TASK VERSION 1.1

# ROBOT DESIGN AND COMPETITION

2024

DEPARTMENT OF ELECTRONIC AND TELECOMMUNICATION ENGINEERING

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# PREMISE

## HAWKINS...
## DO YOU COPY...

Figure 1 - Stranger Things

In the quiet town of Hawkins, Indiana, where the boundary between our world and the mysterious Upside Down has grown dangerously thin, a group of young scientists and their robotic creations stand as humanity's last line of defense. The Hawkins National Laboratory, once a place of dark secrets and dangerous experiments, has been repurposed as a training ground for these brilliant minds and their mechanical companions.

As the veil between dimensions weakens, strange phenomena begin to occur with increasing frequency. The young scientists realize that only by mastering the complexities of both our world and the Upside Down can they hope to prevent a catastrophic merging of the two realms. Thus, the Hawkins Interdimensional Challenge is born – a series of trials designed to push the limits of human ingenuity and robotic capabilities.

Dr. Sam Owens, now heading the revamped Hawkins Lab, addresses the assembled competitors: "Welcome, brave souls, to the Hawkins Interdimensional Challenge. The fate of our world hangs in the balance. Your robots must complete these trials to gather the knowledge and skills needed to seal the rift between dimensions. Good luck – we're all counting on you."

The first challenge begins in a simulated version of Hawkins' eerie forests. Competitors must guide their robots through a series of intersecting lines of varying widths, representing the chaotic path left behind by a Demogorgon as it moves between dimensions.

"The Demogorgon's movements are erratic," Dr. Owens explains. "Your robots must be able to track and follow these dimensional disturbances with precision. Only then can we predict where the creatures might appear next."

As the robots navigate the complex web of lines, the air crackles with otherworldly energy. Those who successfully complete the task feel a surge of hope – perhaps they can outmaneuver these interdimensional predators after all.

The scene shifts to a recreation of the old Hawkins National Laboratory. Here, robots must demonstrate their ability to handle delicate interdimensional artifacts – represented by an imaginary box that must be carefully maneuvered through the facility's winding corridors.

"In the event of a dimensional breach," Dr. Owens warns, "you may need to transport unstable artifacts. One wrong move could have catastrophic consequences." The robots gingerly lift their invisible cargo, moving with calculated precision. They can only move forward or backward while holding the box, simulating the extreme care required when handling objects touched by the Upside Down. To change direction, they must momentarily release the box, adding an extra layer of challenge to the task.

As the robots near the exit, they encounter two checkpoints – one bathed in an eerie blue light, the other in a pulsing red glow. "Choose wisely," Dr. Owens intones. "The path you take here will influence your journey ahead."

Emerging from the lab, the robots find themselves on a twisting path that splits into two distinct color trails – one blue, one red – based on the checkpoint they passed in the previous task. These intertwining paths represent the conflicting energies emanating from the dimensional rift.

"The Gate's influence spreads like veins through our world," Dr. Owens explains. "Your robots must follow the correct energy signature to track the dimensional disturbances." The colored paths cross and overlap, creating a dizzying maze. Robots must stay true to their designated color, avoiding confusion even when the trails intersect. Those that stray from their path experience static interference, a chilling reminder of the Upside Down's encroaching presence.

## THE MIND FLAYER HAS COME...

The next challenge draws inspiration from Eleven's unique abilities. A dotted line path appears before the robots, representing the fragmented psychic visions that have guided the young heroine in the past. "Eleven's connection to the Upside Down has been invaluable," Dr. Owens says. "This task will test your robot's ability to interpret and follow these elusive psychic trails."

The dotted path twists and turns unpredictably, sometimes fading almost to invisibility before reappearing. Robots must use advanced sensors and intuitive programming to stay on course, much like Eleven uses her extraordinary mind to navigate between dimensions.

As the robots approach the final stretch of the course, they encounter a shimmering, fluctuating portal – a gateway to the Upside Down. This imposing door-like structure opens and closes rhythmically, challenging the robots to time their passage perfectly. This is it," Dr. Owens announces gravely. "The moment your robots cross this threshold, they'll enter a simulation of the Upside Down. Everything you've learned so far will be put to the test."

The atmosphere grows tense as each robot approaches the portal. With precise timing, they must slip through the opening, entering a world where everything is inverted. The once-dark arena becomes startlingly bright, and all pathways change from white to black.

