RoboCup Rescue 2022

Draft Rulebook

Part 5: Search and Inspect

Version 2022-04-19

Introduction:

The Search and Inspect test in RoboCup is based on the prototypical Standard Test Method for Search and Inspect. The Standard Test Method has three different settings, which reflect different levels of standardization, environment, and application specificity.

This document describes all three settings: Rectangular Labyrinth, Freeform Maze, and Embedded Scenario. Within RoboCup, the Rectangular Labyrinth is used for the in-person Preliminaries and the remote pre-recorded and live (telecon) competition, while the Freeform Maze is used during the in-person finals. The Embedded Scenario is not used in the competition, however its description is included in this document in case teams wish to make use of it for their own evaluation, given that the apparatus is a subset of that used in Rectangular Labyrinth.

For the purpose of RoboCup, we also provide the option of implementing the Rectangular Labyrinth in simplified form, in acknowledgement of the fact that teams may be limited in space and resources with which to implement these test methods at home. Please see the section on RoboCup Implementation for more details on how to implement this.

Test Description:

The robot traverses through a defined area over terrain of varying complexity, searching for visual acuity targets positioned at various heights and orientations throughout the area, and inspecting and identifying as many of them as possible. The visual acuity targets are positioned in a set of four on a linear inspection rail , with a numeric label in the center as shown in Figure 1. Ten or more linear inspection rails (depending on the test configuration) are located throughout the test apparatus for a total of at least forty visual acuity targets.

(a) Rectangular labyrinth: The robot traverses through a fabricated apparatus of a specified design. This consists of four hallways, three rooms, and four alcoves. There are pre-defined locations that are known to the operator for one set of ten linear inspection rails throughout the labyrinth. The robot navigates following either the left or right hand prescribed traversal path through the apparatus (see Figure 3), which is similar to performing a left or right hand wall follow. ***This is the version to implement at your facility for remote pre-recorded and live (telecon) competition. See the section "RoboCup Implementation" for further details.***

(b) Freeform maze: The robot traverses through a fabricated maze apparatus approximately two to four times the size of the rectangular labyrinth. This maze has multiple routes and intersections of a variable design (not specified) that consists of at least four hallways, three rooms, and four alcoves. It also has variable locations for one or more sets of ten linear inspection rails throughout (not pre-defined and not known to the operator), but following the prescribed heights and orientations for the linear inspection rails as defined (Table 1). The design of the maze layout and the locations of the linear inspection rails is to be determined by following the selected apparatus

clearance width (W) and minimum wall height (H) measurements . Multiple sets of ten linear inspection rails can be used if desired. Robot navigation through the apparatus is unrestricted meaning there is no prescribed traversal path for the robot. ***This is the version that will be implemented during the in-person finals.***

(c) Embedded scenario: The robot traverses through a real-world environment with multiple hallways and rooms (e.g., a residential or office building) or a large open space (e.g., a gymnasium). The environment is approximately 2-4 times the size of the rectangular labyrinth with variable locations for one or more sets of ten linear inspection rails throughout (not pre-defined and not known to the operator), to be determined by the test sponsor. Multiple sets of ten linear inspection rails can be used if desired. Robot navigation through the environment is unrestricted meaning there is no prescribed traversal path for the robot.

