Scheduling and Motion Planning of iRobot Roomba

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Introduction

This paper is concerned with the developing of the next model of Roomba. Paper presents a new feature that allows the robot to resume its work after sections of charging. Paper also modeled the robot's working behaviors under different battery storage conditions. We simplify and approximate ancillary parameters, while focusing on features associated with the self navigation system. The key components are expressed as a state machine. We presented the entry actions, exit actions, transition actions, and the operation solutions for each state. We also provided possible solutions and algorithm for each state. We do not, however, provide an implementation of the state machine, or test plan with the model.

Preliminaries

We would assume the robot for this research has the advanced navigation features as the company claimed. We would also simply the problem by considering only the parameters that are related to the self navigation system of the robot.

Assumption1—lighthouse sensor system
Assumption2—self navigation algorithm

Problem Formulation

Key concept 1—cleaning in a batter-reserving mode:

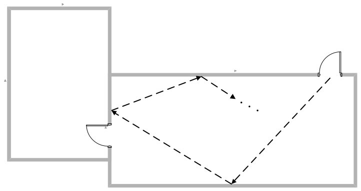

Figure 4. The original tour

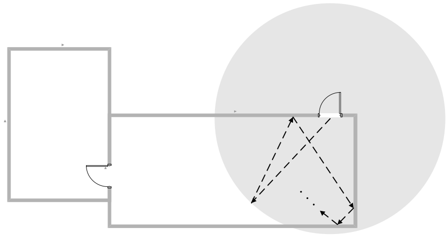

Figure 5. The tour in battery-reserving mode

Key concept 2—the shortest path on an explored map (implementation of A algorithm):*

Algorithm is designed to look for the shortest path on a grid-based continuous map. In order for the robot to travel with the minimal battery consumption, it takes the shortest path to get from place to place as fast as possible. This scenario happens when the robot needs to resume a task; when the robot runs out of battery and needs to go home; when the robot needs to get to the navigation signal.

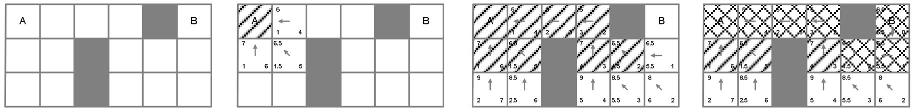

Figure 6. Implementation of A* algorithm to find the shortest path on a continue map

Configuration of the state machine:

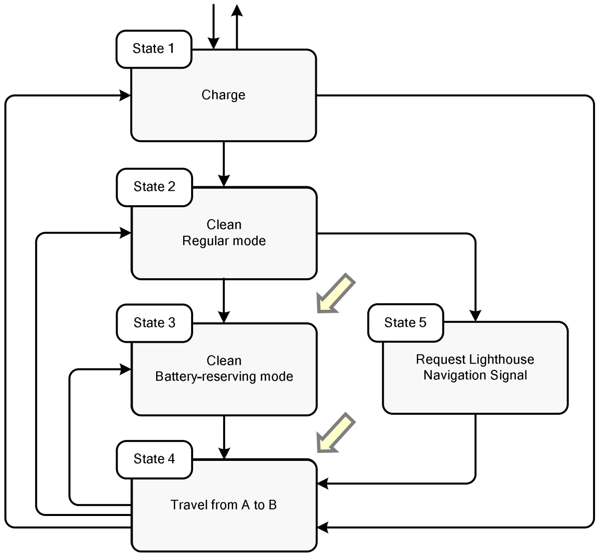

Figure 7. Problem is formulated as a state machine

Analysis of the Problem Formulation

We now analyze the state machine by defining the entry actions and exit action and the operations. Once we solve each individual state, we solve the problem conceptually.

State 1: charging

Entry action
1. Starts manually
2. Starts as self-charging

Exit action
1. Enters state 2, cleans in the regular mode
2. Enters state 4, travels from A to B
3. Enters state 6, terminates state machine

State 2: cleaning in the regular mode

Entry action
1. Starts after charging
2. Starts after finding the right position
3. Starts when entering a new room

Exit action
1. Enters state 5, requests for lighthouse signal
2. Enters state 4, travels from A to B
3. Enters state 3, cleans in battery-reserving mod

State 3: cleaning in the battery reserving mode

Entry action
1. Starts after charging with regular mode

Exit action
1. Enters state 4, travels from A to B
2. Enters state 5, requests the lighthouse signal

State 4: traveling from A to B

Entry action
1. Starts after charging
2. Starts after receiving the signal
3. Starts after finishing task in regular mode
4. Starts after finishing task in battery-reserving mode

Exit action
1. Enters state 2, cleaning in the regular mode
2. Enters state 3, cleans in battery-reserving mode
3. Enters state 1, charging

State 5: requesting for the lighthouse navigation signal

Entry action
1. Starts after cleaning with sufficient battery
2. Starts after cleaning in battery-reserving mode

Exit action
1. Enters state 4, travels from A to B