Figure 2 - Willy witnessing the Upside Down

"Welcome," Dr. Owens' voice echoes ominously, "to the Upside Down."

In this mirror world, the robots encounter a scene of chaos. Three boxes of varying heights are scattered across the arena, with three empty platforms on the opposite side. This challenge represents the delicate balance between dimensions that must be restored.

"The Upside Down is a realm of disorder," Dr. Owens explains. "Your robots must bring harmony to this chaos, just as we must stabilize the relationship between our worlds." The robots must use their "telekinetic" abilities – advanced gripping mechanisms and precise movements – to rearrange the boxes on the empty platforms. The specific arrangement required depends on which colored checkpoint the robot passed in Task 2, adding an extra layer of complexity to the challenge. As each box settles into its correct position, a subtle shift can be felt in the simulated environment. The oppressive atmosphere of the Upside Down begins to lift, ever so slightly.

With the balance temporarily restored, the robots face their most insidious challenge yet. They must navigate a treacherous part of the Upside Down, transporting a small box through a larger structure with a precisely sized opening.

"Beware," Dr. Owens cautions. "The Mind Flayer is cunning. This task may be more than it appears."

Unbeknownst to the competitors, the small box is magnetized, secretly collecting metallic particles as the robots move. This hidden aspect of the challenge represents gathering crucial information about the Upside Down's composition – data that could be key to sealing the dimensional rift. As robots carefully maneuver their cargo through the confined space, the air grows thick with swirling particles. Those with keen operators might notice the strange behavior of the metallic dust, providing a clue to the task's hidden nature.

In the final, climactic challenge, robots must traverse an uneven terrain, simulating the unstable foundation of the dimensional boundary. They carry a special "coin" – a device developed by the young scientists to seal the rift between worlds. "This is the moment of truth," Dr. Owens declares. "Find the focal point of the dimensional disturbance and place the seal. Our future depends on your success."

The robots carefully pick their way across the shifting landscape, searching for the precise spot where the magnetic forces align. As they draw near, compasses spin wildly and electronic equipment fritzes – signs that they're approaching the heart of the dimensional tear. With utmost precision, the robots must place their coin on the exact spot where the magnetic forces converge. As each one succeeds, a light bulb flickers to life, representing another section of the rift being sealed.

As the final robot places its coin and the last bulb illuminates, a palpable wave of relief washes over the arena. The simulated Upside Down begins to fade, giving way to the familiar sights of Hawkins. Dr. Owens addresses the triumphant competitors: "Congratulations! Your ingenuity and determination have given us the tools we need to defend our world. But remember, the real challenge lies ahead. The Upside Down is relentless, and we must remain ever vigilant."

The young scientists and their robotic creations stand proud, knowing that they are now humanity's best hope against the encroaching darkness. As they exit the arena, the lights dim, and for a moment, the faint outline of the Mind Flayer can be seen lurking in the shadows – a reminder that their work is far from over.

"The Hawkins Interdimensional Challenge is complete," Dr. Owens concludes. "But our true test is just beginning. Are you ready to face what comes next?"

# TASKS

## INTRODUCTION

You are expected to design a mobile robot within the specified physical constraints for this task, which accounts for 30% of your overall marks. **There will be a 30-minute live coding session at the event, during which teams will be tasked with coding for an unknown region, as specified in Figure 9 of Task 7. This challenge will test the teams' ability to adapt and develop solutions in real-time under time constraint.**

