

Firefighting contest

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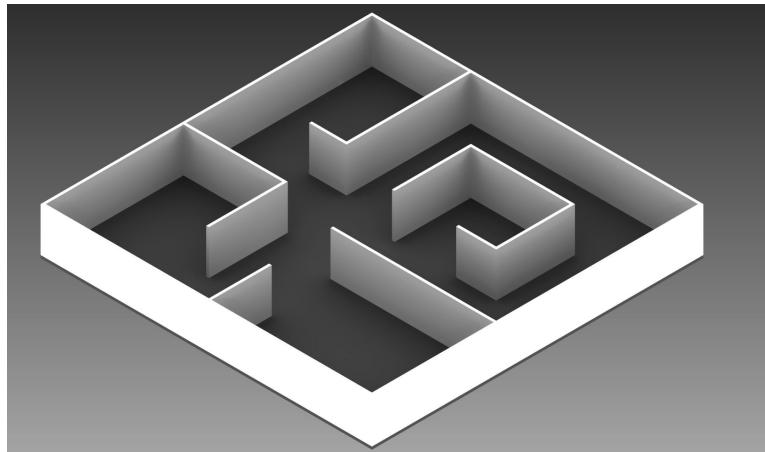


Figure 1: Firefighting arena without any special modes

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This document is based on the official “Trinity College Firefighting Home Robot Contest 2020 Rules”.

If you find an error or inconsistency, please email the Contest Organization at simst932@student.liu.se

1 General

These rules change every year. Each team is responsible for reading these rules and building a robot that complies with them. Robots designed for previous contests may not be acceptable under the current rules.

Any substantial changes since the last published version will be marked with red color like this.

1.1 Multiple entries

The challenge for contestants is to prepare a unique robot of their own design. However, we recognize that some teams may wish to enter a kit-based robot or a robot that shares many design features with another robot entered in the contest.

Each robot must differ visibly and significantly from other robots in at least some aspects of electronics or mechanics. Team may thus not register multiple identical robots as separate entries.

1.2 Spirit

The mission of the firefighting contest is to encourage innovation by roboticists of all ages and skill levels by creating an atmosphere of friendly and cooperative competition. The contest foster creativity, cooperation and achievement by the contestants themselves. The contest's highest priority is education, not winning.

The event has succeeded when teams and individuals invent their own autonomous robots and learn from their successes and failures during that process and the contest weekend, not when they blindly assemble components and programs designed by others.

1.3 Judge's Rulings

The Chief Judge is the final and absolute authority on the interpretation of all rules and decisions.

A team may challenge any ruling or scoring of the Arena Judges by stating that they wish to appeal the problem to the Chief Judge. The Chief Judge will then be called in to decide the matter.

The challenge must be made before the team leaves the arena after the completion of a trial.

All results, scores, and decisions become irrevocable after the team leaves the arena.

1.4 Safety

Any Contest official may stop any robot at any time if, in their opinion, it is performing or is about to perform any action that could be dangerous or hazardous to people, facilities, or other equipment.

Robots must not use flammable or explosive materials to extinguish the flame.

1.5 Environmental Conditions

The goal of the contest is to make a robot that can operate successfully in the real world, not just in the laboratory. Such a robot must be able to operate successfully where there is uncertainty and imprecision, not just under ideal conditions. Therefore, the arena dimensions and other specifications listed below will not be precisely what the robots will encounter at the contest: they are provided as general aids.

The size limits on robots are, however, absolute and will be enforced by the Judges.

Object dimensions are generally given as length x width x height, as the robot encounters the object.

- Length is front-to-back
- Width is side-to-side
- Height is top-to-bottom.

Although the robot contest arenas present an idealized version of the real world, you must not assume:

- Exactly square corners
- Precisely vertical walls
- Perfectly flush joints
- Recessed fasteners and brackets

- Uniformly colored surfaces
- And so forth and so on...

Every robot must successfully handle small misalignments, inaccuracies, discolorations, and other arena imperfections. You must test your robot under less-than-ideal conditions and verify that it works properly.

Teams should expect environmental conditions at a tournament to be different than at their home practice field.

Lighting conditions will certainly vary both in general and along the path in the arena. Teams must therefore come prepared to calibrate their robot-based on the lighting conditions at the venue.

NOTE Flash photography *will occur* during the entire contest. Your robot must withstand frequent sensor glitches from IR and UV impulses. If your robot operates incorrectly due to external interference, *it will not be given another trial.*

Teams should design their robots to cope with variations in environmental conditions and come prepared to calibrate their robots to contend with the alternate environmental conditions found at the venue.

