A Novel Approach for a Robot Traversal in an Anonymous Plane

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ABSTRACT

In the modern technological world, where top technology within affordable cost is the order of the day and robots or silico-sapiens are need of the hour, a robot with cameras and transmitter is not cost effective. So, we have tried to device an algorithm which will eliminate the need of costly devices and help us in navigating the robot. For solving the problem, we have used Fuzzy Route Planning Technique. The main input to the algorithm will be the picture of the space in which the robot will traverse. According to the input, the algorithm will find out the optimized or the shortest path between initial place to goal place and the cost that will be incurred in traversing this path.

Keywords - Fuzzy route planning technique, Goal place, Initial place, Path, Robot.

1. INTRODUCTION

Whenever we are using the services of a robot, we need a high quality camera and a transmitter fitted into the body of the robot. The camera captures the landscape that is in front of the robot and the transmitter transmits these pictures to the user who will control the robot using some mechanism. But assembling the robot with high quality cameras and transmitters would aggravate the cost of its manufacture. So we have tried and suggested a new algorithm, which will be feeded into the memory of the robot. We will need to capture the landscape in which the robot will traverse. The captured snapshot will act as the input to the algorithm. After this happens, we need to specify the start point and the end point to which the robot would traverse. The algorithm would execute and find out the shortest way to the destination and the cost that would be incurred in traversing this path.

2. FUZZY ROUTE PLANNING TECHNIQUE

The Route Planning Technique is based on Fuzzy Petri Nets. This propagates over the net the certainty value of places and transitions. The initial choice of the places' values guarantee that after their propagation, the least valued transitions are those which lead faster to the goal place. Each propagation step consists of three phases. The first one corresponds to what in fuzzy reasoning is known as Composition. In this phase the transition values from each node is updated by accumulating the estimated cost in crossing each transition. Therefore, the updated value of each transition is obtained by adding the value of the place where the transition ends and the estimated cost of transition. The second stage, Thresholding is very common in fuzzy reasoning. It assigns an arbitrary value to transition t_i such that its computed value does not exceed the activation threshold. So, the number of rejected transitions can be easily controlled. Finally the third phase, usually known as Inference in fuzzy reasoning, updates the values of the places depending on their transitions. The final value determines the actual place.

3. ALGORITHM

To solve the problem, we have used Fuzzy Route Planning Technique. As mentioned earlier, we will take a snapshot of the arbitrary plane in which the robot will traverse. Then by the processing the image, we will convert this into a graph format. The graph will contain nodes and edges. The nodes will contain values 1 and 0, where 1 represents the value of the source and the intermediate nodes and 0 will represent the destination node. The edges will notify some value, which will represent the cost that would be incurred in traversing from one node to another which the edge connects. Now, we come to the main algorithm.

I. Initialize the goal places p_g so that value $(p_g) = 0$ and rest of the values pi gives value $(p_i) = 1$.
II. While starting place p_s holds value $(p_s) = 1$
(a). Update the transitions t_i by means of expression (1)
(b). Again update the transitions t_i by means of expression (2)
(c). Update the places p_i by means of expression (3)
III. We repeat steps II (a), II (b) and II (c) until we reach the goal place p_g. We then add the values that will be stored in the nodes that will constitute the path, and get the cost that would be incurred by the traversal.

Value $(t_i) = \min[\text{cost}(t_i) + \text{value}(p_j)]$ (1)
Where, p_j is the next node the robot visits.

If value (t_i) > threshold value, discard the transition (2)

Value (p_j) = value(t_i) (3)

4. EXAMPLE

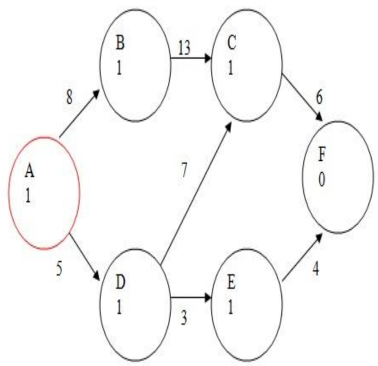

Fig 1

This graph will be the input to our algorithm. We get this graph by applying image processing to the snapshot of the area where the robot will traverse. As in the algorithm, we initialize the goal place, i.e node F to 0 and rest of the nodes including the source node, i.e node A has values 1. Node A is marked red as because the robot is situated there.

