

RULES FOR RSSC HALLWAY NAVIGATION CONTEST

Revision 5/28/05

1. CONTEST OBJECTIVE

The hall contest is designed to lead to a successful demonstration of home navigation for a mobile robot. To this end, the contest is geared around activities that would be expected of a robot within a home environment. The contest de-emphasizes speed as a goal and emphasizes sensors, navigation and intelligence.

2. CONTEST ARENA

The contest will be held in the 2nd floor hallway of the Engineering building at Cal Sate Fullerton. A map of this hallway follows. The arena will consist of the 100-foot long central hallway and the two intersecting hallways at each end of the main hallway. The arena may also contain various obstacles (defined later) to make navigation more challenging. These obstacles will include the participants and the spectators. They will also be in the hallway, but their positions will generally be along the edge of the hallways.

3. CONTEST METHODOLOGY

The contests are designed for all levels of robot builders. The idea is once you have attained mastery of one level, you move on the next level contest. Contests will be regularly scheduled, but can be run anytime as long as there is a judge to certify the results.

Beginning – Level 1

Purpose: Demonstrate ability to travel a predefined course and return without obstacles. This event is to show basic dead-reckoning skills, not range sensing or target sensing.

Motivation: Provide a robot with simple navigation and mobility skills using simple encoder distance sensing and/or just power and time speed control.

The robot will be placed by its operator on a start circle. This circle will not be suitable for navigation purposes, just for judging. The starting circle position will be announced 5 minutes before the contest as X/Y coordinates in the hallway. Programming will be allowed during this period. Upon contest start, the robot must navigate from the start circle to the south end of the hallway. The door will be closed at the south end. The robot must approach the end of the hallway within two feet. This will be determined by the judge noting whether any part of the robot crosses an undefined line marked on the floor two feet from the wall baseboard. The line is undefined since it is meant to be a judging aid, NOT a robot navigational aid. The robot should pause after crossing the line for judging. After judging, the operator provides a command to the robot to continue (method at designer's option). It should then return to the original start circle as closely as possible.

Scoring will be determined after return by measuring the distance from the robots reference point to the circle center. A penalty of 6 inches (?) distance will be assessed if the robot touches the wall at the end of the hallway.

Note: this level is intended to test ONLY dead reckoning. A competing robot may have sensors installed in anticipation of higher level events (e.g. range sensors, cameras etc.). Such sensors must be physically disabled by disconnecting the wiring or placing a piece of tape (or equivalent) over the sensor.

Beginning: Level 2

Purpose: Demonstrate ability to use range sensors for navigation purposes.

Motivation: Need other localization or beacon for accuracy in locating final position. Since the robot will be placed on the starting circle with some angular error, some form of sensing will be necessary to maintain alignment within the walls.

Same contest as above except:

- The judges will place the robot accurately on the starting circle but some angular error making pure dead reckoning impossible. The angular error will be high enough to ensure the robot would hit the wall if it continues straight for the distance to the end of the hall.

Beginning: Level 3

Purpose: Demonstrate ability to travel a specified course

Motivation: More complex path using methods from levels 1 and 2.

Same contest as Level 2 except:

- The start location will be specified in advance as well as the locations of several waypoints which the robot must navigate to in order.
- When the robot reaches each waypoint, it will stop for judging until given the instruction to start again (same as in level 1).
- The score will be the sum of the distances from each waypoint.

Intermediate: Level 4

Purpose: Demonstrate ability to identify target objects on the floor

Motivation: long range object sensing ability (CMUcam etc.)

- Travel down the hallway from an unspecified starting point to the end of the hallway.
- Robot is placed on start point by judges as in level 2.
- Find one or more target tiles placed on the floor between the start point and the hall end.
- Robot is to stop over each target tile for judging.
- Scoring will be based on the highest number of target tiles found. Ties will be decided by the lowest sum of distances from each target tile.

Intermediate: Level 5

Purpose: Demonstrate ability to differentiate target objects on the floor

Motivation: add more complexity to simple object detection.

Same as Level 4 except:

- There will be two types of object
- The robot is to find and stop at one type of object
- The robot is to avoid the other type.
- Scoring will be based on the highest number of type 1 target tiles found less the number of type 2 tiles that any part of the robot passes over. Ties will be decided by the lowest sum of distances

- from each target tile. There will always be a path to get by a type 2 tile which is at least 30 inches wide.
- Note: A judge may follow closely **behind** the robot to observe if it passes over a type 2 object.
 - . (does anyone object to these being colored tiles? E.g. red and green? Or do we want to allow the robot owners to supply their own tiles?)

