through the guardian's watchful gaze just as it turned away. Adrenaline coursed through their veins as they progressed toward the Winning Square. Victory was tantalizingly close, and their resolve remained unshaken.

At last, they arrived at the Winning Square, where the culmination of their trials and tribulations awaited them—a triumphant declaration of their status as the ultimate champion of the Squid Game. As they stood there, victorious and resolute, they couldn't help but reflect on the perilous path they had traversed, the challenges they had conquered, and the unwavering determination that had carried them through.

The voice of Mastermind S once again filled the chamber, this time resonating with admiration, "You have navigated the Squid Game with unwavering courage and cunning. You are the true champion."
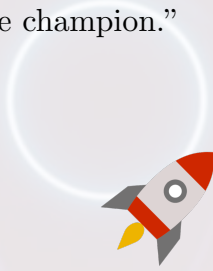


Figure 4 — Squid-Game-Launch

And with that, the Squid Game's enigmatic odyssey came to a resounding conclusion, leaving our champion with the ultimate reward—a renewed sense of purpose and the knowledge that they had emerged victorious in a game where the odds had seemed insurmountable.

**"Now," Mastermind S declared, "It's your turn to win this Squid Game."**

# "Are you ready?"



Figure 5 — Get ready for the Game

# 2 TASKS

## 2.1 Introduction

You are expected to design a mobile robot within the limits specified for the physical task. This task will account for 30% of your overall marks.

## 2.2 Game

### 2.2.1 Sub Task - 01

The robot should be placed on the starting white square (checkpoint - 1). The robot first has to follow a white line on a black surface. The lines may include curved lines, normal straight lines, and normal junctions as shown in figure 6. Then, the robot reaches the checkpoint - 2.
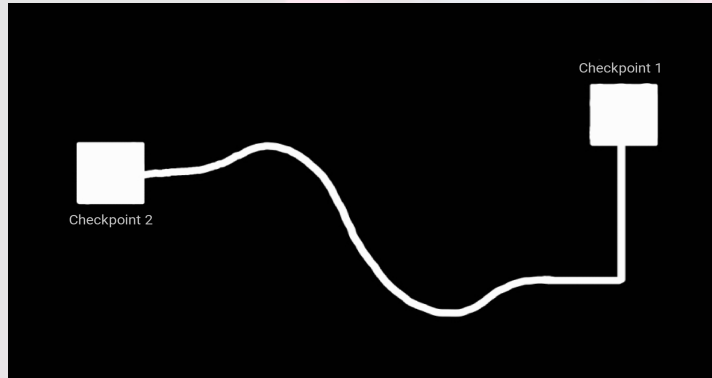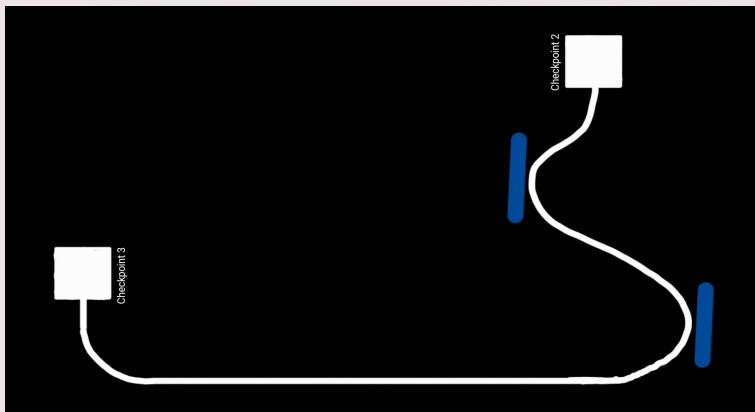


Figure 6 — Sub Task - 01

### 2.2.2 Sub Task - 02



Figure 7 — Sub Task - 02

After the completion of the line following the robot has to follow a curved line while avoiding wall segments as shown in figure 7. After the completion of above mentioned region, the robot will reach checkpoint - 3.

### 2.2.3 Sub Task - 03

The robot will start the sub task - 03 from a white box (checkpoint - 3). As shown in figure 8, the robot must surmount a bridge structure. After the bridge, the robot needs to follow the white line until it finds the next checkpoint - 4.