Figure 1: Linear Inspection Rail

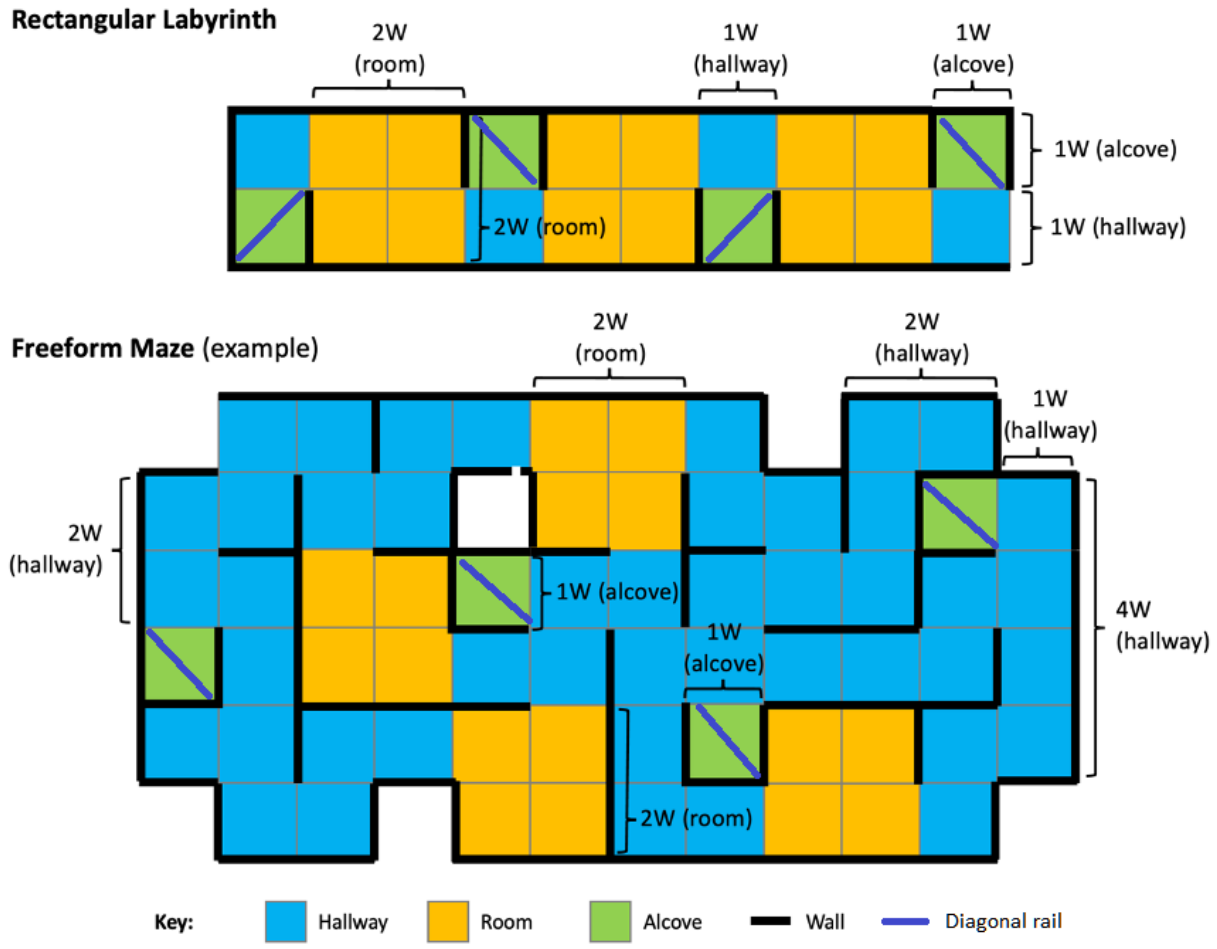


Figure 2: Maze Configurations

