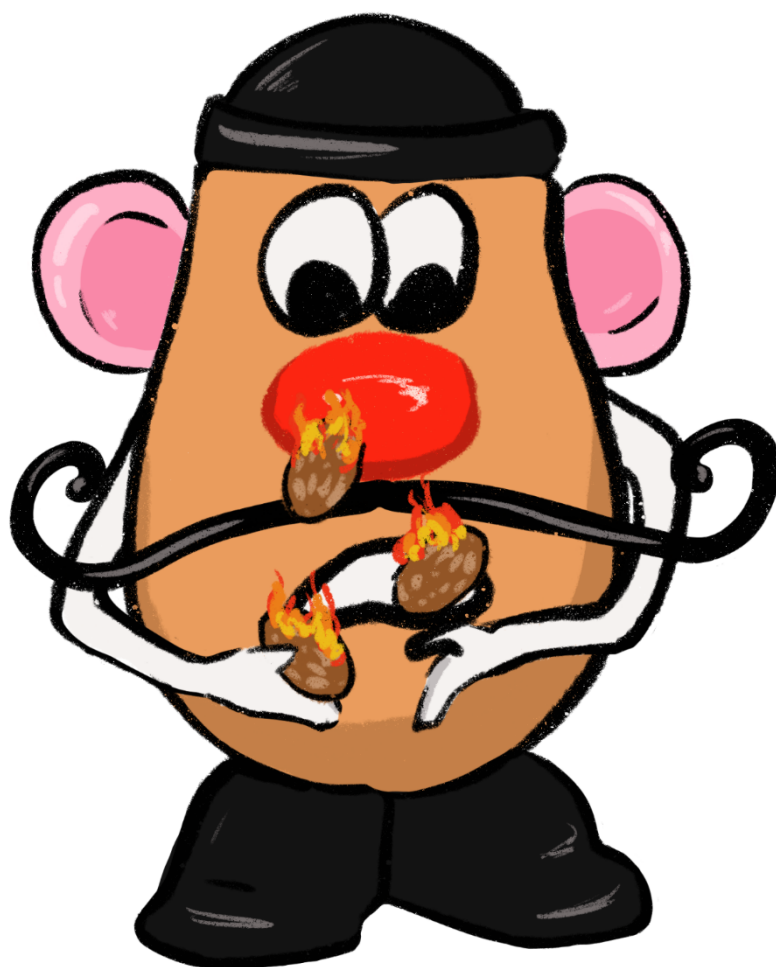


*Hills Road Sixth Form College*

# **ROBOCON**

## **2024**



## **HOT POTATO**

### **RULEBOOK**



**Hills Road  
Sixth Form College  
Cambridge**



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# HOT POTATO

*Generate a short story/context for a robotics competition. The competition name is "Hot Potatoes". The aim of the game is to eject hot potatoes from your area, and collect your sole "Jacket Potato". Include potato puns.*

In the bustling town of Spudsville, where potato farms stretched as far as the eye could see, there was an annual robotics competition that had everyone talking - the "Hot Potatoes" challenge. This quirky event brought together the brightest minds in robotics to showcase their innovative creations. The aim of the game was simple yet amusing - each team had to design a robot capable of ejecting hot potatoes from their designated area, all while ensuring their precious "Jacket Potato" remained unscathed.

The competition grounds were abuzz with excitement as teams from all over Potato County arrived with their spud-tacular robots. The atmosphere was electric, with potato puns flying as fast as the robots themselves. From "Mashinators" to "TaterBots," each team had a creative name and a potato-themed strategy.

In the first round, aptly named "Spud Storm," teams had to navigate their robots through a field of flying potatoes, dodging them with precision. Laughter echoed as robots, resembling giant french fries and mashed potatoes on wheels, zipped around, trying to outmaneuver the hot potatoes.

The tension reached a boiling point in the second round, "Tater Tornado." Here, teams faced a whirlwind of potatoes being flung from all directions. The robots skillfully caught some potatoes mid-air, while others were promptly ejected from their area with spud-tacular speed. The crowd cheered for their favorite teams, chanting slogans like, "Fry 'em up!" and "Bake the competition!"

Finally, the climax of the competition arrived - the "Jacket Potato Jamboree." In this round, the remaining teams battled to be the first to collect the sole Jacket Potato placed at the center of the arena. The stakes were high, and the robots, now equipped with potato scoops and peelers, raced toward the prized spud.