Advanced: Level 6

Purpose: Demonstrate ability to travel a course with sparse obstacles, and ability to control robot between points.

Motivation: Demonstrate obstacle detection and navigating around obstacles and still able to traverse course.

Same contest as Level 2 except:

- Three Obstacles will be placed along the course that the robot must go around. There will be one close to the left, middle and right guaranteeing that a robot may hit an obstacle no matter where it starts.
- The door at the south end of the hallway will be opened. The robot must pass completely through the door and stop within two feet of the following wall.
- When the robot reaches the destination, it will stop until given the instruction to start again (same as in level 2).
- The final winner will be the robot who is closest to the start/end point. A penalty of 12 inches will be assessed for each obstacle or wall which is touched (other than by a sensing device like a whisker; a bumper is NOT a sensing device).

Note: following classes will get more details after we see how things are going.

Advanced: Level 7

Purpose: Demonstrate ability to travel entered course with obstructed paths.

Motivation: When traveling indoors, the direct route to a place may be obstructed.

Same as Level 6 except:

- There will be more obstacles, and there can be false passages similar to a maze requiring backtracking.

Advanced: Level 8

Same as Level 4 except:

- There will be a variable number of points to traverse (does not necessarily return to starting point).
- Any one of the points may have no open path to it. If not, then the robot must indicate this, and proceed to the next point on the list.

Advanced: Level 9

Involves the RSSC classroom and ability to recognize doors.

- One waypoint will be located in the RSSC classroom near the wall near the hallway (chairs can be removed?). One or both doors may be closed. If there is no path, then robot indicates that a door is shut and continues. Note that the indication for a blocked waypoint and a shut door should be different.

Master: Level 10

Since the ultimate goal is to lead to being able to enter closed rooms, this goal incorporates partially closed doors.

Unfortunately, this one eliminates really small robots.

- One or both doors may be only partially shut. If so, the robot must push the door open and proceed to waypoint.
- Certain locations in the hall or classroom will have designated aliases (classroom, elevators, doorway, etc.) Waypoints will be referenced by the aliases.

Master: Level 11

Incorporates shut doors.

- One or both doors may be shut. If so, the robot must open the door open and proceed to waypoint.

Master: Level 12

Requires position determination

- Robot is placed in unknown location in the hallway. Robot must figure out where it is and travel to a specified unmarked waypoint.

4. ROBOT SPECS

There is no limitation on robot size or weight. Practical limitations will be imposed by the other contest rules listed herein. e.g. Obstacles must allow a minimum path for the robot to traverse of 30 inches in width. Hence a robot of more than 30 inches width can not succeed

The robot must be totally autonomous after it is started.

Offboard processors are legal, but discouraged.

5. OBSTACLES

Initially, obstacles will consist of cardboard boxes. In the future, other obstacles may be added. The boxes may be of any size between 12 inches and 26 inches in length and width. All boxes will have a minimum height of 12 inches and a maximum of 48 inches. Boxes may be painted in primary colors (R, G and B) with a flat paint to promote use of cameras to assist navigation.

The trash cans available in the building may also be used as obstacles. These cans meet the dimension requirements for boxes above and are a dark brown color.

Obstacles will be placed in the hallway by the judges in such a way as to make simple wall following or hall center following navigation impossible.

Obstacles will always leave a path for the robot to pass of at least 30 inches in width. This will permit both large and small robots to complete with similar difficulty.

Future obstacles might include chairs, moving people, etc.

6. OBSTACLE RULES

Since these simple obstacles may be combined in such a way as to make very difficult challenges, these rules will provide some indication to the robot designers of what situations they must design for. All of these rules are subject to change in the future when this gets too easy.

- a. Boxes will be oriented parallel to the walls of the hallway to facilitate detection by sensors oriented with respect to the hallway. Boxes may be placed at arbitrary angles in future events.

- b. Boxes will not be placed within 10 feet of the start circle or a specified waypoint.
- c. Boxes will not be placed within 10 feet of the doorways at the ends of the main hallway or in the intersecting hallways at the end.
- d. The obstacles will not present dead-end paths (prior to level 7).
- e. Classroom doors will be closed.

A drawing that follows shows examples of legal box locations.

7. START CIRCLE

The start circle will be a 12 inch diameter circle of white paper or cardboard taped to the floor. The circle will be solid white (not an outline of a circle). Taping will be done with double sided tape to ensure the circular appearance is not changed.

