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PATH-FINDING ALGORITHM FOR THE MOBILE ROBOT

INTRODUCTION

The man-to-robot change in the dangerous tasks becomes more and more pressing need. The air heading monitoring, archeological and rescue operations etc need robots and other autonomous or remote controlled devices for performing different actions.

PATH-FINDING ALGORITHM

The robot that can execute tasks successfully must have intelligent control system that contains path-finding algorithm with allowance for obstacles.

The path-finding tasks we can divide into two groups: with full information about obstacles a priori and without such information.

The first type usually can guarantee that route will be the shortest one or will have the lowest "cost" (for example, when there are territories with roads heaviness – swamp, sand etc). But we can`t always use them. The second one works under any conditions but route that we get can be far from optimal one.

The best solution is to combine both types of routines. At the first, the shortest route which avoids all known obstacles has been guided. If robot strikes a snag, the second type algorithm will be activated.

One of the best routines for the path-finding with known obstacles is A*.

The heuristic search evaluates each map node inverse proportion to the efficiency of the trajectory that contains this node. It means better node has less "cost".

The typical formula of the "cost" is given by

$$f(n) = g(n) + h(n) \tag{1}$$

f(n) – resulting node n cost;
g(n) – cost of the most efficient way from start to current node;
h(n) – heuristic evaluation of the cost from current node to the finish.

The length of route from start point to current has been chosed as the g(n). The distance from current point to finish ignoring the obstacles has been choised as heuristic h(n).

This algorithm is very flexible because we can add different penalties for going through “bad” regions, for example with roads heaviness or dangerous ones and A* routine will generate route taking into account all this conditions.

A* has next properties:

• it guarantees the shortest (optimal) way if heuristics h(n) is not greater than correct distance to the finish;

• number of the calculations of the f(n) is minimal.

The board tracing method has been chosen for the pass-around the unforeseen obstacles. It consits of going near obstacle border while the direction to finish is blocked by obstacle.

Thus we have chosen the combination of A* and board tracing algorithms.

ROUTE SMOOTHING

Route that we have got from A* method has some disadvantages. The main disadvantage is discreteness and aliasing. Because of square configuration of the node and crossover ia allowed to the nearest-neighbor nodes only, the route has a great number of turns. (look fig. 1)

For example, the stage on the angle of 30 degrees will be substituted with some lines on the angle of 0, 45 and 90 degrees. That is why the route smoothing algorithm had been developed. Here it is.

Step 0. Let us take two checkpoints (that are given by operator, not by path-finding routine)

Step 1. Try to connect them with the right line. If there aren`t obstacles between them then go to the step 2. If there is an obstacle then go to the step 3. If the second point is finish point, then logout.

Step 2. Replace the first point with the second point and the second – with the next checkpoint that is given by operator. Go to the step 1.

Step 3. Replace the second point with the temporary that lies in the middle of path-finding routine generated route between two current checkpoints. Go to the step 1.

Software interface and route example is shown on fig. 1, 2

ROBOT CONTROL

The Delphi program for the robot control and above mentioned algorithms implementation has been developed. Performance capabilities:

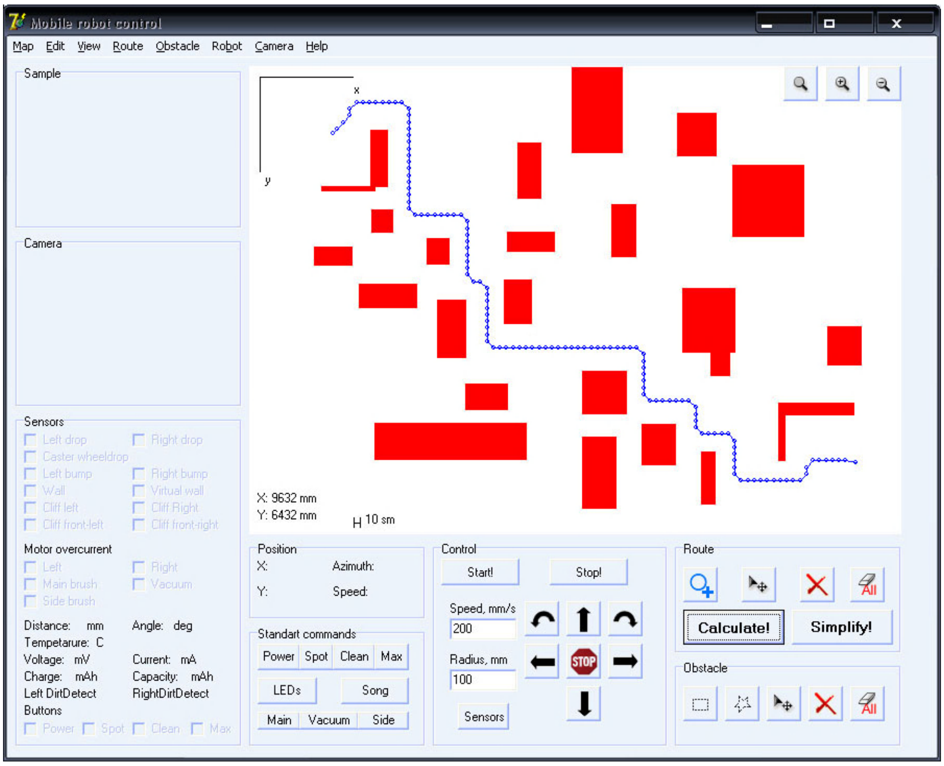

Fig. 1. Interface of the “Robot mobile control” software and route generated by A* algorithm configuration

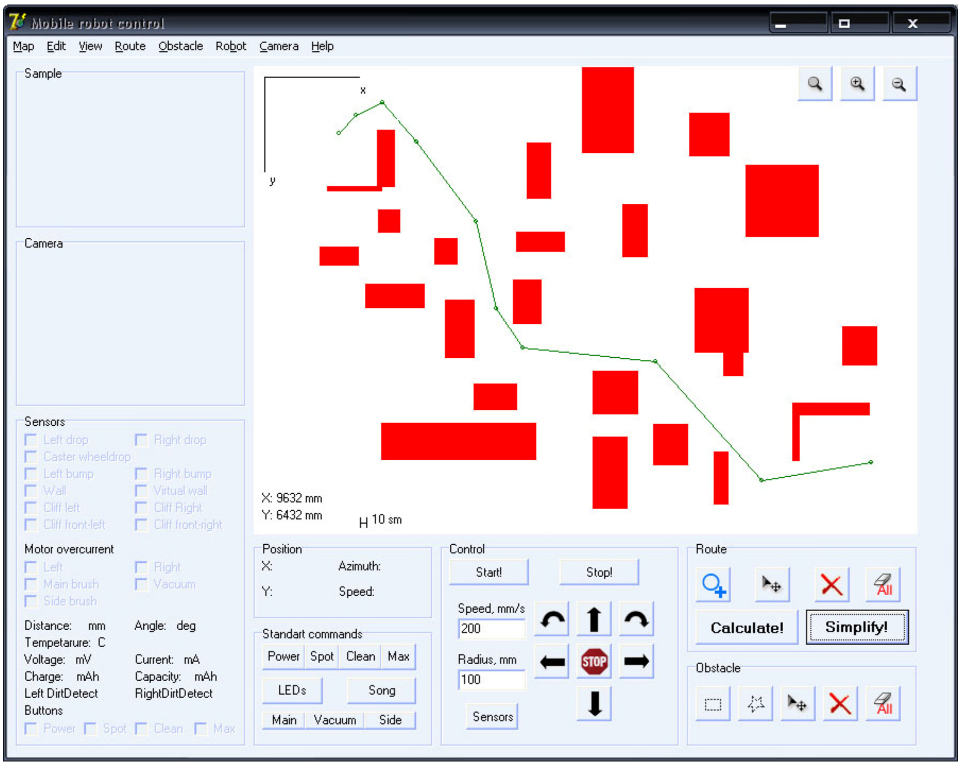

Fig. 2. Route after smoothing

- to create the map of the territory where the robot is operating and add checkpoints and obstacles by operator;

- to generate the shortest way taking into account all the obstacles and robot size;
- to trace the robot position on the map and to get full data from the robot sensors in real-time mode;
- to perform remote control of the robot if it is necessary.

Conclusion

The robot control software and hardware for the automatic and autonomous path-finding and going has been developed.

References

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