Amidst the chaos, one team, "The Potato Pros," designed a robot with a rotating peeler that skillfully peeled the hot potatoes before ejecting them (see section 4.4), earning them a fan following with their clever strategy. Another team, the "Spud Squad," opted for a net-like contraption that caught potatoes mid-air, showcasing their impressive catching skills.

As the dust settled and the potatoes flew no more, "The Potato Pros" emerged victorious, proudly holding their Jacket Potato aloft. The crowd erupted in applause and cheers, celebrating the ingenuity and creativity displayed in the competition. The organizers awarded them the prestigious "Golden Spud" trophy, and they became legends in Spudsville, their victory forever etched in the potato history of the town.

And so, the Hot Potatoes competition came to an end, leaving behind memories of laughter, friendly competition, and a shared love for potato puns. It was a day that Spudsville would never forget, reminding everyone that with a little creativity and a whole lot of spuds, anything was possible in the world of robotics.

## GAME RULES

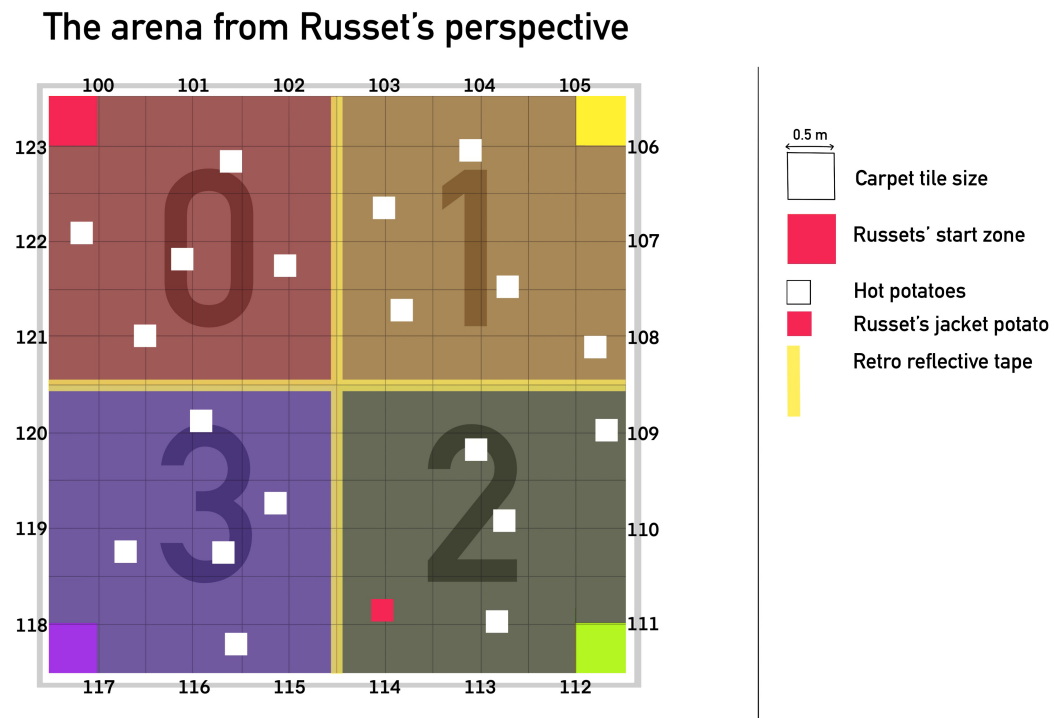


FIGURE 1: THE ARENA

The competition will take place in the area defined in Figure 1.

The features of the arena are described further in section 1.

The competition proceeds through a series of rounds.

The aim of each round is to get as many points as possible by moving hot potatoes out of your patch and bringing the jacket potato into your patch.

## 1. GAME FEATURES

### 1.1. Potato patches

- 1.1.1. The arena is divided into four zones. These are called potato patches.
- 1.1.2. Each patch is 3x3 meters, and the patch borders are separated by reflective yellow tape as specified in figure 1. A sample of the retroreflective tape is provided in the kit.
- 1.1.3. The retroreflective tape does not count as being in either patch.

### 1.2. Starting zone

- 1.2.1. Before the start of a round, participating teams will be given time to set up their robot in the arena. During this time, teams must place their robot in the corner that they are assigned such that it is entirely within its starting zone of their assigned patch, with no parts overhanging the boundary.