1.6 Practice Time

The teams will have opportunity to test their robots in the competition arena before the competitions starts.

You should use the practice time to calibrate sensors for the conditions in the arena and to troubleshoot any last minute problems. It is not likely that you will manage to do any extensive coding or construction during the competition day. After the first competition rounds have started there will be no possibilities to practice in the arena.

1.6.1 Damage During Practice

Several robots will be permitted on the arena at the same time during practice. Since we will not monitor practice, you are responsible for the safety of your robot at all times.

If two or more robots damage each others during practice, the contest officials must be contacted immediately to decide the following:

- damage to a robot
- which team is responsible for any damage

- which teams (if any) may compete
- which teams (if any) will be disqualified
- and all similar questions

The decisions of the contest officials are final and can not be appealed.

NOTE If you put your robot in an arena where another team is practicing with their robot with the intent to deliberately harm the enemy team or their robot; your team will be disqualified.

1.7 Inspection of Robots

Each robot will be inspected before the contest to verify that it meets the specifications stated in these rules. Judges will inspect that the robot meets the following specifications:

- Size constraints
- Start and Stop button locations

Each team will present its robot to the Judges at a Robot Inspection Table and will be awarded a grade of pass or fail. A robot must pass the inspection to compete. Furthermore, each team must either have a Robot Handle (See Section 2.2.7) or instruct the Judges on how to carry the robot during the competition.

1.8 Starting the Trial

When arriving at the arena the team will put the robot on the judges table and tell the judge which Operating Modes that they want to use.

NOTE If you are not ready at the assigned starting time of your trial, you will miss your turn.

Team members must not touch the robot after placing it on the Judge's arena table.

The team must not transfer any information to the robot regarding the layout of the arena, the starting position, or the position of any objects after placing the robot on the arena table. The team must download any required programs or firmware to the robot before arriving at the arena.

The Judges will use the selected Modes to determine the arena configuration, then place the robot and any objects in the arena. The team must

not request special placement of objects or changes to the robot's placement in the arena.

The Judge will determine when the trial begins and will activate the robot using either the Start Button or the Standard Sound Start Device, as required by the Operating Modes.

1.8.1 Failing to Start

If the robot fails to start when activated with a start button, the Judges will wait for 30 seconds, then record a failed trial. Teams may decide that the robot will not move and terminate the trial before that time by informing the Judge.

If, in sound activation mode, the robot has not started moving 15 seconds after the signal is given it will be started manually by the judge as described in Section 3.4.1.2

This applies regardless of the reason the robot does not start. All that matters is that the robot does not begin moving after the Judge presses the Start Button or activates the Sound Start Device.

Teams must not request a re-run following a failure to start.

1.8.2 Premature Start

If a robot begins moving before the Judge has placed it in the arena, it has failed the trial.

If a robot begins moving after being placed in the arena, but before the Judge presses the Start Button or activates the Sound Start Device, it has failed the trial.

Teams must not request a re-run following a premature start.

2 Specifications

2.1 Arenas

The arena dimensions and specifications listed below are not exactly what will be encountered at the contest: they are provided as general aids.

2.1.1 Arena Dimensions

All arenas use a common layout, with dimensions as shown in Figure 2. In addition to those dimensions,

- Hallway width: 46 cm
- Door opening: 46 cm
- Walls: approximately 2 cm thick, 27 to 34 cm tall