## GAME SPECIFICS

### Task 1: Counting and Line Navigation

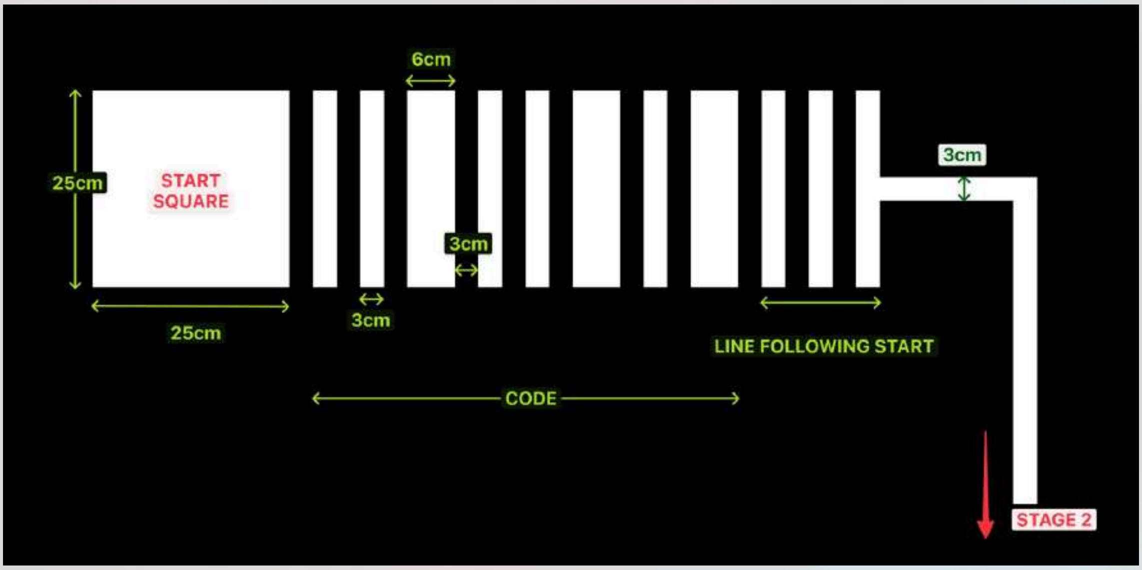


Figure 3 - Sample Arena for Task 1

**At the beginning of the task, the robot will be provided with a 2 Rupee coin to carry.**

As shown in Fig.3, the robot should start from the starting square and navigate through the black and white line pattern on the floor. During this navigation, the robot have to identify the binary code, 0 for a narrow white line (3cm) and 1 for a wide white line (6cm), (NOTE: The last 3 lines are not part of the code and marks the beginning of the line following. The code will be designed such that lines of the same thickness are not repeated cosecutively for 3 or more times).

For example, the code scanned from the figure 3 would be 00100101 (The last three consecutive narrow lines will be ignored)

## Task 2: Maze Navigation and Box Manipulation

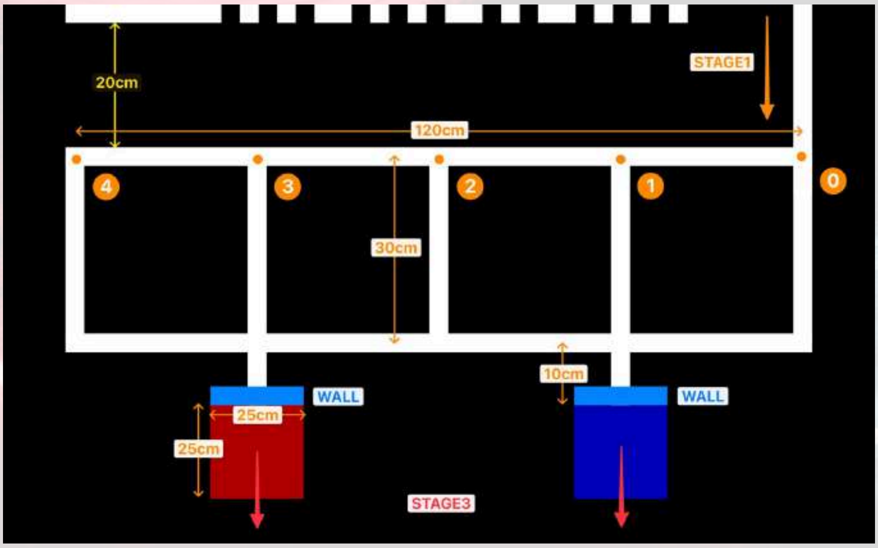


Figure 4 - Sample Arena for Task 2

Upon following the white line, the robot will arrive at the maze (Hawkin's Lab) and a virtual box will be placed at one of the positions: 0, 1, 2, 3 or 4, as shown in Fig.4.

The initial position of the virtual box is determined by taking the modulus 5 of the decimal value of the code in Task 1. Considering the sample code from Task 1 above, the position of virtual box would be,
37 % 5 = 2.

The robot should indicate it has grabbed the virtual box by illuminating a **Blue** LED and indicate releasing the virtual box by turning off the **Blue** LED. The **robot cannot move through the virtual box.** After grabbing the virtual box, the robot can move forward or backward only. If it needs to move in any other direction, the robot must release the virtual box. At the end of the maze, there will be a **Blue** and a **Red** square, and one of the paths leading to these squares will be blocked(**Black** wall, but shown in **Blue** for clarity). The robot's task is to move the virtual box from the initial position to the unblocked square.