Then the robot should find the path to reach checkpoint - 5. For that, the middle section of the bridge (the box between the two ramps) should be opened using a small box attached to it. The robot should move the middle part by pulling from the small box and opening the path toward checkpoint - 5. Then, the robot should move through the white line to reach checkpoint - 5.
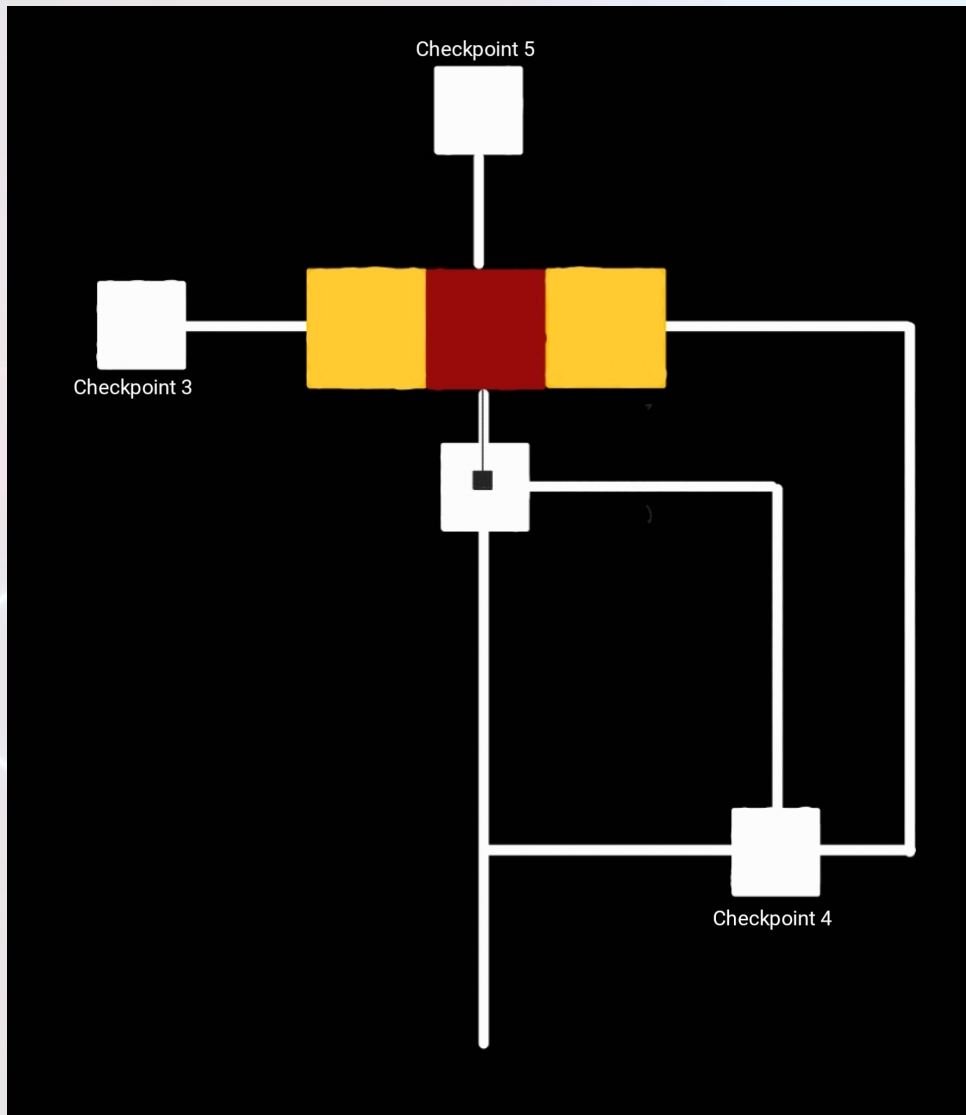
Figure 8 — Sub Task - 03
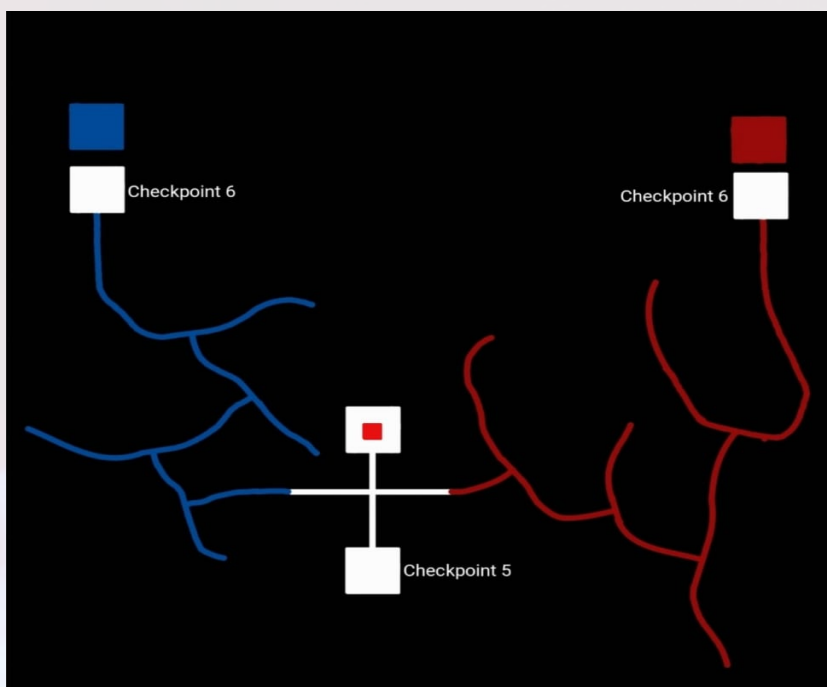
### 2.2.4 Sub Task - 04



