

ESC100 Design Challenge - 2009
ROOMBA CHALLENGE

MOTIVATION

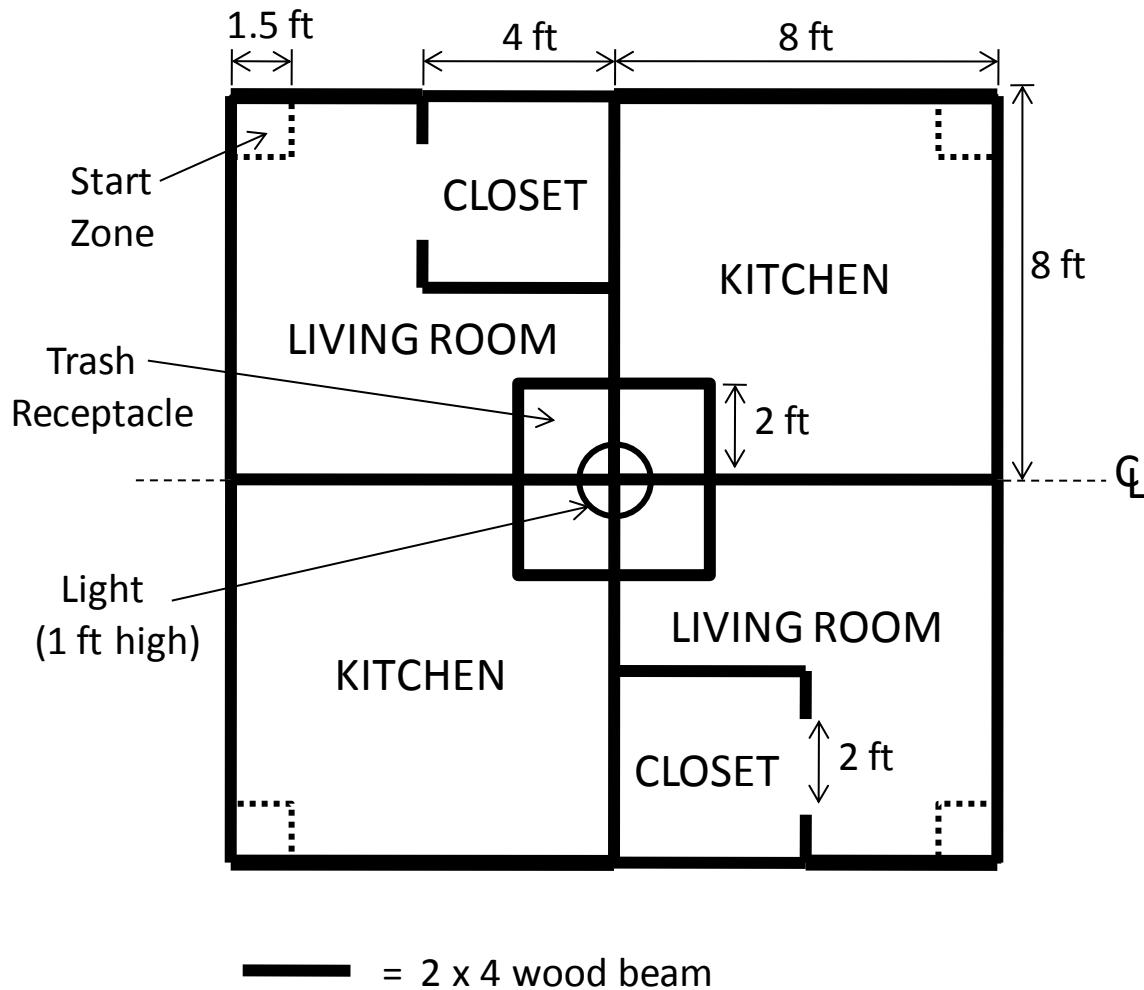
The Roomba self-piloted vacuum cleaners are inspiring a new generation of household robots aimed at improving quality of life at home.

PROBLEM DEFINITION

Design a machine to remove simulated dirt and food particles from the floor of two different rooms. It should also have one capability that the Roomba does not have – that of being able to deposit the captured food and dirt particles in a centrally located trash receptacle.

ROOM LAYOUT

Your machines will be tested on the room layout shown in the figure below.



The perimeters of the rooms and the trash receptacles will be formed by assembling pre-cut 2"x 4" wood beams on the floor, where the 2"x 4" designation implies that the actual width and height of the perimeter will be 1.625 in and 3.625 in, respectively.

There are two different rooms – the kitchen and the living room (which includes a closet). An identical pair of rooms is provided to speed up testing. Both the kitchen and the living room must be navigated by your machine, though in separate rounds.

A light source will be located 1 ft above the center of the test area to aid in navigation.

DIRT AND FOOD PARTICLES

The dirt particles will be represented by plastic (wiffle) golf balls. The balls will be positioned at specific locations on the floor of each room. Since these locations will not be revealed until the day of the final competition, you should consider them as randomly distributed within the rooms.