### 1.3. Potatoes

- 1.3.1. 20 potatoes are distributed evenly across the 4 patches. Robots will be judged based on their ability to get rid of hot potatoes from their patch.
- 1.3.2. Four hot potatoes start in your patch. You gain points for moving these hot potatoes out of your patch.
- 1.3.3. You have one “jacket potato” which is placed randomly in the diagonally opposite patch to yours. You gain points for bringing this back to your patch. See table 1 for scoring.
- 1.3.4. Potatoes are made of side lengths  $100 \pm 5$  mm single-walled cardboard boxes and are identified by AprilTag markers on each face. These are specified in section 6. A sample potato and markers are provided in the kit.
- 1.3.5. A potato is considered in a patch if its centroid is in that area.
- 1.3.6. If a robot is in the possession of a hot potato it is considered in a neutral area and does not contribute to the scoring of the patch.
- 1.3.7. If a robot is in the possession of its jacket potato it is considered in a neutral area and scores two points.
- 1.3.8. If a potato is on the retroreflective tape, it does not score.

## 2. RULES OF THE ROUND

- 2.1. A round lasts 180 seconds.
- 2.2. There will be up to 4 robots in a round.
- 2.3. Scoring will begin 10 seconds after the end of the round and will depend only on the final positions of items in the arena.
- 2.4. There must be no team members in the arena during the minute before a round starts. Robots must be placed in the arena before this time. Teams that do not get out of the arena in time may be forfeit from the round at the discretion of Potato Head.
- 2.5. Teams must not, under any circumstance, enter any body part or object into the arena during a round, except to press the start button on their robots at the beginning of that round. Interfering with potatoes or any robot during the round will result in the offending team's disqualification, and they may be asked to leave the arena.
- 2.6. A round may be terminated prematurely if all participating teams state to Potato Head that they are happy for the round to end.
- 2.7. At the end of a round, Potato Head will total the score for each competing team. Teams must not enter the arena or touch any robots or potatoes in the arena during this time in order to ensure fair scoring. Any robot touched before Potato Head 'releases' the arena may result in the offending team's league points for the round being forfeit. Any potatoes touched before it is released will result in the offending team losing 3 game points.
- 2.8. Scoring is judged according to the state of the arena at the end of the round unless specified otherwise\*.
- 2.9. Game points are scored as follows:

Condition		Score
Your robot leaves your starting zone*		+1
Robot first contact with a potato*		+1
Your jacket potato in your patch and not in your possession		+4
In possession of your Jacket potato		+2
Hot potato in your possession		No score
Hot potatoes in your patch (but not in possession)	0	+5
	1	+4
	2	+3
	3	+2
	4	+1
	5+	+0

\*SCORED ON FIRST SIGHT

**TABLE 1: THE POINTS SYSTEM**

### 3. LEAGUE POINTS AND KNOCKOUT ROUNDS

- 3.1. The competition is split into a seeding league followed by knockout rounds.
- 3.2. League rounds:
  - 3.2.1. Only teams with robots present in the arena at the start of a given round can score league points from it.
  - 3.2.2. The team with the most game points in a round will gain 8 league points.
  - 3.2.3. The team with the second-most game points in a round gain 6 league points.
  - 3.2.4. The team with the third-most game points in a round will gain 4 league points.
  - 3.2.5. The team with the least game points in a round will gain 2 league points.
  - 3.2.6. In the case of a draw, in which two or more teams score the same number of game points, each of the teams will gain the average number of points of their places. For instance, if two teams score equally and are therefore in joint first, they will both score the average of the first and second place scores, 7.
  - 3.2.7. Teams whose robots were disqualified from a round will gain no league points for the round.
- 3.3. Knockout rounds:
  - 3.3.1. Once the league has been completed, a knockout competition will begin. The positions of the teams in the league will seed the positions of teams in the knockout rounds.
  - 3.3.2. Each round in the knockout competition involves up to 4 teams. The teams that come 1st and 2nd in each knockout round will continue to the next round of the knockout.
  - 3.3.3. In the event of a tie in a knockout round, the team that ranked highest in the league will go through.
  - 3.3.4. If there is a tie in the final for first place, then a rematch may be played at Potato Head's discretion.



