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Navigation Algorithm for Floor-Mopping Robot

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Abstract

This paper presents the navigation for a floor-mopping robot by new navigation algorithm. This algorithm is used for a robot that design of cleaning with rags. Which it makes a floor-mopping robot improved efficient. We designed the navigation algorithm using the behaviour-based structure to cover a working area as much as possible without wetting the floor too much. The effectiveness of the algorithm is tested on simulation only. The results indicated that the behaviour-based algorithm provided more completeness while maintaining low energy compared to other methods. We study other navigation algorithm compared with our algorithm. It includes with zigzag, random and our behaviour-based algorithms. From simulation results, I confirm that behaviour-based algorithm is better than zigzag and random algorithms.

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Keywords: Robot; Simulation; Navigation Algorithm; behaviour-based algorithm

1. Introduction

Thai households usually have no floor-carpet due to hot and humid weather. Therefore, the most common method to clean a floor is mop with a damp cloth. Therefore, instead of vacuum cleaning, we designed a floor -mopping to clean a smooth floor. The robot imitates the mopping action on the floor by using a cloth to clean the floor. We proposed a navigation algorithm that is suitable for mopping. The robot

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should be efficient but not wetting the floor too much. In order to cover as large area is possible. While minimizing repeatedly mops the same area

2. Navigation Algorithm

Behavior-based [1] approach is utilized to control the robot in a working area. We designed for controlling behaviors as follows.

2.1. Moving

It is the behavior for the moving of the robot from one place to another. By moving around, the robot build map according to the data from its sensors. It records the position from detecting the obstacles and the places that already visited. It uses information to decide the place to go next which it visits the next areas by a random. It rand four directions: left, right, up, down.

2.2. Avoidance

It is the behavior to avoid obstacles such as walls, objects, and etc. It uses sensors to detect obstacles and keeping data into the mop model.

2.3. Not repeated the mopping'

It is the behavior that avoid going to the former places

2.4. Measuring the pit size

It is the behavior to search for free spaces in the map model (free space is still not keep into map model). The robot will try to go to the largest space that has not been visited. We calculate the largest free space from the current map by using the component labeling [2] that is four components. We will label the value at to be zero to put in Array. Therefore, we compare the space size and prepare a sequence by large space to equal "1" at spaces small than first to equal "2" and decreasing a sequence. It uses for calculating to find the moving way.

2.5. Measuring the distance

It is the behavior to measure for finding the closet free space that has not been visited by referring to the map model. The robot tries to go to the closet space that has least repeated visit. This way distribute out four directions (four zones include "Left, Right, Up, Down") as figure 1. It keeps in such the value of distances by keeping values in the map model. It continuously keeps until meeting zero and ten values (Ten is the value of walls, Zero is the value of objects). It calculates best distance into its zone. These methods take best distance in four zones to calculate the best distance into these four zones. The formula use to find the distances as equation (1).

$$Distance_N^Z = \sum_{begin}^{End} value \quad in\ Map\ Model \tag{1}$$

When: N is the number of line for distributing into four directions.
Z is the number of line in each zones.

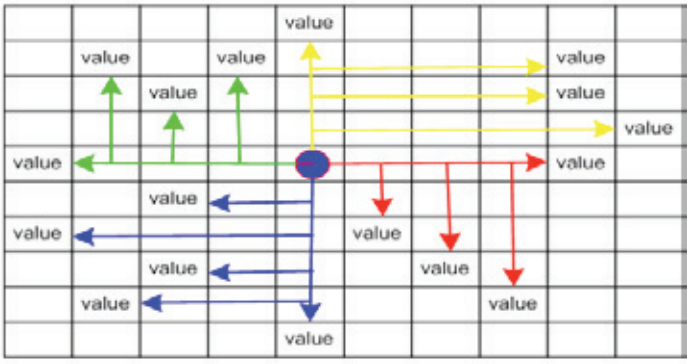


Figure 1. Showing the ways for finding distances in map model

2.6. Calculation for finding the best distance

How to find the best distances move into the no cleaning area that is the center among the ready mopping area. It find as equation (2).

$$Scores_n = Distance_n^z + PitSize_n \tag{2}$$

When: n is the number of zone in four zones.

Z is the number of line for distributing into four directions.