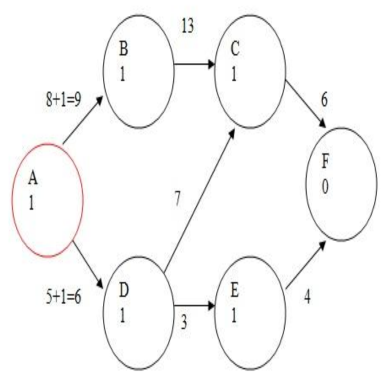

Fig 2

From node A, there are two paths, viz AB and AD. According to expression 1, we calculate the cost of both the paths by adding the cost of the edge and value of the node B and node D respectively.

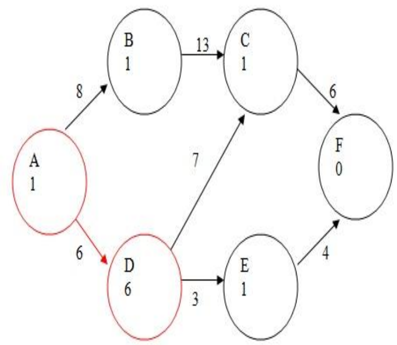

Fig 3

We see that path AD has the minimum cost. So the algorithm selects this path and the calculated cost is stored as the value of the next node, i.e value of node D becomes 6. This is done in accordance with expression 3.

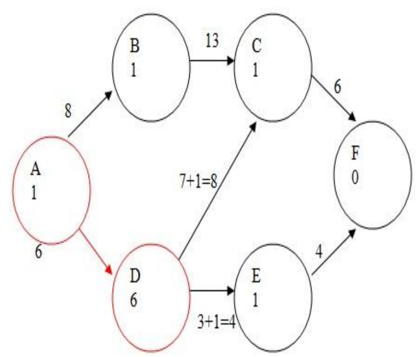

Fig 4

Now, the algorithm calculates two paths from node D, i.e path DC and path DE by adding cost of the edges and values of node C and node E respectively. This is done with accordance with expression 1.

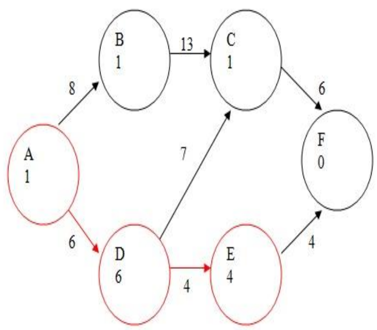

Fig 5

The algorithm finds out that path DE is the path with the minimum cost. So it selects this path and replaces the value of node E with the value 4. This is done in accordance with expression 3.

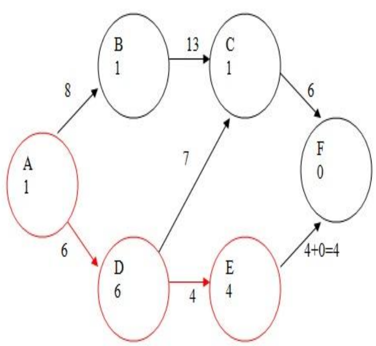

Fig 6

Now, there is only one path from node E, i.e path EF. So, the algorithm adds the cost of the edge and value of the node F. This is done in accordance with expression 1.

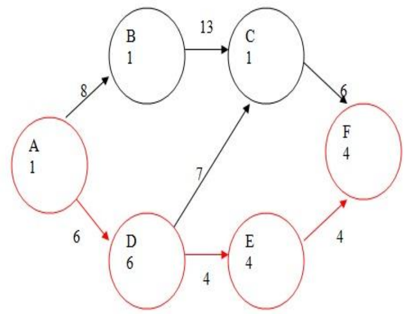

Fig 7

The algorithm selects this path and replaces the value of node F with value 4. This is done in accordance with expression 3.

We can see from the diagram that a path connecting the source node to the destination node, i.e node A to node F has been found out. Now we add the values of the nodes that comprises the path. In this case the cost of the traversal is A(1)+D(6)+E(4)+F(4)=15.

5. IMPLEMENTATION

We implemented the whole algorithm using visual basic. Instead of taking a snapshot of the area where the robot will traverse and then processing the image to get the graph representation, we have used a dynamic table to construct the graph. After creating the graph, we implemented the proposed algorithm on the graph. Some snapshots of the implementation are shown below.