1. If there is a virtual box on a junction/corner the path/junction is blocked and the robot cannot move through it without picking it up. (If the robot hasn't picked up the box and is on a junction/corner with the virtual box, the robot cannot turn anywhere and the only possible next action is reverse or picking up the virtual box)
2. Virtual boxes are unstable and can only be placed at junctions or corners.
3. Picking the virtual box up restricts the robot's steering control and the robot can only move forward or backward.

## Task 3: Color Line Following

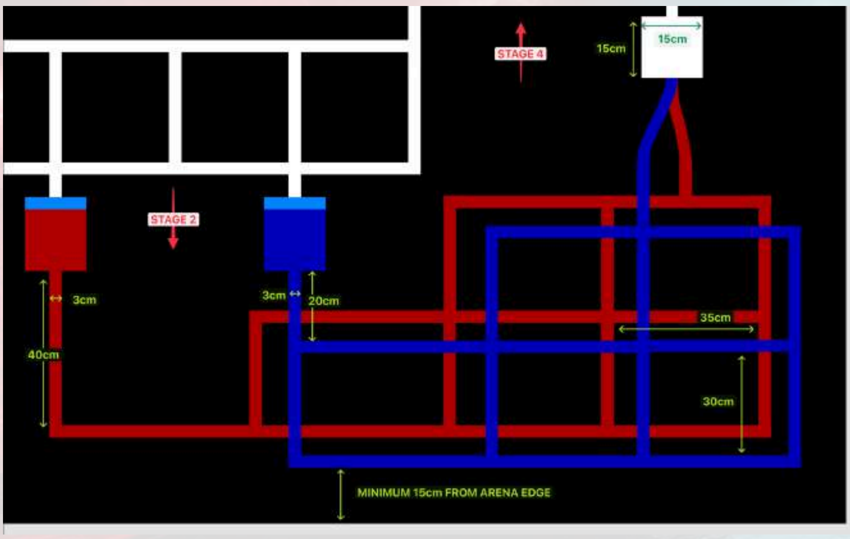


Figure 5 - Sample Arena for Task 3

Upon arriving at either the **Red** or **Blue** square, the robot should follow the line continuing from that square(Fig.5). The **Red** square will have a **Red** line and the **Blue** square will have a **Blue** line. The robot should follow the respective colored line and reach the white square.

***Some Red and Blue lines will be removed (from the arena) at the beginning of the competition to make the path random. There will be no grid to solve by the robot. Only the Red and Blue line following will be tested.**

## Task 4: Dashed Line Navigation

After reaching the white square, the robot must navigate through a white dashed line and reach the white rectangular area to pass through the portal as shown in Fig.6.

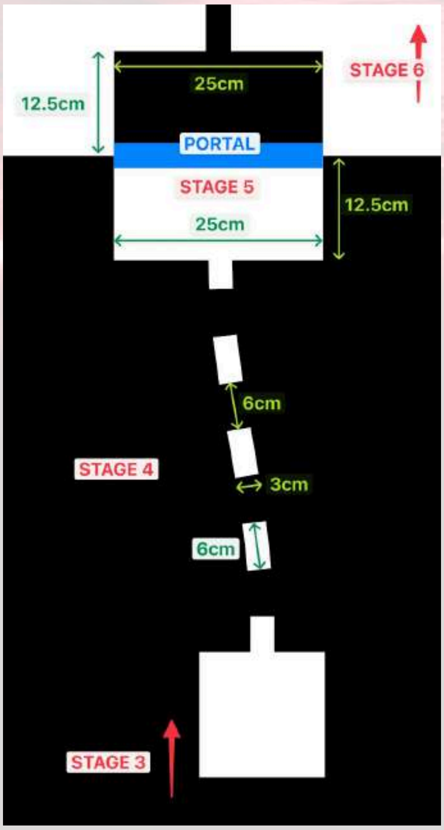


Figure 6 - Sample Arena for Task 4

## Task 5: Portal Navigation

As depicted in Fig.7, a gate will open for 5 seconds and close for 5 seconds. At the portal, the robot must navigate to the other side of the gate without hitting it. After the gate, the robot will need to follow a black line on a white background instead of the previous white line.