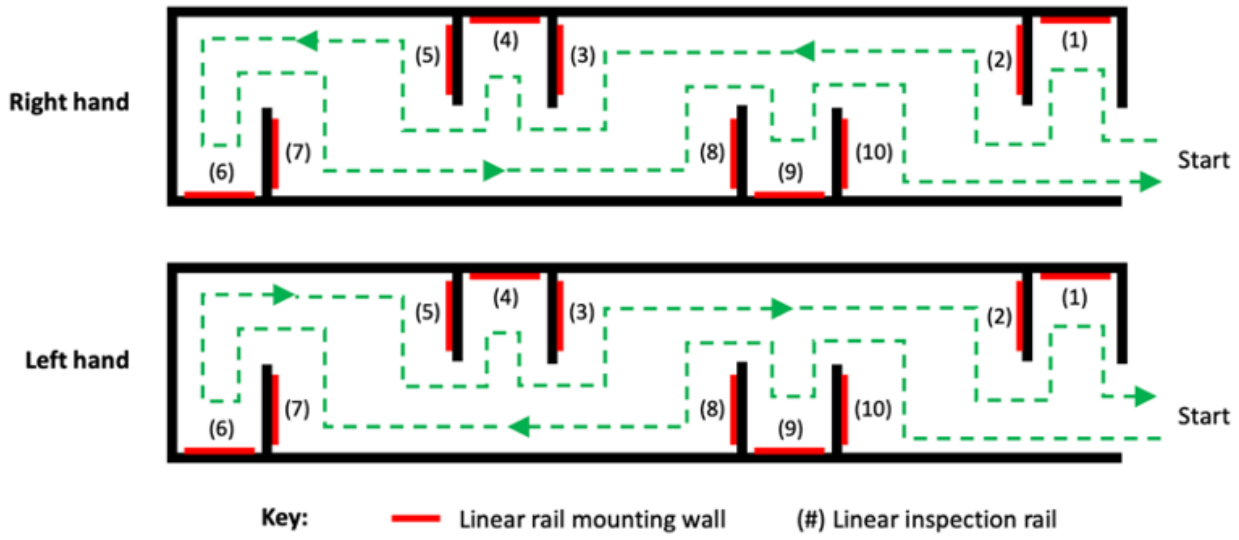
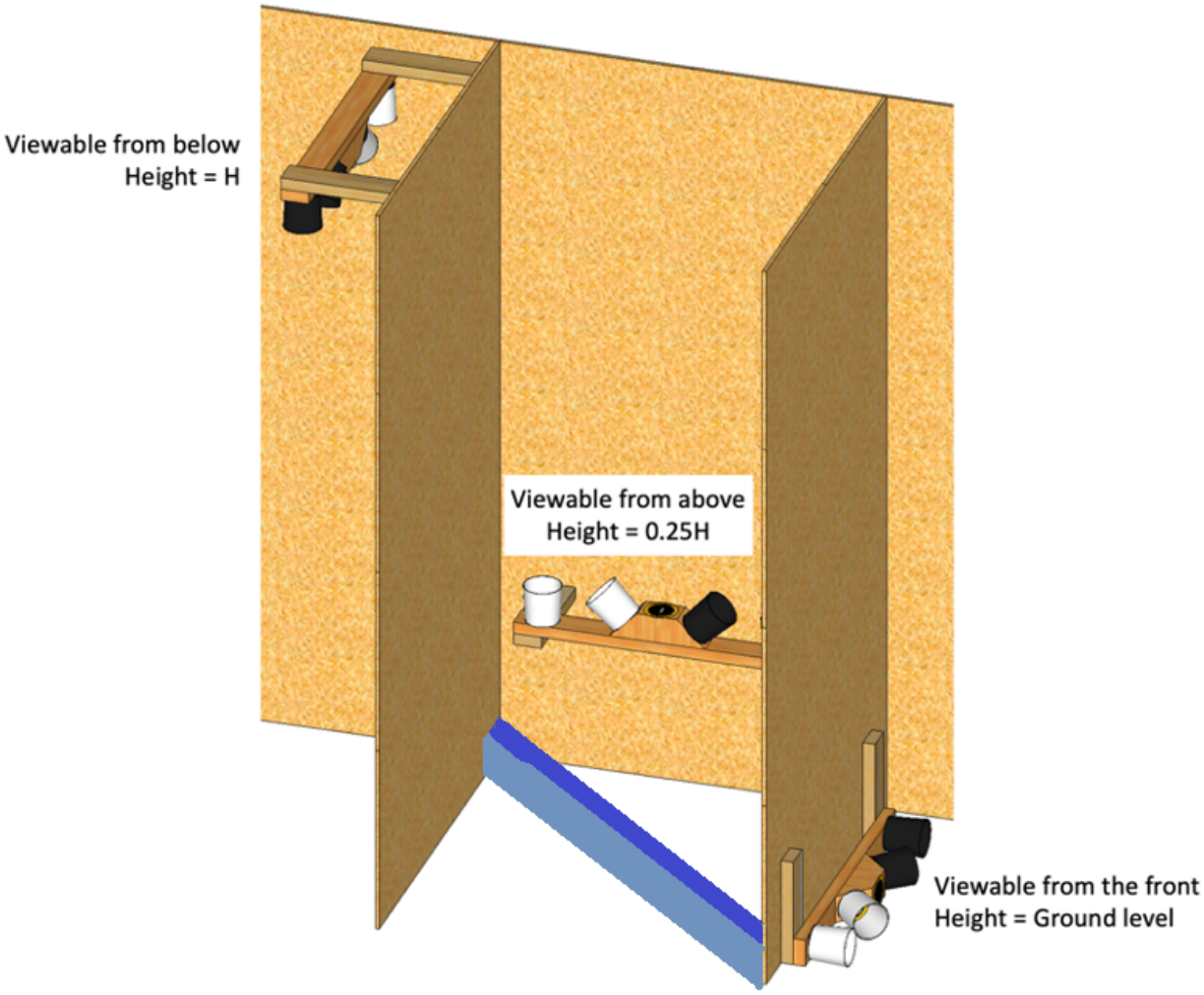