## REGULATIONS

### 4. REGULATIONS OF HOT POTATO

- 4.1. Potato Head's decision is final.
- 4.2. No remote-control systems may be used during the competition.
- 4.3. This is a non-contact sport, although accidental bumps and scrapes are inevitable. We do not want to have any mashed potatoes.
- 4.4. Robots may not deliberately damage anything – including potatoes, the arena and other robots. At Potato Head's discretion, teams who engage in collisions deliberately or do not take sufficient precautions to avoid collisions may be disqualified from rounds until the issue has been resolved.
- 4.5. Robots may not deliberately leave debris in the arena.
- 4.6. Teams must not imitate any features of the arena in a way that could potentially confuse other teams' robot.
- 4.7. Hills Road RoboCon reserves the right to examine your robot software and hardware at any time.
- 4.8. Assistance provided by Hills Road RoboCon is provided with no guarantees.
- 4.9. All kit deployed by Hills Road RoboCon remains the property of Hills Road RoboCon. The kit must be returned to Hills Road RoboCon at the end of the competition.
- 4.10. Robots must pass an inspection by a Hills Road RoboCon Inspector before they are permitted in the arena.
- 4.11. At the beginning of each round, robots must fit into a cube with internal dimensions of 400x400mm on each side. During the round, the robot may extend beyond this size.
- 4.12. For everyone's safety, the robot's power switch must be red and easily accessible at all times – including throughout the game.
- 4.13. The robot is to be started in the arena using a physical start button. You must position this where a team member can reach it from outside of the arena.
- 4.14. You may use custom hardware to enhance your robot's electronics, but all power must be drawn from the connectors on the BrainBox.
- 4.15. The BrainBox and battery must not be disassembled, altered or otherwise tampered with in any way.
- 4.16. All wires connected to the robot's ground (0V line) must be black. Black wires must not be used for anything else. It is strongly recommended that all wiring is neat and removable, as this will reduce the time required to debug problems, and teams may be asked to tidy their wiring before a member of Hills Road RoboCon will approach any issues with their robot.

- 4.17. All electronics should be securely fixed to the robot and should also be easily removable if required.
- 4.18. It must not be possible to injure oneself on the robot. This will be tested using a Frankfurter sausage to simulate a finger – anything that could cause harm, such as high-speed rotating parts, should be suitably shielded.
- 4.19. The lithium polymer battery provided in the kit must be shielded from mechanical and thermal harm. This includes ensuring that it is protected from harm in the case of accidental collision with another robot. Teams found to be in violation of this rule will have their batteries confiscated until they have demonstrably rectified the issue.
- 4.20. If teams wish to use batteries, chargers or cables other than the ones provided with the kit, they must seek approval from Hills Road RoboCon through [robotics@hrsfc.ac.uk](mailto:robotics@hrsfc.ac.uk) first.
- 4.21. Robots may not include additional radio transmitters or receivers to those in the BrainBox.
- 4.22. Attaching a GoPro or similar small video recorder to your robot to record a round is permitted, but it must be powered by its own internal batteries and cannot be connected to any of the other electronics of the robot. It must fit within the internal dimensions defined in section 3.10.
- 4.23. The USB port must remain free and accessible for the use of Hills Road RoboCon during the competition. If you want to use a USB device such as a USB camera, you will need to provide your own USB hub.