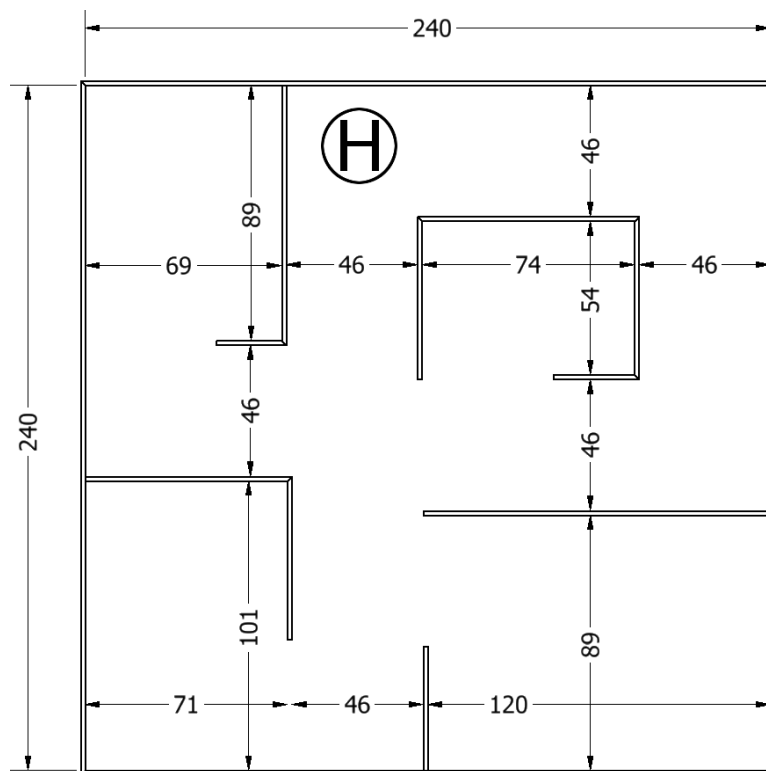


Figure 2: Arena Dimensions, in centimeters.

Door openings do not have doors: white tape on the floor marks each door opening. The tape extends across the entire door opening, and is aligned with the walls on each side. The tape may have gaps up to 2.5 cm on each side and may not be precisely aligned with the walls.

NOTE We strongly recommend that your robot should not depend on precise dimensions. Our experience shows that the intensity of a protest based on arena dimensions corresponds directly with the robot's failure to operate at all. See Section 1.5.

The location of the doors in the rooms to the right will differ on each trial, as described in Section 3.4.1.7, if you have chosen that Operation Mode.

2.1.2 Materials and Finishes

The arena floor will be painted flat black at the start of the contest. Our best efforts will be made to clean up after each robot, but there is no guarantee that the floor will stay uniformly black throughout the entire contest. There may for instance be traces of stearin. The floor may also have small colored dots on it to indicate potential locations for candles and other objects.

Arena walls will be painted flat white at the start of the contest. Angle brackets supporting a wall may extend about 4 cm into the hall or room, with screws into the wall and floor. The walls will not be completely white everywhere, see Section 2.1.3

The white tape marking the doorways will become scuffed and discolored during the contest: your robot must detect the difference between a black floor and a white tape line regardless of their cleanliness.

NOTE Remove your shoes before stepping into the arena! Shoes produce hard-edged dust marks on the floor that may be mistaken for white tape. The arena must be left in the same state as when you entered it.

2.1.3 Wall Decorations

The arena represents a decorated home, and just like in a such, there will be decorations on the walls.

Wall decorations, including pictures, tapestries, and mirrors, will be hung from the walls of rooms and hallways. These will not protrude more than 1 cm from the wall. The walls may also have wallpaper in various patterns and colors, as well as painted surfaces in any color.

Mirrors will not appear in the room where the candle is located.

2.1.4 Start Orientation

Except in Arbitrary Start Location Mode (Section 3.4.1.3), the robot will start at the Home Circle location marked by the H in Figure 2. The Home Circle is a 30 cm diameter solid white circle, without the H, centered in both the halls. The robot may begin motion in any direction it chooses.

NOTE The Home Circle is not anchored to the arena floor and may be dislodged by an accelerating robot. There is no penalty for this, but the loss of traction may misalign the robot in the hallway.

The team may choose in which direction they want their robot to be placed in.

NOTE The alterations in the arena will be made AFTER the team has chosen the start orientation. The team can not change the orientation after the alterations are made.

2.2 Robot

The robot dimensions, hardware requirements, and performance specifications are absolute and will be enforced by the Judges.

2.2.1 Operation

Once turned on, the robot must be autonomous: self-controlled without any human intervention. Firefighting robots must not be manually controlled.

A robot may bump into or touch the walls of the arena as it travels, but it cannot mark, dislodge, or damage the walls in doing so. The robot must not leave anything behind as it travels through the arena. It must not make any marks on the floor of the arena that aid in navigation as it travels. Any robot that, in the Judge's opinion, deliberately damages the contest arena (including the walls) will fail that trial. This does not include any accidental marks or scratches made in moving around.

NOTE Although a robot may bump the arena walls as it moves, it should not repeatedly crash into the walls at high speed. "Navigation by crashing" would not be acceptable in an actual house and is discouraged in this contest. If the robot crashes hard enough to move the arena walls, it will fail that trial.

2.2.2 Robot Dimensions

When starting the robot must fit in a Bounding Box with a base 30 x 30 cm square and 30 cm high. After beginning the trial the robot may exceed these dimensions. If the robot has feelers to sense an object or wall, the feelers will be counted as part of the robot's total dimensions.