We obtain the value of four zones. It finds the best distances for moving between the robot and the target.

3. Simulation Results

Beginning, the robot randomly moves inside a map. The beginning value of map is all zero.

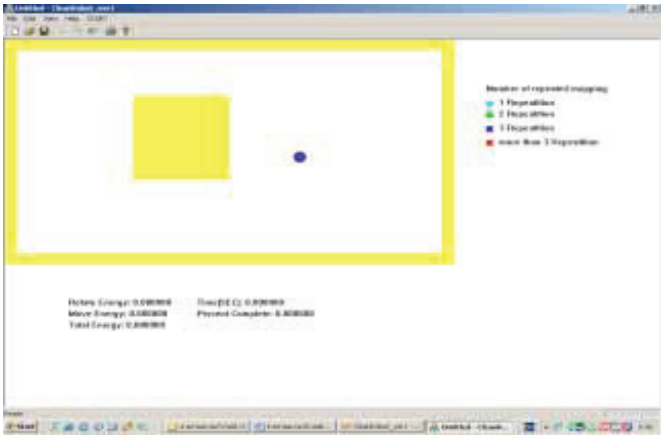


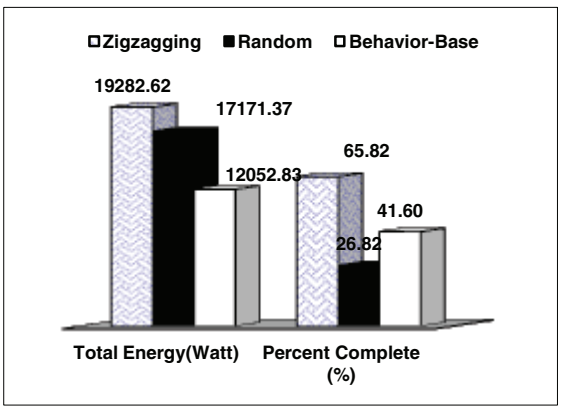
Figure 2. Beginning the simulation and the map model

For simulation, we measure the efficiency of robot. This includes the rotation energy that the indication of energy is in the moving of robot. Total energy is to sum between the rotate energy and the moving energy. All energy is "Watt". The indication of cover area at cleaning is percent complete that unit is percent (%).

Besides, we still have the indication of repeating number to divide four colours. It include sky-blue as one repeating, green as two repeating, blue as more than two repeating.

This experiment make at 120 sec. Which we divide two experiments that have obstructs and no obstructs. Such as, experiment include Zigzagging, Random, Behaviour-based. How to moving include.

1. Zigzagging move from left to right and button to below.
2. Random depend to select for the moving directions
3. Behavior-based has map model which moving same Random but it add map model for using the navigation and no repeating of moving.



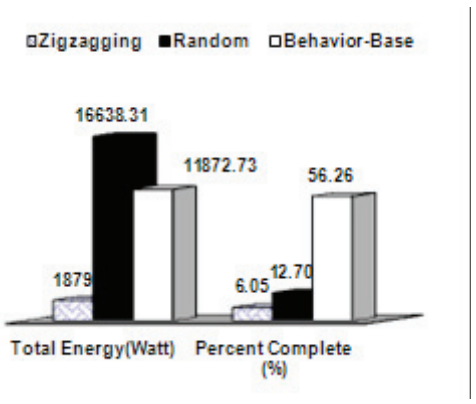


Figure 3. (a)Energy and Percent Complete at on obstacles (b) Energy and Percent Complete at obstacles

4. Conclusion

We implemented a floor-mopping robot. Its effectiveness was measured by using three navigation algorithms: Zigzagging, Random, Behaviour-based.

When there were not obstacles. The energy of zigzagging algorithm use most energies but the completeness of areas is best. The total energy of behaviour-based algorithm use little energy. While the completeness of behaviour-based algorithm was less than zigzagging algorithm but it is more than random algorithm.

When there were obstacles. The total energy of behaviour-based algorithm use energies less than random algorithm and the completeness of areas is best. The energy of zigzagging algorithm uses very little energy and completions because the robot isn't pass obstacles.

We conclude from three algorithms that zigzagging appropriate with no obstacles on area. The behaviour-based appropriate with obstacles and no obstacles on area.

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