Figure 3: Acceptable path for standard Labyrinth

Figure 4: Correct alignment is defined as when the operator is able to see the entire black or white outer ring outside of the Landolt Cs (inside of the colored ring), as shown in the left and middle image.

Settings	Rectangular labyrinth	Freeform maze	Embedded scenario
Apparatus	Fabricated apparatus of a prescribed design with four hallways, three rooms, four alcoves	Fabricated maze apparatus (2-4 times larger than rectangular labyrinth) with four or more hallways, three or more rooms, four or more alcoves	Real world environment (2-4 times larger than rectangular labyrinth); residential, industrial, etc.
Number of linear inspection rails	One set of 10 for a total of 40 visual acuity targets	One or more sets of 10 with 40 visual acuity targets per set	
Locations of linear inspection rails	Prescribed	Variable	
Heights and orientations of linear inspection rails	Prescribed per set of 10 linear inspection rails: Four viewable from the front at ground level, 0.25H, 0.5H, and 0.75H high Three viewable from above at ground level, 0.25H, and 0.5H high Three viewable from below at 0.5H, 0.75H, and H high		Same as rectangular labyrinth and freeform maze with +/- 0.125H allowed variance for each height in order to fit within what is available in the scenario
Terrain	Homogeneous terrain throughout Terrain options: flat flooring, K-rails, continuous ramps, crossing ramps, stepfields, sand, gravel. **For RoboCup the terrain consists of a diagonal square beam of at least 90 mm (3.5”) in size, across each alcove.**		Existing scenario terrain (e.g., carpet, concrete)
Route(s)	Single route to dead end and back	Multiple routes via intersections for navigation choices	
Navigation	Left or right hand prescribed traversal path	Unrestricted; there is no prescribed traversal path for the robot	
Metrics	Completeness, acuity, time	Completeness, acuity, time, return to start	

Table 1. Search test configurations summary.


Viewable from below
Height = H
Viewable from above
Height = 0.25H
Viewable from the front
Height = Ground level