To simulate the effect of a ceiling, the robot may not move itself or parts

thereof during any point of the trial into another room and gather information except by the designated doors.

NOTE The height is measured from the floor. Therefore the robot must not have its highest part more than 30 cm above the floor at the start.

The robot is not allowed to fly higher than 2 cm from the floor/stairs.

Unlike the arena specifications, the robot size limits are not approximate: robots must not exceed the given dimensions when measured.

There are no restrictions on robot weight or materials.

2.2.3 Start Button

All robots, including those using Sound Activated Mode, must have exactly one Start Button switch that starts the robot with one single press.

The start button must be clearly marked and easily accessed without using any tools. It must also be placed so that there is no risk for the judge to be in the way of fans or other mechanical parts of the robot or to get injured in any other way, when pressing the button.

The team must inform the judge how to start the robot before it is placed in the arena.

2.2.4 Stop Button

All robots must have exactly one Stop Button switch that stops the robot immediately with one single press.

The stop button must be clearly marked and easily accessed without using any tools. It must also be placed so that there is no risk for the judge to be in the way of fans or other mechanical parts of the robot or to get injured in any other way, when pressing the button.

The judge may press the stop button at any time.

2.2.5 Communications

The robot may not communicate with anything outside of the arena in any way. This is to ensure that the robot operates autonomously and to avoid any kind of human control or tampering with the robot. Internal, short-range communication within the robot itself is allowed.

The judges will determine if a robot is communicating with anything outside of the arena.

2.2.6 Sensors

There is only one restriction on the type of sensors that may be used as long as they do not violate any of the other rules or regulations. The robot must not extend any sensors beyond the dimensions specified in Section 2.2.2.

The restriction is the following: For safety reasons robots must not use lasers of any output effect larger than 1mW (class 2 according to Strålsäkerhetsmyndigheten (Swedish department of radiation safety)). Any mounted laser must be pointed along the floor-plane or angled towards the floor. It may not be angled towards the ceiling. This ensures the safety of participants, judges, spectators and any other person near the event.

Contestants are not allowed to manually place any markers, beacons or reflectors on the walls or floors, whether inside or outside of the arena, to aid in the robot's navigation. The robot itself may leave and use these kind of things as long as they obey the rules stated in Section 2.2.5.

2.2.7 Robot Handle

In order to protect the robots from unnecessary damage and/or unintentional side effects of touching, the robots should be equipped with a carrying handle. The competition committee are aware of the many hours spent into the making of each robot, and would like to assure that damages from unwanted electrical or mechanical effects are minimised.

The competition staff will use the carrying handle during the competition.

The requirements for the handle is that:

- It is strong enough to allow staff to pick up the robot
- It is designed for easy access

The handle may be constructed in any material including metal, plastic, or wood.

In case of a handle missing, the team must instruct the Judges on how to carry the robot during the inspection of the robot (see Section 1.7). However, damages as a result of Judges carrying the robot will be regarded as damage inflicted by the team itself.

The competition committee strongly recommends that buttons (such as Start and Stop button) are located on the handle for easy access.

2.3 Fires

For obvious reasons of safety and economy, fires will be simulated by small candle flames.

The candle flame will be from 15 cm to 20 cm above the nominal floor level. The candle thickness normally will be between 2 cm and 3 cm. The exact height and size of the flame will change throughout the contest depending upon the condition of the candle and its surroundings. The robot is required to find the candle no matter what the size of the flame is at that particular moment.

The candle will be placed at a random position in one of the rooms of the arena.

The candle will not be placed in a hallway, but it might be placed just inside a doorway of a room. The Candle Circle (Section 2.3.1) will not touch the doorway line and this means that the front of the robot will be able to move at least 30 cm into the room before it encounters the candle.

The candle will be mounted on a small wooden base. This base prevents the candle from tipping over easily, but a robot can knock the candle over by bumping into it. Judges will give penalty points if that occurs (Section 3.4.4).

2.3.1 Candle Circle

Unless Candle Location Mode is used the robot must come within 30 cm of the candle before it attempts to extinguish the flame. There will be a white 30 cm radius solid circle (or circle segment, if the candle is near a wall) on the floor around the candle, and the candle will be placed in the center of the circle. The robot must have some part of its body over the circle before it extinguishes the candle flame.

NOTE The Candle Circle is not anchored to the arena floor and may be dislodged by a decelerating robot. There is no penalty for this, but the moving paper may knock the candle over and there is a penalty for that.

2.3.2 Extinguishing the Candle

The robot must, in the opinion of the Judges, have found the candle before it attempts to put it out. For example, the robot cannot just flood the arena with CO₂ thereby putting the flame out by accident.