Figure 9 — Sub Task - 04

Next, the robot should pick a colored box. With the colored box, it should follow the same colored path, (there will be only Red or Blue colored boxes) until it identifies checkpoint - 6 as shown in figure 9. At checkpoint - 6, the robot should place the picked box in the colored square in front of the white box at checkpoint - 6.

### 2.2.5 Sub Task - 05

Motion in this path segment will be governed by the sound emitted by a sound tower as shown in figure 10. The robot should freeze when it hears a sound, and it can only move when the sound tower emits no sound. Likewise, the robot should move until checkpoint 7.
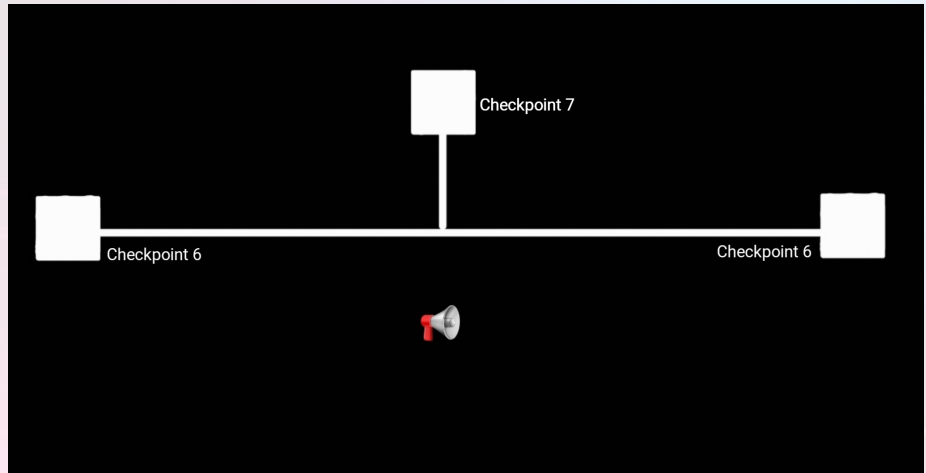


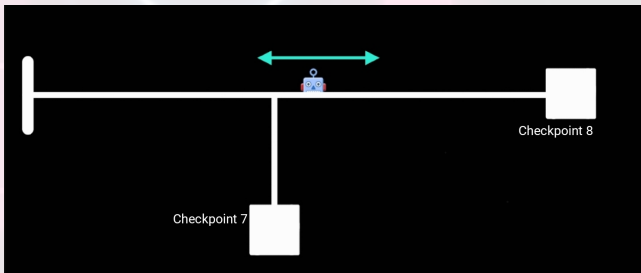Figure 10 — Sub Task - 05

### 2.2.6 Sub Task - 06



Figure 11 — Sub Task - 06

The final stage is from checkpoint - 7 to checkpoint - 8, where the robot has to avoid a moving robot guard. The robot guard will move periodically on a straight path between the final destination and the white line on the opposite side. The guard robot moves right to left and stops at the left endpoint for a few seconds and restarts to move left to right and then again stops at the right endpoint for a few seconds. Likewise, the guard robot motion will happen as shown in figure 11. When your robot is navigating toward the final destination it shouldn't collide with the guard robot.