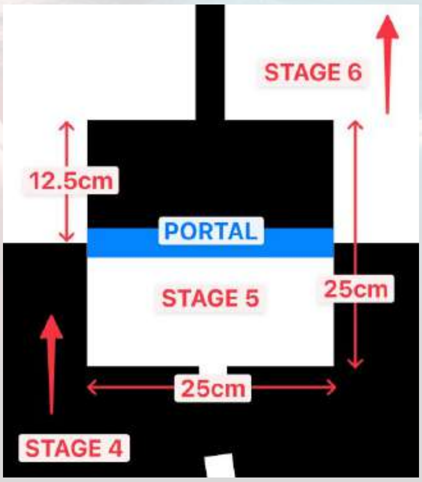


Figure 7 - Sample Arena for Task 5

## Task 6: Box Arrangement

After crossing the portal, the robot will reach the box manipulation area, where there will be three boxes of heights 5 cm, 10 cm, and 15 cm at the end of each line(Fig.8). If the robot followed a **Blue** line in Subtask 3, it should arrange the boxes in ascending order of height (shortest near the portal) or in descending order of height (tallest near the portal) if it followed a **Red** line. Then, the robot should reach the black square.

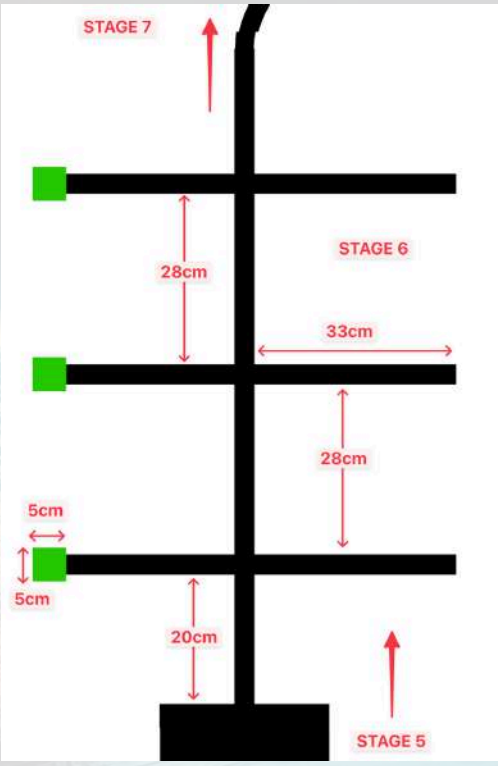


Figure 8 - Sample Arena for Task 6

## Task 7: Hidden Task and Chamber Insertion

After reaching the black square, the robot has to grab the box shown in Fig.9, follow the line to a hidden task (revealed during final evaluation), after completing the hidden task the robot should go ahead and insert the box into the chamber as shown in Fig.9. The robot then needs to move to an area with three stripes which marks the beginning of the open arena.


Figure 9 - Sample Arena for Task 7

## Task 8: Coin Drop and Task Completion

Upon reaching the area with three black stripes, the robot should navigate through the uneven terrain to find the place marked with an X as shown in Fig.10. The robot must drop the 2 Rupee coin given at the start of the challenge at the center of the X mark which has a small magnet. This will close a circuit and light a bulb, indicating the end of the task. The uneven terrain will consist of styrofoam squares with a thickness of approximately 0.5 cm, with up to three squares stacked on top of each other as shown in Fig.10. The size of the squares will decrease as the robot travels upward.