The robot must not use any destructive or dangerous methods to put out the candle.

The robot may extinguish the candle by blowing air or other oxygen-bearing gas. However, this is not a practical method of extinguishing a fire in the real world, so robots that do not use air streams to blow out the candle can operate in Non-Air Extinguisher Mode for an improved score. See Section 3.4.1.5 for details.

Normally the robot must come within 30 cm of the candle before it attempts to extinguish the flame, meaning that it has to have some part over the Candle Circle.

Candle Location Mode omits the candle circle and minimum distance requirement. See Section 3.4.1.8. The robot need not be within 30 cm of the candle, but must demonstrate that it has detected the candle before extinguishing it. This may be by a distinctive action, an illuminated LED, or other means.

Robots that touch a lit candle with either the robot chassis or a sensor will incur a penalty as specified in Section 3.4.4.

2.3.3 Methods of Extinguishing the Flame

Robots may extinguish the flame using air, inert gas, water mist/spray, or mechanical means. The use of powders of any type is not allowed.

Air

A fan is an example of an air-based extinguisher.

Carbon dioxide (CO₂)

Robots may use a single CO₂ capsule containing up to 16 grams to extinguish the candle on each trial; larger CO₂ containers are prohibited. The Judges will verify that CO₂ is the extinguishing material.

Water mist or spray

Water is the only liquid allowed in this contest. You may not add foaming or gelling agents. The water tank volume must be no larger than 50 ml. Judges will verify the tank volume. Water must be applied only as a mist or spray, not a jet. **Exception:** We will allow a robot to extinguish the flame with no more than three accurately aimed water "bullets". This would be a water jet with an extremely short pulse, not a continuous stream: think rifle rather than machine gun. Contact us before you register to verify that

your design will be accepted. Any robot that floods the room will fail that trial.

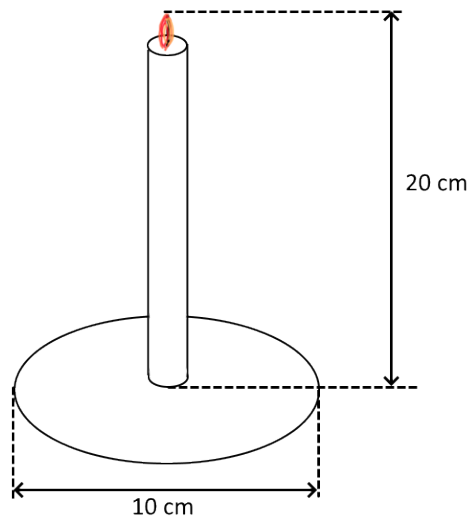
Mechanical means

A wet sponge or snuffer.

Carbon dioxide, water mist, and mechanical means qualify for the non-air extinguisher deduction. See Section 3.4.1.5.

2.3.4 Candle

The candle will be mounted in a candle holder. The candle holder base will be 10cm in diameter with a base plate height of 5mm. The total height including the candle and its holder will be at most 20cm. Because of the nature of a lit candle, the height will be reduced as the competition progresses. It is reasonable to expect that the flame will be at least 15cm from the ground. Judges will make sure a candle is replaced if it is burnt down beyond acceptable height.



2.4 Trial Procedures

The robot must perform certain operations during each trial in the arena. Other sections of this document provide further details.

The robot may use any of the available Operating Modes (Section 3.4.1) to improve its score for the trial. The robot may use different Modes in

different trials, but the team cannot change Modes after a trial begins. Each successful trial consists of the following sequence of steps.

1. The robot must start when commanded by the Judge
2. It must find the candle in one of the rooms
3. It must extinguish the candle
4. Optionally, it may return to its starting location if using Return Trip Mode (Section 3.4.1.4)

3 Scoring

The overall scoring flow follows this pattern:

1. The team presents their Trial Options Sheet to the Judge to select the optional tasks the robot will attempt; this determines the Operating Mode factors in effect for that trial.
2. The Judge measures the Actual Time required for the robot to complete its trial.
3. The Judge records any penalties.
4. The Judge computes the Operating Score for the trial.
5. The Judge computes the Final Score from the Operating Score and whether the trial was successful or not
6. After all trials is done, the Judge computes the Total Final Score from the Final Scores of all trials.

3.1 Operating Score (OS) Computation

During the trial, the Judges will:

1. Record the robot's Operating Modes (OM.x) options (Section 3.4.1)
2. Measure the Actual Time (AT) for the trial (Section 3.4.2)
3. Determine the Room Factor (RF) for the path used (Section 3.4.3)
4. Record any Penalty Points (PP) incurred (Section 3.4.4).