### 2.3 Game Play

1. All robots will commence their journey from the designated starting location.
2. If you are unable to complete the task by starting from the designated starting location, you can start from a checkpoint that is not the designated starting checkpoint with a penalty.
3. While following the line, the robot shouldn't collide with any object that isn't specifically mentioned in the document.
4. When the robot is navigating from checkpoint - 3 to checkpoint - 4, it must go over the bridge section and follow the line afterward. There will be line on the bridge, as well.
5. You can use any mechanism to find the path to reach checkpoint - 5.
6. Pick and place the colored box in the relevant colored space.
7. The robot should freeze when sounds emit from the sound tower.
8. The robot shouldn't collide with the guard robot.
9. The game is considered finished when the robot completes all six sub tasks, sequentially.
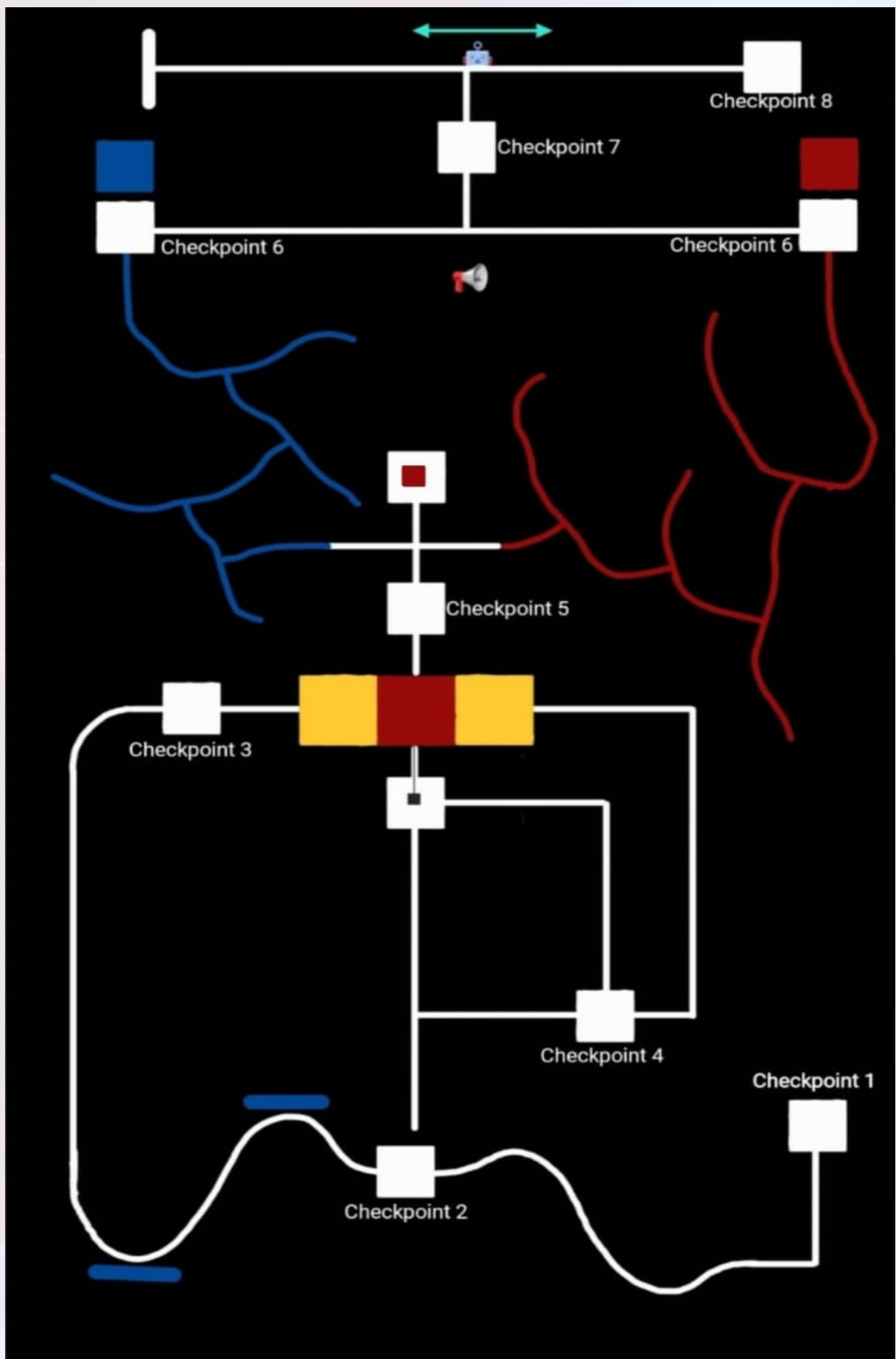
Figure 12 — Full Arena