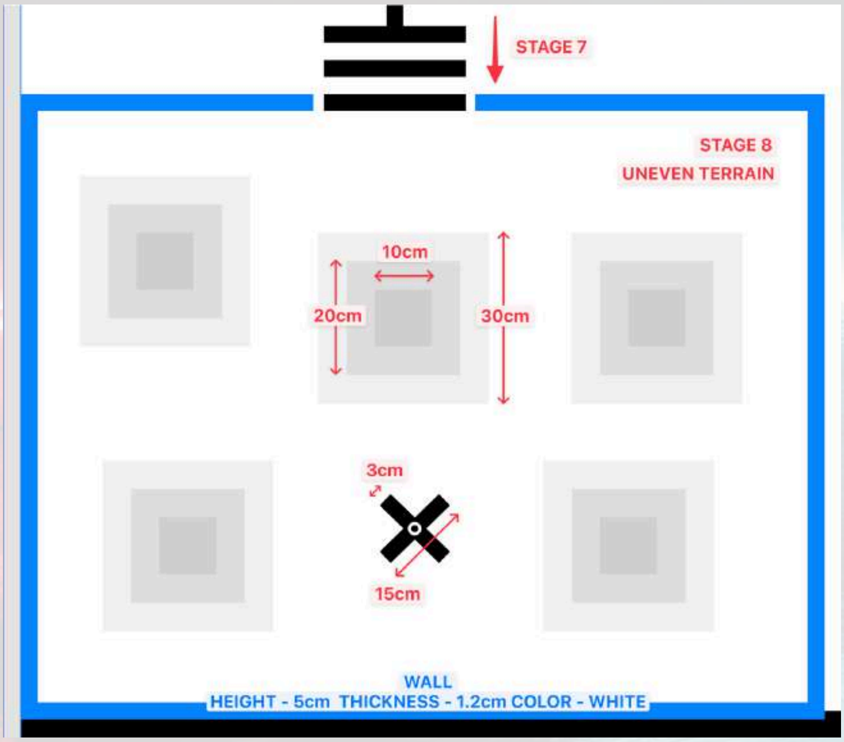


Figure 10 - Sample Arena for Task 8

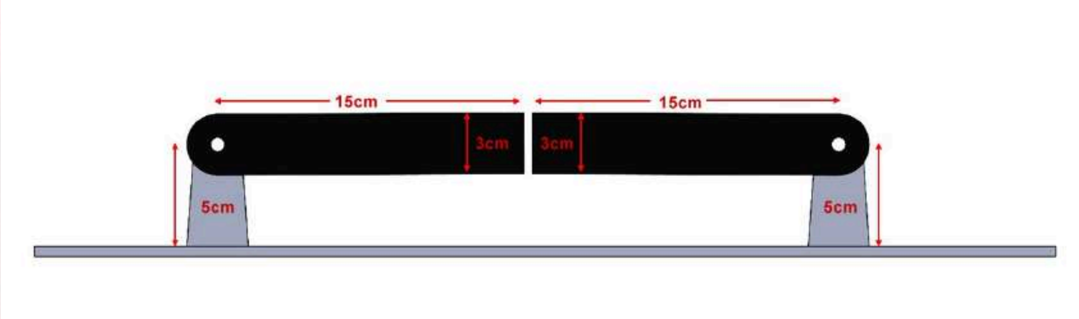


Figure 13 - Gate 3D Model

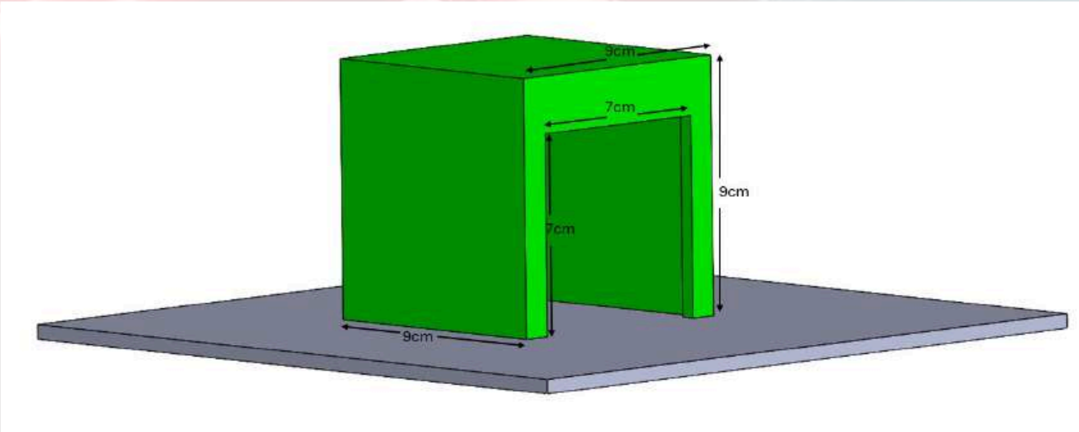


Figure 13 - Chamber 3D Model

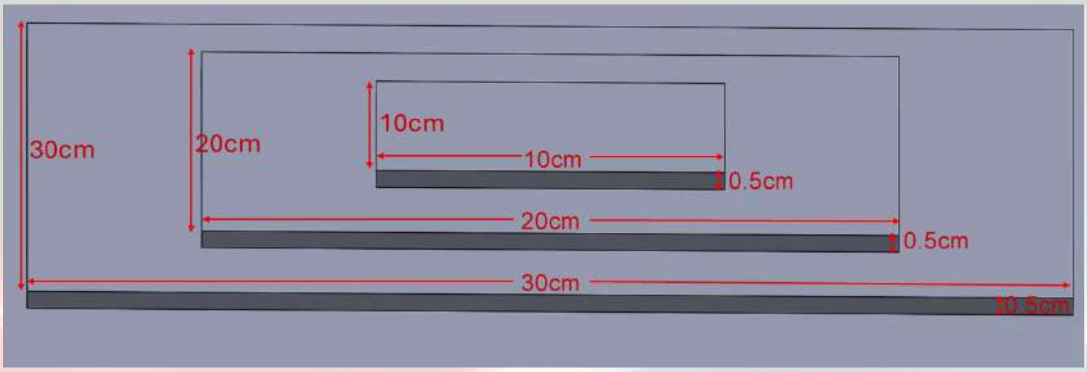


Figure 13 - Uneven Terrain Mountain 3D Model

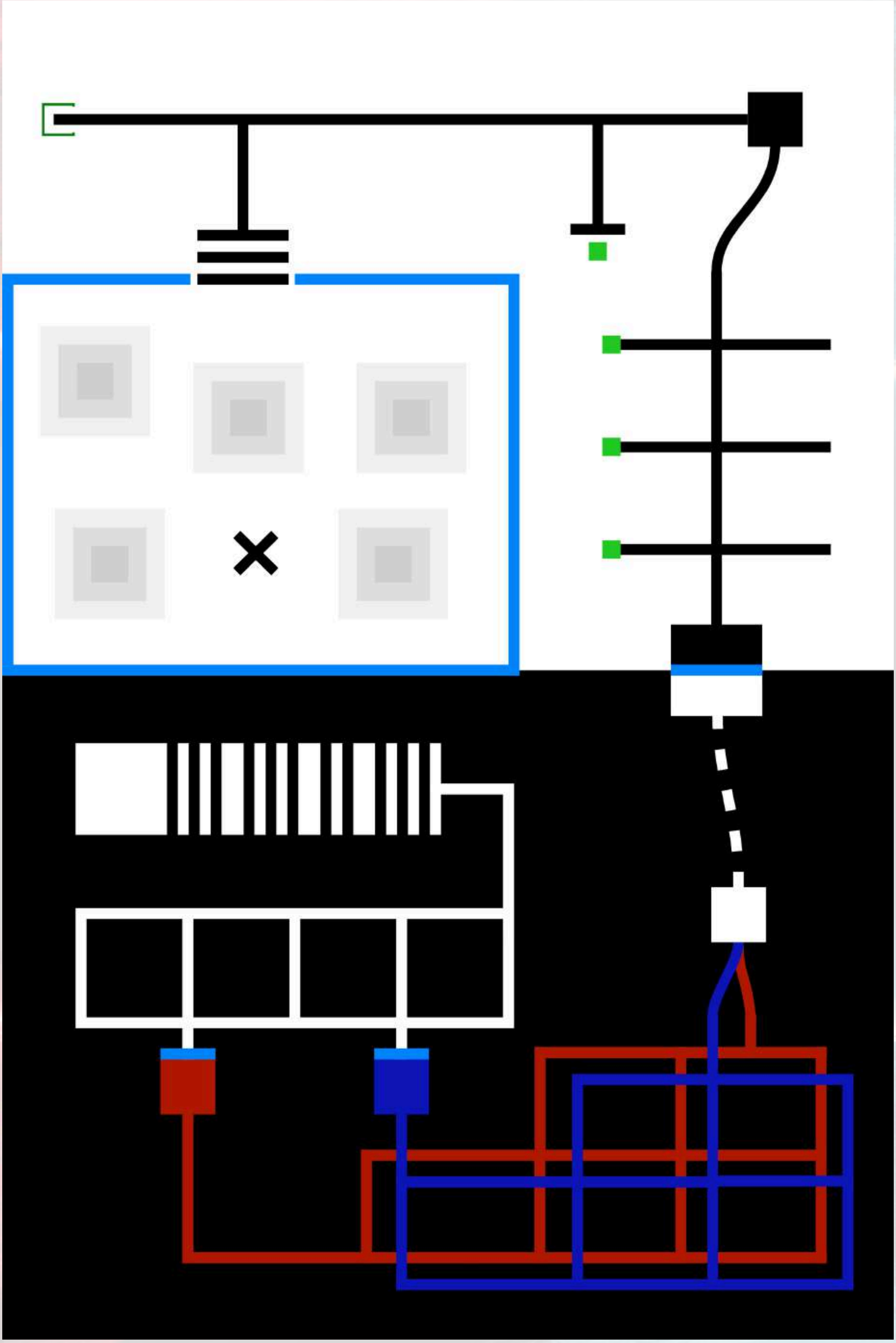

Figure 14 - Sample Full Arena

# Game Overview

1. Task 1: Robots will cross lines of varying widths.
2. Task 2: Robots grab the virtual box and move it to a specific checkpoint.
   Movement is restricted to forward and backward while carrying the box.
   To turn left or right, the robot must release the box.
   There are two checkpoints: one is blocked.
3. Task 3: Robots follow a path marked with a specific color.
   The color depends on the checkpoint reached in Task 2 (**Blue** or **Red**).
4. Task 4: Robots follow a path marked with dotted lines.
5. Task 5: Robots navigate through a door-like portal.
   Pre-portal arena is black with white paths; post-portal arena is white with black paths.
6. Task 6: Robots rearrange boxes of different heights into a specific order based on the color of the checkpoint reached in Task 2.
   The heights are 5cm, 10cm and 15cm
7. Task 7: Robots grab a small box and insert it into a larger box's hole.
8. Task 8: Robots navigate uneven terrain and place a coin on a magnetized spot.

# Game Arena Specifications

1. Dimensions
   - Arena size: 12 feet by 8 feet.
2. Arena Layout
   - Tasks 1-4: Black arena with white paths.
   - Tasks 5-8: White arena with black paths.