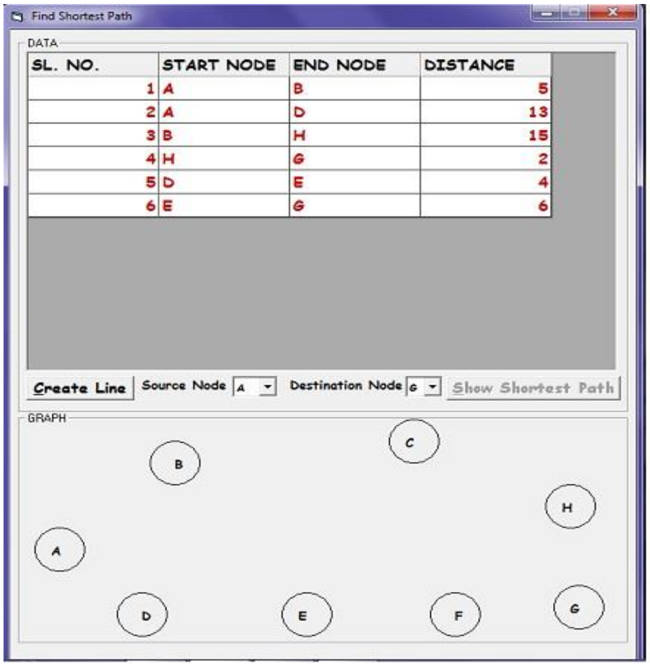

Fig 8

As told earlier, we have specified the values in the dynamically created table. We have specified the starting and the ending node.

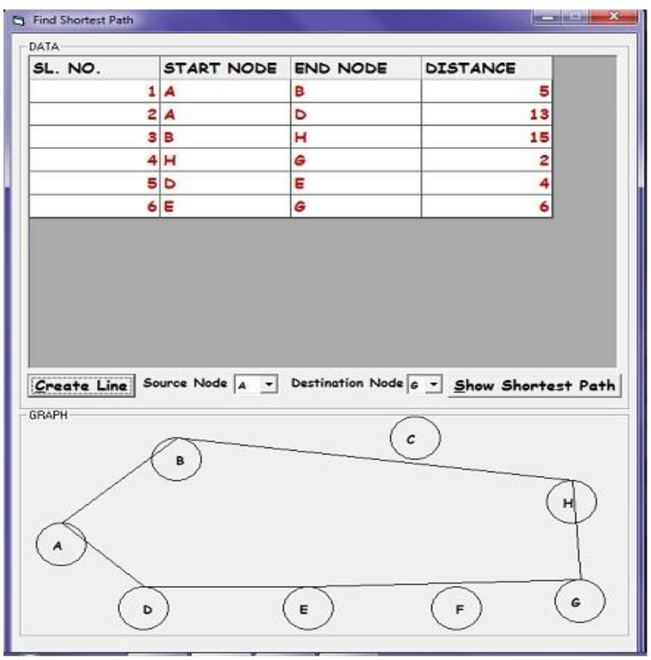

Fig 9

After we press the "create line" button, we get the following graph.

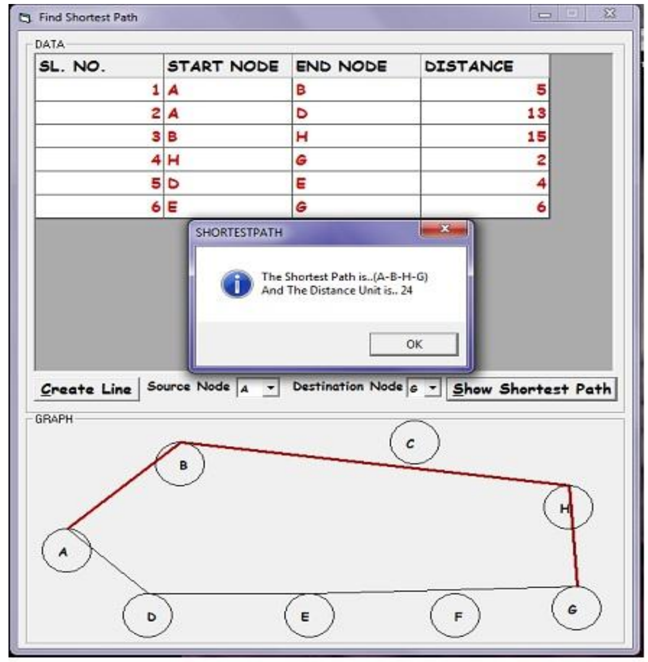

Fig 10

After this, we press the "show shortest path" button, to get the shortest path and the cost of that path.

6. CONCLUSION

We conclude that by using the proposed algorithm, we can easily feed this into the memory of the robot and find the optimized path and cost that would be incurred in traversing the path. We do not need to use external cameras and transmitters. Excluding these gadgets greatly reduces the cost incurred in manufacturing the robot.

7. REFERENCES

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