After the trial has completed, the Judges calculate the Operating Score (OS) from those values using this procedure:

1. Multiply all of the active Operating Mode values together to find the Mode Factor. If no OM.x factors apply, then $MF = 1.0$.
2. Add all of the Penalty Point (PP) values to the Actual Time (AT) to determine the Time Score: $TS = AT + PP$.
3. Compute the Operating Score: $OS = TS \times RF \times MF$.

Although the “units” of the Operating Score appear to be seconds, they bear little relation to actual wall-clock time.

3.2 Final Score (FS) Computation

Scoring rules convert the Operating Score into the Final Score for each trial. The Final Score becomes a component of the Total Final Score (TFS) used to rank the robots.

If the robot extinguishes the candle, then the Final Score for that trial equals the Operating Score. If it did not extinguish the candle, then the robot receives a score of 600 with credit for tasks completed during the unsuccessful trial by subtracting points as described below.

3.2.1 Time Reduction for Unsuccessful trials

Room Searching

$TASK.search = -30s$ times the number of rooms searched

Deduct 30 points for each room searched before finding the candle. The maximum reduction is 120 points because the candle must be in the fourth room.

Candle Positioning

$TASK.position = -60s$

The robot must stop within 30 cm of the candle without touching it.

3.3 Total Final Score (TFS) Computation

After all robots have completed their trials, the Judges compute the Total Final Score (TFS) for each robot by adding its Operating Scores for all its trials together.

3.4 Score Components

These sections explain how the Judges assign values that determine the Operating Score.

3.4.1 Operating Modes (OM.x)

A robot's overall performance depends on its ability to handle real-world situations. The Basic contest arena includes a level floor, high-contrast walls, and no obstructions, but additional operating modes allow you to improve your robot's score by completing more difficult tasks.

Operating modes act as multipliers to the Actual Time required for the robot to find and extinguish the candle. If no Operating Modes are in effect for a trial, the Actual Time is multiplied by the Standard Mode, which is exactly 1.0. The team can select different Operating Modes for each of the three trials. The candle and any furniture will be placed in different locations for each trial.

The modes do not apply to an unsuccessful trial, where the robot does not extinguish the flame or fails for any other reason. The operating score for an unsuccessful trial is 600, regardless of any operating modes applied to that trial.

3.4.1.1 Standard

OM.standard = 1.0

The team must inform the Judge of any operating modes for the current trial before the trial begins. In the absence of that notification, the robot will compete in Standard Mode and the Actual Time will be multiplied by 1.0.

3.4.1.2 Sound Activation

OM.sound = 0.80

The robot begins operation when it detects a sound signal of 1.0 KHz.

The Judges will begin timing the trial when the sound signal begins, not when the robot begins moving. The sound will last 5 seconds and will not be repeated. The time will be counted from the end of the signal

The robot must not start until the Judge activates the sound signal. If

the robot mistakenly detects ambient noise (even an activation sound from a different arena) and begins to move, then the trial will have begun, but the Sound Activated Mode factor will not apply to the robot's score.

If the robot does not start within 15 seconds from the signal is given it will be started manually by the judge by pressing the startbutton.

NOTE The robot's circuitry should detect the correct frequency and should not rely only on sound amplitude. We strongly recommend using an analog band pass filter tuned to the starting frequency: the arenas are very noisy and a robot that detects only amplitude (triggered by whistling or clapping) will start prematurely during its trial.

3.4.1.3 Arbitrary Start

OM.start = 0.45

The Judge will place the robot in an arbitrary location and orientation within any room that does not have the candle, as determined by a randomization program.

The robot may be facing a wall or pointed into a corner, but will not be trapped by furniture.

NOTE Teams must not request any particular orientation or position.

There is no "Home Circle" in Arbitrary Start Location Mode.

The starting room does not count as a searched room for the Room Factor calculation (Section 3.4.3). When the robot leaves the starting room, the next room it encounters is its first searched room.

3.4.1.4 Return Trip

OM.return = 0.80

The robot must return to its starting location after extinguishing the flame.

In Standard Mode, the robot must return to the Home Circle. It must stop with any part of its chassis within the 30 cm diameter white Home Circle, but need not be in the same position or orientation as when it started the trial.

In Arbitrary Start Location Mode, the robot must return to the room it started from. It must stop with all parts of its chassis within the starting room and stay there, but need not be in the same position or orientation

as when it started the trial. See Section 3.4.1.3.