Intended deployment environment	Apparatus clearance width (W)	Minimum wall height (H)	Ratio (W:H)	Linear rail length (L)	Target buckets/ pipes (T)	Visual acuity targets (V)	Linear rail height: 0.25H	Linear rail height: 0.5H	Linear rail height: 0.75H
Hallways and rooms	**120 cm (48 in.)**	**240 cm (96 in.)**	**1:2**	**90 cm (36 in.)**	**10 cm (4 in.)**	**8.3 cm (3.25 in.)**	**60 cm (24 in.)**	**120 cm (48 in.)**	**180 cm (72 in.)**
Bathrooms and closets	60 cm (24 in.)	240 cm (96 in.)	1:4	45 cm (18 in.)	5 cm (2 in.)	4 cm (1.5 in.)	60 cm (24 in.)	120 cm (48 in.)	180 cm (72 in.)
Public transportation	60 cm (24 in.)	180 cm (72 in.)	1:3	45 cm (18 in.)	5 cm (2 in.)	4 cm (1.5 in.)	45 cm (18 in.)	90 cm (36 in.)	135 cm (54 in.)
Cluttered interiors	60 cm (24 in.)	120 cm (48 in.)	1:2	45 cm (18 in.)	5 cm (2 in.)	4 cm (1.5 in.)	30 cm (12 in.)	60 cm (24 in.)	90 cm (36 in.)
Constrained spaces	30 cm (12 in.)	120 cm (48 in.)	1:4	22.5 cm (9 in.)	2.5 cm (1 in.)	2.1 cm (0.8 in.)	30 cm (12 in.)	60 cm (24 in.)	90 cm (36 in.)
Confined spaces	30 cm (12 in)	90 cm (36 in)	1:3	22.5 cm (9 in)	2.5 cm (1 in)	2.1 cm (0.8 in.)	22.5 cm (9 in.)	45 cm (18 in.)	67.5 cm (27 in.)
Voids in collapsed structures	30 cm (12 in)	60 cm (24 in)	1:2	22.5 cm (9 in)	2.5 cm (1 in)	2.1 cm (0.8 in.)	15 cm (6 in.)	30 cm (12 in.)	45 cm (18 in.)

Table 2. Apparatus dimensions based on intended deployment environments. The Major Rescue Robot League uses the “Hallways and rooms” scale only.

Procedure:

Perform a Test: Once the apparatus is prepared and the operator is ready, perform the procedural steps below:

(a) ***The Organizing Committee should*** **record apparatus configuration at the beginning of the event.**

(b) Start the robot outside of the apparatus.

(c) The trial starts once the start signal is given or the timer is started. The robot crosses the threshold of the apparatus to begin the test.

(d) When a target is inspected, record which target and the orientation of the Landolt Cs observed by the operator on the scoresheet.

(X) For the rectangular labyrinth, the robot shall acquire targets in order alternating between the left hand and right hand paths (see Figure 4). For the freeform maze, the robot shall acquire targets in any order but may not repeat a target for the N'th time unless all targets have been acquired N-1 times.

(e) Robot will continue acquiring targets until the end signal or the timer has elapsed.

(h) Record a fault if the robot damages the apparatus or targets significantly enough such that repairs are required to return it to the initial condition

(i) Record the number of targets inspected, compare the Landolt C orientations observed by the operator to the answer key, any faults encountered.

RoboCup Implementation:

The Remote pre-recorded and live (telecon) competitions are held within each team's facility (or a local facility), where it may be impractical to implement the full Rectangular Labyrinth apparatus according to the standard. Teams are allowed to make simplifications to the apparatus as long as the following points are adhered to.

- All of the linear inspection rails must be in the prescribed locations and orientations.
- All of the diagonal rails on the ground must be in the prescribed locations, and be of the prescribed height.
    - The rails shall be secured so they do not move when the robot drives on them. This may be achieved by securing them to a board, for instance.
- Walls need not be full height but must be high enough to block the robot's manipulator (if present).
- All of the linear inspection rails must be inspected as if the walls are full height. For instance, if the robot can only reach 1.2 m high, the walls may be 1.2 m high but the robot may not inspect the linear inspection rail within an alcove unless it is inside the alcove (even though the rail is now visible from the outside).
- Walls may be constructed of any material as long as it is opaque and does not move during the test.
- The test may be constructed in an existing hallway with a width of between 2.4 m (8 ft) and 4.8 m (16 ft) to save on fabrication cost. The dimensions of the alcoves and the distance along the hallway must still be according to the specification. There is no additional time (or other allowance) is provided for the additional traverse distance at the far end due to the increased width.