   - Contains sections for line crossing, color path following, dotted line following, a door-like portal, and uneven terrain.
3. Paths and Lines
   - Line width: 30 mm.
   - Non-reflective matte surface.
4. Checkpoints and Boxes
   - Checkpoints are in different sizes(the sizes of each checkpoint are shown in the task documentation).
   - Boxes: 5 cm x 5 cm.
   - The heights are 5cm, 10cm and 15cm
5. Walls
   - Colored white.

# Robot Specifications

1. Autonomous Operation
    - Robots must operate autonomously without external input.
    - Once the robot initiates its actions, team members are prohibited from making any contact with it.
2. Dimensions
    - Maximum size: 250 mm x 250 mm.
    - 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
    - The robot must demonstrate stability and stand independently at the starting zone when the run begins. Failure to meet this criterion will result in disqualification.
4. Mechanisms
    - Expansion during the run is allowed without damaging the arena.
    - Robots must remain a single entity. (The robot cannot split into multiple units during gameplay.)
    - It is strictly prohibited to leave behind any parts or marks while moving within the arena.
5. Components
    - Pre-made microcontroller boards and sensor kits allowed.
    - Wireless modules, ready-made Lego kits  and off-the-shelf kits are prohibited.
6. Starting Procedure
    - Simple starting procedure without manual force.
7. Team Limit
    - One robot per team.

# Game Rules

1. Submission and Preparation
    - Robots must be submitted before the competition starts.