Initial testing indicates that a white circle has relatively low contrast on the light colored floor. In addition, the overhead florescent lights have large white reflections on the floor. Also, some contestants have requested a circle with specific mark on it to aid in image recognition. Hence, for the time being, the contestants can bring their own circle if they want. It should be 12 inches in diameter with the center clearly marked for judging.

The robot must start centered on the circle.

The start circle will be located anywhere in the north end of the hallway. Its center will be at least two feet from a wall.

Some members desire to enter relatively small and slow robots. To accommodate these, contestants can petition the judges to shorten the course for their robots. The distance should only be shortened enough to permit the robot to run the course in under the time limit. It should not be shortened in such a way as to give the smaller robot more time to solve navigation problems. The change in distance and obstacle placement will be left to the discretion of the judges.

A drawing that follows shows examples of legal start circle locations.

8. BEACONS

Also, for initial contests, it will be permissible for the robot to have a beacon(s) placed in the contest arena. Such beacons should provide general information about the location of the robot in the hall way and no directly indicate the pathway of the contest.

9. COORDINATES

When required, locations of start and end circles as well as waypoints will be given in inches from the northwest corner of the hallway as defined in the following map. Coordinates will always be to the center of the reference object unless stated otherwise.

10. STOP FOR JUDGING

When the event requires the robot to stop at a waypoint etc. for the judge to make a determination, the robot shall stop at the position to be scored. When the judging is completed, the operator will be given permission to proceed. The operator may use any method to tell the robot to continue which does not require programming; e.g. a button, a sound, voice commands, a light, whatever).

11. ROBOT REFERENCE POINT

When the event requires measurement of the distance from the robot to a waypoint etc., the robot must have an identified point on the robot to which the measurement is to be made. This point should be shown to the judges before the event starts.

12. SPECTATORS

As there is no convenient place for people to watch the contest from, the hallway will also hold the spectators. This will make the contest more challenging as the people will appear as additional obstacles to the robots. However, we don't want to make it too difficult (yet), so the following rules apply.

Spectators must stand close to the edge of the hallway as the robot passes. A spectator may move away from the side of the hall, but must not come closer than 10 feet to the robot.

Spectators must not stand within 10 feet of the start circle or an obstacle on the side that the robot is approaching from.

13. PROCEDURE

The judges will select a location for the starting circle and the obstacles. Contestants will have an opportunity to see the course before starting but it will not be legal to make any changes to the robot's programming or provide course information to the robot in any other manner.

For now, the start circle will be in the north end of the hallway and the course will go to the south. This may change in the future.

The contestant will position his robot in any orientation desired over the starting circle.

When the judge says to start, the contestant will start the robot by any means desired. The time limit will start when the judge says "start", not when the robot actually starts.

14. SCORING

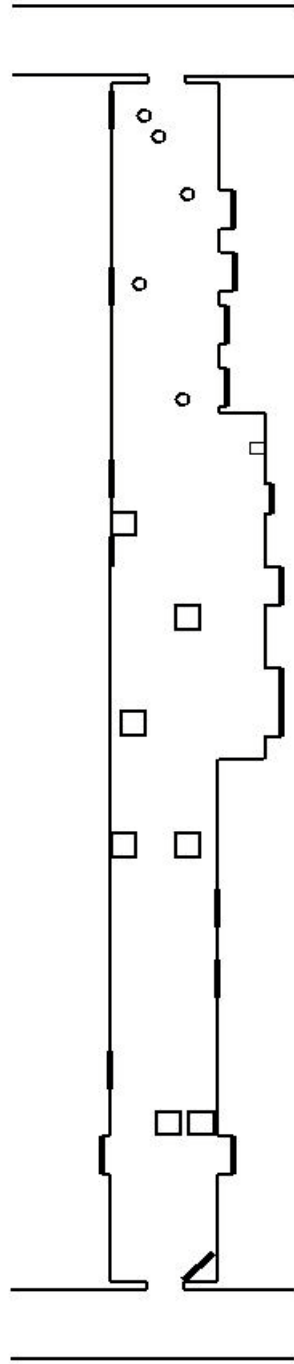
See above for each specific level of competition

If the robot pushes an obstacle more than 1 foot, it is disqualified.

If a robot hits an obstacle or a wall more than 4 times, it is disqualified. Touching a wall with a whisker type sensor is permitted.

15. TIME LIMIT

This contest is over a long distance and with many obstacles to slow the robot's progress. In order to ensure that the contest doesn't take too long, the robot must complete the course within 4 minutes or be disqualified.



Examples of legal locations
for start circles and obstacles.

