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Казьмирук И.Ю., Кирсанов М.Н. Адаптивный алгоритм выбора оптимального маршрута

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Adaptive algorithm for selecting the optimal route

В системе символьной математики Maple с использованием известного алгоритма выбора оптимального маршрута проанализировано влияние изменения геометрии среды на решение задачи. Задача сводится к построению графа возможных путей и отбраковки вариантов ребер с пересечением препятствий

Ключевые слова: оптимальный маршрут, алгоритм Дейкстры, Maple, препятствие

In the system of symbol mathematics Maple using a known algorithm for choosing the optimal route analyzed the impact of changes in the geometry of the environment on the solution of the problem. The goal is to build a graph of possible paths and sorting options of edges crossing obstacles

Key words: optimal route, Dijkstra's algorithm, Maple, obstacle

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To solve the problem of choosing the optimal route of a vessel usually involved the various methods of artificial intelligence, discrete mathematics and analysis. In many cases, the task is effectively solved by reduction to the problem of the shortest path in the graph. One of the most common for solving this problem methods is Dijkstra's algorithm [1,2]. This article analyses the influence of changes in environment on the choice of the path and its optimal length. The basis algorithm [3] developed in the computer mathematics system Maple [4]. The task is to find the optimal path among a given set of obstacles (Fig. 1). The initial (No. 8) and final (No. 16) route point are determined. The algorithm consists of two parts. First creates a complete graph of all routes with vertices at the end points of the segments. Then filtered out of the edges crossing the obstacles. Developed a routine in which the segment number k is represented in parametric form in two equations $e_{x,k} = x_{k,1}t_1 + (1-t_1)x_{k,2}$, $e_{y,k} = y_{k,1}t_1 + (1-t_1)y_{k,2}$, where $x_{k,1}$, $x_{k,2}$, $y_{k,1}$, $y_{k,2}$ the coordinates of

the endpoints of the interval (the vertices of the graph), $0 < t_1 < 1$ is the parameter. Similarly presented edges of complete graph: $e_{x,j} = x_{j,1}t_2 + (1-t_2)x_{j,2}$, $e_{y,j} = y_{j,1}t_2 + (1-t_2)y_{j,2}$, where $0 < t_2 < 1$. The conditional operator the routine is implemented, which in the case of the solution of a system of four equations $e_{k,x} = 0, e_{k,y} = 0, e_{j,x} = 0, e_{j,y} = 0$, when the conditions are met $0 < t_1 < 1$ and $0 < t_2 < 1$ (the segments intersect) excludes the edge from a complete graph. The subscripts in the subroutine k and j run through all numbers of line segments and edges of a complete graph. The corresponding fragment program has the form

```
> CrossTest:=proc(i1,i2,j1,j2) local
  t1,t2,eq,X1,Y1,discr;
  > discr:=(X[j2][1]-X[j1][1])*(X[i1][2]-
X[i2][2])+(X[i1][1]-X[i2][1])*(X[j1][2]-X[j2][2]);
  > if discr=0 then 1 else
  > eq[1]:=X1=X[i1][1]*t1+(1-t1)*X[i2][1];
  > eq[2]:=Y1=X[i1][2]*t1+(1-t1)*X[i2][2];
  > eq[3]:=X1=X[j1][1]*t2+(1-t2)*X[j2][1];
  > eq[4]:=Y1=X[j1][2]*t2+(1-t2)*X[j2][2];
  > solve({seq(eq[i],i=1..4)},{X1,Y1,t1,t2}):
  > assign(%):
  > if (t1<1) and (t1>0) and (t2<1) and (t2>0)
  then 0 else 1; fi;
  > fi;
  > end proc;
```

To the resulting graph we can apply the Dijkstra's algorithm, it is the second part of the algorithm. Figures 2 – 4 shows three variants of optimal routes for different values of the coordinates $x_6 = \varepsilon$.

Fig. 1. Obstacles Fig. 2. $\varepsilon = 10$

Schedule changes the length of the path (Fig. 5) shows that the problem can result in the conditional steady-state mode, wherein changing the position of the vertex has little effect on the quantitative component of the result is reflected only in the configuration of the route.

Fig. 3. $\varepsilon = 11$ Fig. 4. $\varepsilon = 13$

Dijkstra's algorithm in Maple is implemented in the **GraphTheory** package and is invoked by the operator **DijkstrasAlgorithm(Karta, PointBegin, PointEnd)**, where **Karta** is specified by the vertices and edges of the graph, **PointBegin**, **PointEnd** – the start and end points of the route. Let us build a chart based on the length of the optimal path from the abscissa of the point 6:

Fig. 5. The dependence of the length of the route from the coordinates of the point $x_6 = \varepsilon$

To solve the problem of an optimal route are also used neural network approaches [5], ant algorithms and their modifications [6,7]. The more difficult problem

of path selection arise in the analysis of group behavior of agents [8] and in problems with obstacles as polygons [9].

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