If the robot has split into separate, physically not-connected parts/blocks/machines (here labeled blocks), then the block that extinguished the flame is the block that will be monitored and needs to return to the starting location.

The robot's Actual Time (AT) recorded for the trial will include only the time required to find and extinguish the candle, not the time for the return trip.

The robot must return its starting location within 2 minutes; if not, then the Return Mode factor is not in effect.

The robot need not retrace its path in returning to the starting location or take the most efficient route, but it must not enter any other rooms along the way.

The robot will fail the Return Mode if any part of the robot/block that extinguished the flame is within the home circle or starting room when the flame is extinguished.

3.4.1.5 Non-air Extinguisher

OM.extinguisher = 0.75

The robot must extinguish the candle using inert gas, water, or mechanical means. See Section 2.3.3

Robots that use an air stream of any kind do not operate in Non-air Extinguisher Mode.

3.4.1.6 Furniture

OM.furniture = 0.75

Every room will have one or more pieces of furniture. This includes the room where the robot starts in Arbitrary Start Location Mode. Furniture consists of yellow cylinders approx. 11 cm in diameter, 30 cm high and weighing more than 1 kg.

Furniture will always be placed to allow at least one path to the candle that is at least 30 cm wide. The furniture will not block the doorway and a maximum-size robot will be able to come into a room at least halfway before it encounters furniture. Furniture may block the robot's view of the candle, so it must move to different locations to see the candle and plan a path to reach it.

The robot may have to go around the furniture to extinguish the candle

or exit from the room. It may touch the furniture, but it cannot push it out of the way. Robots that push the furniture away lose the Furniture Mode deduction for that trial.

3.4.1.7 Variable Door Locations

OM.variabledoor = 0.80

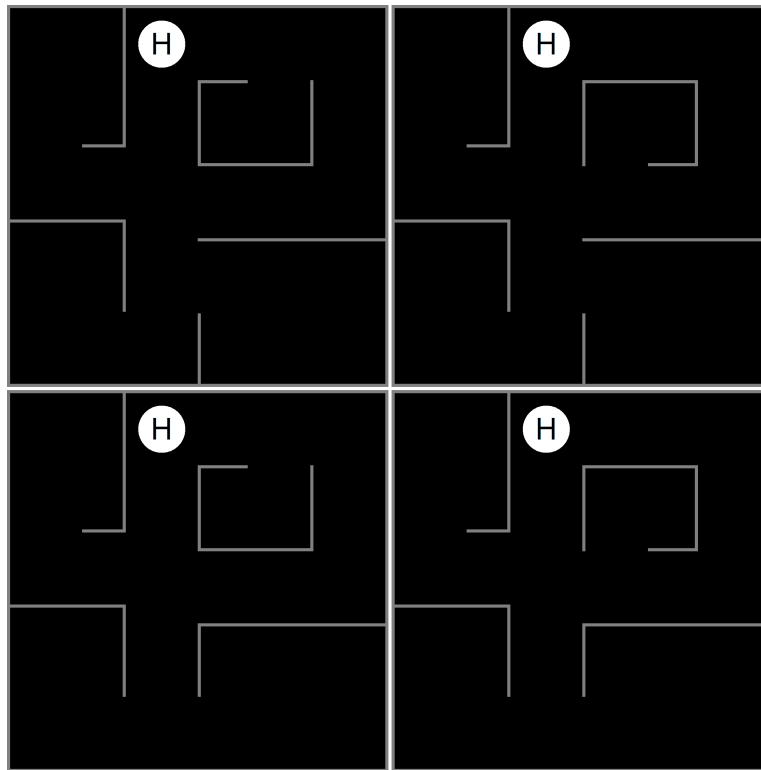


Figure 3: The four possible door locations.

This option changes the locations of the doors in the rooms on the right side, so that dead reckoning will not suffice to navigate the arena and search the rooms. At the start of a trial the arena Judge will determine the door locations randomly or using a computer-assisted method. Therefore, the robot may encounter a different door location on each trial. See Figure 3.

3.4.1.8 Candle Location

OM.candle = 0.75

This option challenges robots to find candles without a candle circle. The Judge will place the candle at a randomly chosen location within a room for each trial.

The candle may be in any location within the room that does not block the doorway. A maximum-size robot can enter the room at least halfway before encountering the candle and there will be at least a 30-cm wide path around the candle.

The candle won't be directly adjacent to a wall, to reduce the chance of damaging the wall by overheating. There is no specification for the exact distance from the wall.