## SPECIFICATIONS

## 5. THE ARENA

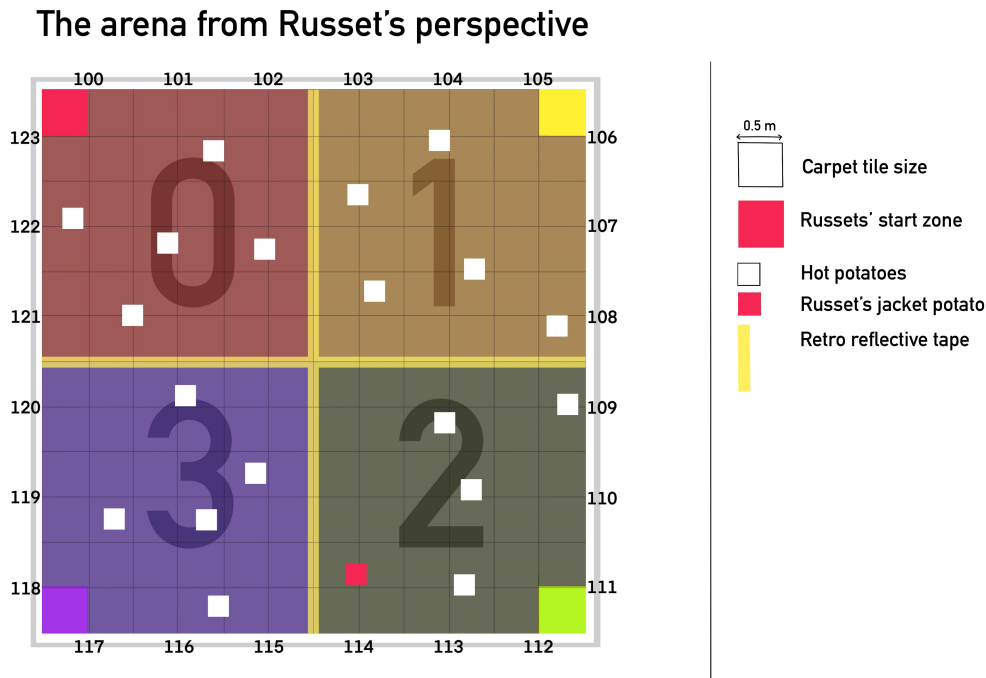


FIGURE 2: THE ARENA

- 5.1. The floor of the arena is carpeted. A close pile industrial carpet will be used.
- 5.2. The arena will be surrounded by 0.5m tall walls. No competitors or audience members will be permitted beyond these walls into the arena during a round.
- 5.3. The arena contains four patches. These extend from the arena corners by 3m along the arena wall in each direction to form 3 x 3m squares.
- 5.4. In the outer corner of each patch is a start zone, which extends from the arena corners by 0.5m along the arena wall in each direction to form a 0.5 x 0.5m square.
- 5.5. Each wall of the arena features 6 AprilTag markers (see figure 3). Their spacing along the arena wall and their numerical values are as indicated in Figure 2.

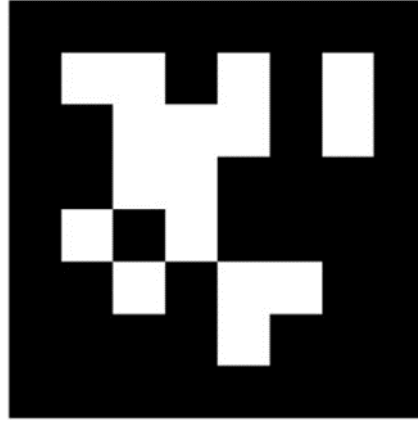


FIGURE 3: THE ARENA WALL

- 5.6. The bottom of the AprilTag markers will be 50mm from the floor.

## 6. MARKERS

- 6.1. The arena and the potatoes involved in the game are labelled using AprilTag markers. Each marker pattern encodes a number. Each marker number is associated with a specific feature of the arena and has an associated size.



**FIGURE 4: AN EXAMPLE APRILTAG MARKER**

- 6.2. The markers can be printed on a black and white printer, and their designs can be downloaded from the documentation section of the Hills Road RoboCon website <https://www.robocon.uk/markers.zip>.
- 6.3. At the start of the game, each patch will contain five potatoes, each with their own unique AprilTag code. The potatoes and the corresponding numbers are as follows:

Function	April tag Number range (inclusive)
Arena markers	100-123 (refer to fig.2)
Russet jacket potatoes	00, 20
Sweet potatoes jacket potatoes	01, 21
Maris piper jacket potatoes	02, 22
Purple potato jacket potatoes	03, 23
Arena owned hot potatoes	04-19, 24-39

**TABLE 2: APRIL TAG NUMBERS**

## KIT RETURN

7.1. Each team will be provided with a kit which contains a disclaimer form detailing your obligations with respect to assembly, use, and return of the kit which is lent to you for the duration of RoboCon 2024. Each team is issued with a kit with the following parts, which is to be returned at the end of the competition.

7.2. Items to be returned:

- Electronic Kit:
  - 1x BrainBox
  - 1x Power switch- latching (red switch, black connector)
  - 1x Start Button- momentary (Black switch, green connector)
  - 1x 6-pin GPIO connector
  - 1x 2-pin 12V Accessory connector
- Batteries:
  - 2 x 3S (11.1V nominal) LiPo Battery
  - 1 x Turnigy E3 Compact 2S/3S Lipo Charger
  - 1 x "LiPo Safe" bag for storage and charging of batteries
- Computer:
  - Windows operating system, paired with electronics for programming and Wi-Fi download
  - Power brick and lead
- Other:
  - 1x 12L Really Useful Box
  - 1x Really Useful Box Lid
  - 1x IR proximity sensor

7.3. Items to be returned if still in working order:

- 1x Minibot chassis
- 2x TT motors with connectors
- 1x microservo 9g SG90
- 4x Potato markers  $\Delta$
- 1x Potato  $\Delta$
- 1x Retroreflective tape sample  $\Delta$

7.4. If possible, the kit should be returned at the competition, but in no case later than 14 days after the competition. If you wish to keep the kit beyond that, this must be arranged by us prior to the competition date via an email to [robotics@hrsfc.ac.uk](mailto:robotics@hrsfc.ac.uk).