## 2.4 Game Field (Arena) Specifications

1. The game arena is characterized by dimensions of 8 feet by 8 feet as shown in figure 12.
2. Within the arena, you will find two sections dedicated to line following, obstacles avoiding, motion with a buzzer's sound, a bridge, a robot guard moving section, a designated starting point, and a specified stopping point.
3. The area designated for line following and obstacles avoiding is marked by white lines, 30 mm in width, on a non-reflective matte black surface.
4. The square boxes (which may not always be positioned at the center) are 5 cm by 5 cm in size.
5. White squares and colored squares, located on the floor are 15 cm by 15 cm in size.
6. The wall/obstacle has a height of 10 cm and is colored white.
7. Specific dimensions for the bridge section will be included in the next version (length measurements are in centimeters ).
8. The wording "checkpoint X" will not be on the arena. They are shown in the figures just for understanding purposes, only.

## 2.5 Robot Specifications

1. **Autonomous Operation:** The robot must operate entirely autonomously. Once the robot initiates its actions, team members are prohibited from making any contact with it.
2. **Robot Dimensions:** The robot's dimensions should enable it to fit comfortably within a 250mm x 250mm box (length x width). There are no height restrictions. The robot must be started using a single onboard switch. Teams may use separate switches for restarting and for starting from checkpoints, which must be presented to the judges prior to the run.
3. **Stability Requirement:** The robot must demonstrate stability and stand independently at the starting zone when the race begins. Failure to meet this criterion will result in disqualification.
4. **Expanding Mechanism:** The robot is allowed to expand during its run as long as no damage is inflicted on the arena. It is strictly prohibited to leave behind any parts or marks while moving within the arena. Non-compliance will lead to potential disqualification for the team.
5. **Unity of the Bot:** The robot cannot split into multiple units during gameplay. Any machines or units that are in contact with each other or are within the start zone will be considered as a single entity.
6. **Use of Components:** Teams are permitted to utilize pre-made microcontroller boards and sensor kits. However, the incorporation of wireless modules, ready-made Lego kits, or similar assemblies are not allowed. The use of off-the-shelf kits is prohibited.
7. **Simple Starting Procedure:** The robot's starting procedure should be straightforward and devoid of any manual force or directional impulse.
8. **Team Limit:** Each team is limited to a maximum of one robot.

## 2.6  Game Rules

1. **Robot Submission:** Teams are required to submit their robots before the competition's commencement. Only teams that complete this submission will be eligible for participation. Robots will be returned to the respective teams just prior to their designated run. Teams will have a 2-minute period to make hardware adjustments and calibration procedures, if necessary. However, modifications to their code will not be allowed under any circumstances.

2. **Task Completion Time:** The maximum duration allotted for task completion is 10 minutes.

3. **Arena Damage:** Robots must not cause any damage to the arena during the gameplay in any way.

4. **Arena Contents:** Participants are not permitted to place anything inside the arena except for the robot.

5. **Electronic Devices:** Laptops, personal computers, and other devices like Wi-Fi and Bluetooth must be turned off and kept away from the arena. The organizers retain the right to inspect these devices, and their usage, and disqualify teams accordingly.

6. **Safety and Control:** Organizers have the authority to halt the bot at any time if there's a perception of imminent danger or hazard to people or equipment due to the bot's actions. The robot cannot utilize flammable, explosive, or otherwise hazardous processes.

7. **Restarts:** Teams can initiate up to 3 restarts within the allocated 10-minute time frame. Starting from a checkpoint rather than the designated starting checkpoint is also considered as a restart.

8. **Restart Process:** While restarting the bot, contestants are not allowed to provide any information to the bot. However, they can adjust sensors' positions and undertake minor repairs. Any alteration to the bot's weight is prohibited during this process.

9. **Organizer Approval:** All restarts require organizers' approval before the bot can be removed from the arena. Unauthorized handling of the bot inside the arena will result in the termination of the run.

10. **Pause Rule:** The timer will not be paused during restarts.

11. **Disassembly Restriction:** Robots must not be disassembled until the results are announced.

12. **Line Following:** If a robot deviates from a line and fails to return within 10 seconds during line following, human intervention will be allowed, and a restart will be required.

13. **Judges' Authority:** The decisions made by the judges will be considered final.

## 2.7  Power Supply

1. The bot must use an on-board power supply (battery). No external power supply will be allowed.

2. Each team should bring its own on-board power supply.

3. The potential difference between any two points should not exceed 24 V DC.

## 2.8   Controls

The bot must not receive any input from anywhere outside the arena.
**If any wireless/wired communication is detected, then the team will be disqualified.**

## 2.9   Contact Details

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