NOTE There are other restrictions on the candle location in this Mode.

The Fire rules in Section 2.3 will be followed except that:

- There will be no candle circle, just a candle in a standard holder
- The robot need not be within 30 cm of the candle, but it must demonstrate (by a distinctive action, an illuminated LED, or other means) that it has detected the candle before extinguishing the flame. You must tell the Judge how the robot will comply with this rule before the trial begins.

The Furniture Mode rules in Section 3.4.1.6 also apply in Candle Location Operating Mode. In particular:

- Furniture may block the view of the candle from the door
- Although the candle will not block the doorway, the robot may have to maneuver within the room to detect and extinguish the flame.

3.4.1.9 Stairs

OM.stairs = 0.75

The robots may choose to go over a block of stairs in order to arrive more quickly to the rooms. The block of stair, if present, will be in front of the Home Circle, between the two rooms. The robot must pass over the stairs to get the deduction. Figure 4 shows the specifications of the block of stairs.

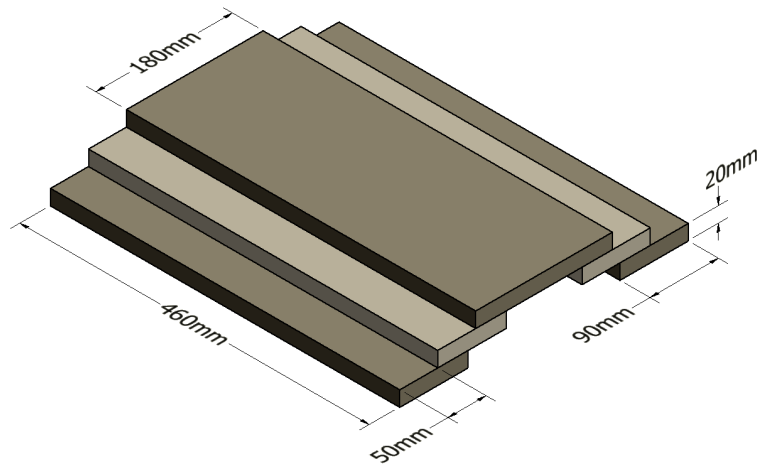


Figure 4: Stairs with measurements

3.4.2 Actual Time (AT)

If the robot extinguishes the flame the Actual Time is the number of seconds elapsed from robot activation to flame disappearance. The maximum Actual Time for such a successful trial is $AT = 300$. If the robot does not extinguish the flame within the limits set below, the Judge will terminate the unsuccessful trial and assign $AT = 600$.

3.4.2.1 Time Limits

The maximum time allowed for a robot to find the candle is 5 minutes, after which the Judge will stop the trial and assign $AT = 600$.

A robot operating in Return Trip Mode must return to the Home Circle within 2 minutes after extinguishing the candle, after which the Judge will stop the trial. The AT equals the time required to extinguish the candle.

3.4.3 Room Factor (RF)

The Room Factor (RF) adjusts the elapsed time based on the number of rooms searched. The more rooms a robot searches before it finds the candle, the lower the Room Factor for that trial.

When the candle is in:

First room searched RF = 1.0

Second room searched RF = 0.85

Third room searched RF = 0.50

Fourth room searched RF = 0.35

It does not matter in which order the robot searches the rooms. The only thing that matters is how many rooms the robot has searched before it finds the candle.

When the robot searches the room with the candle, whether or not the robot extinguishes it, the Judge records the Room Factor for that trial. The room factor will not change regardless of how many more rooms the robot searches.

Because some robots can detect the candle by looking in the doorway without entering the room to search it, when the robot passes a doorway for the first time the Judge will count that room as searched. If the robot has already searched a room and then goes past the doorway again on its way to a different room, that room will not be counted twice.

3.4.4 Penalty Points (PP)

Penalty Points (PP) will be added to the Actual Time (AT) of any robot that touches the candle.

PP.candle = 50

Any robot that touches the candle or its base, either deliberately or accidentally, while the candle is lit will have 50 penalty points added to its Time Score each time the candle is hit.

There is no penalty for a touch that occurs as part of the actual extinguishing process, i.e., smothering the flame with a wet sponge, or after the candle is extinguished.

Touching refers only to any part of the robot's body, including feelers or probes, and does not include the water, air or other material that the robot might use to extinguish the candle.

NOTE Although there is no penalty for touching or knocking the candle over after the robot has extinguished the candle, we strongly recommend that your robot avoid doing that. The Judges may not agree with your opinion of whether the candle was extinguished before it began falling.