Each room will contain 36 plastic golf balls. Of the 36 balls in the living room, half of them will be placed in the closet. The closet balls will be of a different color so that they may be distinguished from the others when adding up the scores.

In addition to the 36 balls, each kitchen will be littered with 4 plastic/toy food items positioned at specific locations on the floor. Here again, these locations will not be revealed until the day of the competition. The 4 food items are: a French fry, a banana, an egg (hard-boiled) and a potato chip.

The plastic golf balls and toy food items will be available for inspection on the day these rules are distributed.

TIMED TRIALS

The duration of each timed trial is 2 minutes. It can end earlier if, in the judgment of the team, no additional points will be scored.

Each machine must undergo 2 timed trials, one in the kitchen and one in the living room. In the first of **two preliminary rounds**, half the teams will be tested in the kitchen and the other in the living room. In the second round, teams switch rooms.

The 4 machines with the highest total score in the two preliminary rounds will qualify for the **two final rounds**. In both final rounds, all 4 teams will be tested simultaneously. In the first of the two final rounds, the two machines with the highest total score in the preliminary rounds will have their first choice of rooms. In the second round, teams switch rooms. Team with the highest total score in the two final rounds will be declared the winner.

The teams must adhere to the following procedure during the timed trials or risk disqualification:

- 1) When 'on deck' for your first timed trial, take your machine to the judge's table and have it checked for adherence to the rules. Machines that are in violation of the rules may still participate in the preliminary rounds, but will not be eligible for the final rounds.

- 2) When it is your turn to test, place your machine in the Start Zone such that no part of the machine extends beyond its perimeter and make any final adjustments before the 30 sec setup time is up. During the setup time, also instruct the referee on how to switch off your machine.
- 3) At the signal of the referee, switch on your machine and watch, ceasing all further contact and communication with the machine. You may want to remain low near the perimeter of test area so that other observers can have a clear view of your machine in action.
- 4) When the referee switches off your machine to conclude the trial, remain out of the room and do not touch the machine or its cargo until the referee has had a chance to tally your score.
- 5) Finally, remove your machine from the test area and return the plastic golf balls and food items to their designated locations.

SCORING

Scoring of performance is based on the status of the balls and food items at the conclusion of each timed trial, at which time each of the balls and food items will be assigned a score as follows:

- +10 = if food item has been deposited in the room's trash receptacle
- +10 = if closet ball has been deposited in the room's trash receptacle
- +5 = if ball has been deposited in the room's trash receptacle
- +3 = if food item has been captured¹ by the machine
- +1 = if ball has been captured by the machine
- 0 = if ball (or food item) remains free on the floor of the room

Final performance score is the sum of the point totals from the two timed trials.

Maximum possible scores are 220 for the kitchen and 270 for the living room, so that the highest possible final performance score is 490.

ADDITIONAL RULES

- 1) Vehicles must be a single unit.
- 2) Vehicles must at all times fit within a cube 13" on a side
- 3) No vehicle can damage, or be attached to the playing field. All must move in a way that does no harm to the field.
- 4) All vehicles using batteries must include in their circuits a length of fuse wire between one pole of each battery pack and the next connected component. No vehicle may use more than eight AA batteries, or any other kind of battery.
- 5) The Board of Education microcontroller board and the servomotors must be mounted in a way that can be removed after the competition and returned undamaged.
- 6) Imaginative strategies in the spirit of the game are encouraged. However, any strategies

¹ "captured" is defined as being confined within the machine such that manual translation of the machine in any horizontal direction (forward, back, side-to-side) will result in the ball (or food item) moving with the machine.

determined by the judges to be contrary to the spirit of the game will be excluded. Contestants have the responsibility of clearing with the judges before the competition any strategies that might possibly violate this rule.

RESOURCE LIST

LIST OF PARTS PROVIDED

- one 11-7/8" x 11-7/8" x 1/4" Plywood Sheet
- one 15" x 20" Foamboard Sheet
- two 3/8" x 3/8" x 24" Bass wood beam
- one 3/8" x 36" Hardwood rod
- 10 Large Craft Sticks AKA tongue depressors
- one 3" x 36" x 3/32" Balsa sheet
- two Parallax continuous rotation servos
- two Boe-Bot Wheels and Tires
- one Tamiza 4 speed Crank Axle Gearbox and Motor
- one plastic ball caster
- two 6-32 Threaded Rod with eight nuts and washers
- two 4-AA battery holders
- one Parallax Board of Education microcontroller board with BASIC Stamp Processor Module
- one box of paper clips
- two light sensors
- 4 contact switches

BATTERIES

- Teams must purchase AA batteries for the microcontroller.

CONNECTORS

- Teams may purchase simple and inexpensive connectors, both mechanical (e.g., screws, nails) and electrical.

OPTIONAL PARTS FOR THE TAMIYA MOTOR

- A circuit design and parts that will allow the Tamiya motor to be reversed will be provided to those who would like to implement it.

TOOLS IN YOUR TOOL KIT

- Philips and regular screwdrivers
- Wire cutters
- Pliers
- Xacto knife
- Tape measure