    - 2 minutes for hardware adjustments and calibration procedures, if necessary. No code modifications allowed.
2. Time Limit
    - Maximum task completion time: 10 minutes.
3. Arena Damage
    - Robots must not damage the arena.
4. Equipment
    - No external items allowed inside the arena.
    - Electronic devices like laptops and personal computers must be turned off.
    - The organizers retain the right to inspect these devices, and their usage, and disqualify teams accordingly.
5. Safety
    - Organizers can halt robots if deemed hazardous.
    - Flammable, explosive, or hazardous processes are prohibited.
6. Restarts
    - Up to 3 restarts allowed within 10 minutes.
    - Starting from a checkpoint is considered a restart.
    - No information can be provided to the robot during restarts.
7. 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.
8. Disassembly
    - Robots must not be disassembled until results are announced.
9. Line Following
    - Robots deviating from the line and failing to return within 10 seconds will require a restart.
10. Pause Rule
    - The timer will not be paused during restarts.
11. Judges' Authority
    - Judges' decisions are final.
12. Power Supply
    - On-board power supply required. No external power supply will be allowed.
    - Each team should bring its own on-board power supply.
    - Maximum voltage: 24 V DC.
13. Controls
    - No external input allowed; wireless/wired communication leads to disqualification.

# Contact Details


Contact via WhatsApp is preferred

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