## AWARDS

### 8.1. Main competition awards

- 8.1.1. Prizes will be awarded to the teams that are placed highest at the end of the competition. The teams in 1st, 2nd and 3rd place will receive awards.

### 8.2. Supreme spuds award

- 8.2.1. This prize is given to the team that demonstrate that impresses the judges through either an ingenious technical or logical development.

### 8.3. A-peeling artistry award

- 8.3.1. This prize is given to the team with the most robot and team flair.

### 8.4. When the chips are down award

- 8.4.1. This prize is given to the team who demonstrate the most perseverance in the face of adversity.

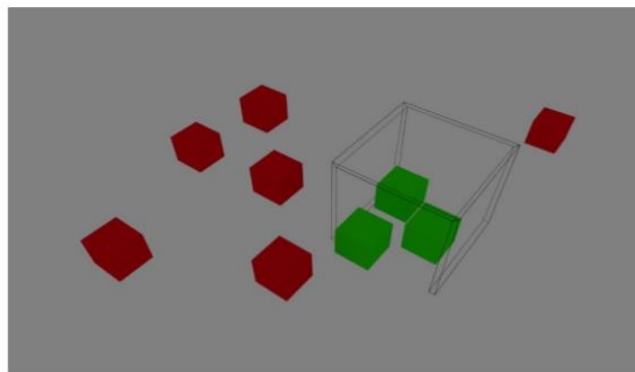
## CLARIFICATION

- 9.1. Requests for rule clarification may be sent to [robotics@hrsfc.ac.uk](mailto:robotics@hrsfc.ac.uk) . Requests received within one month of the competition are unlikely to be processed.
- 9.2. In all cases, the rules on the website are updated and reflect the most recent state of the game and supersede previous versions including the hard copy.

## APPENDIX

### 10. Collecting the jacket potato

- 10.1. Potatoes fully or partially inside the perimeter of the robot are considered to be controlled by that robot.
- 10.2. The perimeter of the robot is defined by a virtual 'thread', wrapped around the furthest extremities of the robot, as shown in Figure 5.



**FIGURE 5: THE RED BLOCKS ARE NOT UNDER ANYONE'S CONTROL. THE GREEN BLOCKS ARE UNDER THE ROBOT'S CONTROL**

- 10.3. The virtual thread is wrapped around the furthest extremity of the robot and defines its perimeter. The potato that is partially within the perimeter is considered to be being collected by the robot, as shown in Figure 6. The wire mesh in Figure 6 also exhibits how a robot's perimeter is defined when it is not of uniform dimensions.

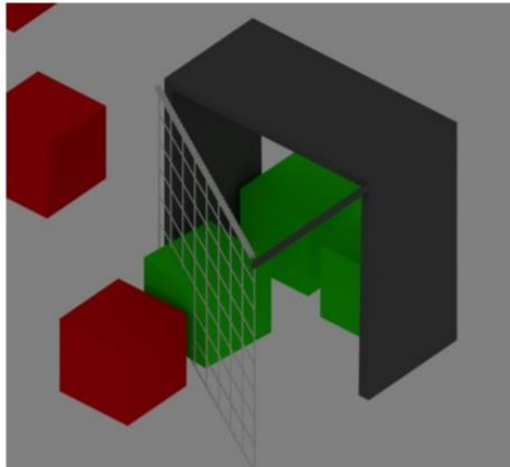


FIGURE 6: HOW A ROBOT'S PERIMETER IS DETERMINED

## THANKS

We would like to thank Will Munns, Mr Smalley, Mr Massey and the sponsors listed below, without whom we would not have been able to run this competition.



“Robotics, cybernetics and artificial intelligence are some of the most rapidly changing fields of science and technology, with tremendous opportunities for future engineers. This generation of students are the ones who will write the next chapter in technology and this competition may be the starting point for their careers. Several Hills Road students who became interested in engineering and robotics through the Robotics group and entering competitions have gone on to degrees and careers in this exciting field,” says David Massey, Founder of Hills Road Robotics.

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