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Automatic Route Planning of Robot Based On Plant Grow Optimization

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***Abstract*—** Robots can replace worker to finish a lot of complex works in complex environment. Recently, much research work has been done in the application of robots. To which robot navigation has become one of the most popular research field. The much emphasis is on programming of a complete, deterministic algorithm which is able to generate an optimum path in real time will and allow achieving a high level of autonomy. This means, for example, that you can read the newspaper when your car takes you to work on its own. In this paper we used the plant growth optimization algorithm for route selection in obstacle environment. The plant grow optimization algorithm is multi-objective optimization technique with multiple constraints such as growing of leaf and competition of branch. The system that needs to be optimized first "grows" from the root of a plant and then continues to "grow" until you find the optimal solution

***Keywords*—** Path Planning, Robotics, Obstacles, Plant Grow Optimisation.

I. INTRODUCTION

Path preparation is one of the core content of mobile robotics research field in recent years, which is to find an optimal and collision free path from the initial point to target point. The problem of path preparation has the characteristics which are complex, more binding, and multi-objective. Traditional route planning algorithms include the Dijkstra algorithm and the A * algorithm [1]. The Dijkstra algorithm is a classic route search algorithm, and is a sort of greedy algorithm, although it is possible to plan an optimal path. The algorithm will expand from the starting point to the outside until the destination node is found. The algorithm has a high and low computational efficiency because it crosses the node. A* algorithm is a heuristic algorithm; it determines the distance from the present position to the final position through the evaluation function. A non-ideal estimation function may lead to find a bad path in a complex environment. In recent years, national and international experts and academics have presented numerous bionic intelligent optimization algorithms, such as the genetic algorithm, the artificial fish algorithm, the leapfrog algorithm, the neural network algorithm and the ant colony algorithm, which were applied to route preparation [3]. Robot path preparation is one of important issues in environment modelling. Modelling is the process of turning the reality of the physical space into the space which is understood by robot through the extraction and analysis according to the known environment information. It can effectively reduce the trouble in the process of path search. This paper divided the environment of robot into two dimensions by using the grid method, and the grids are numbered from left to right and from top to bottom[5]. In the rest part of this paper, section II- plant theory optimization, section III- proposed work, section IV- result & performance analysis and finally section V- conclusions.

II. PLANT THEORY OPTIMIZATION (PGO)

The PGO take the solution space of the problem as the growth area of the artificial plant, one point of the plant as one potential solution to the problem. The algorithm searches the optimal point in the solution space through two behaviours:

1. Producing new points by branching to search the optimal area where the optimum solution is;
2. Growing leaves around the branch points to find the accurate solution in the local area;

Given the definitions of the preceding section, formally the Plant Growth Optimization is:

Start

Initialize:

Set NG=0 {NG is the generations counter}

Set NC=0 {NC is the convergence counter}

Set NM=0 {NM is the Mature points counter}

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Set the upper limit of the branch points N and initialize other parameters.

Select N0 branch points at random and perform leaf growth.

Assign morphogen

Calculate the eligibility of the leaf point.

Assign the concentration of the morphogen of each branch point.

Branching

Select two critical values between 0 and 1 randomly and dispose.

Produce new points by branching in four modes.

Selection mechanism

Perform leaf growth in all the points.

Pick out the mature branch points, the number of which is $k\,(0 \le k \le N)$, by the maturity mechanism.

Set NM = NM + k

Produce a new point in the centre of the crowded area and select the best point to substitute the crowded points.

Eliminate the lower competition ability branch points and select N branch points for next generation.

Competition

Compare the current points with the mature points and get the best fitness value f_{max}

Set: $NG = NG + 1$

$If\ (f_{max} < f_{\max_{old}})\ Set{:}\ f_{max} = f_{\max\_old}$

If $(|f_{max} - f_{\max_{old}}| < \varepsilon)$

$Set{:} NC = NC + 1$

else

Set: NC = 0

else

Set: NC = NC+1

Check the termination criteria:

$If\ (NG < NG_{max} \&\& NC < NC_{max} \&\& NM < NM_{max})$

Goto step 2

else

Exit

Stop

One execution of the procedure from step2 through step6 is called a generation or a cycle.

III. PROPOSED WORK

Automatic route planning is an important area of research in the field of automation. In this dissertation, the plant growth optimization technique was used to plan the selection of the robot path. The plant growth optimization algorithm is inspired by the process of plant development.. The development of plants divided into three section as describe below

1. Morphogen
   In the case of morphogen check the status of plants for growing.
2. Branching
   In the case of branching check the section condition of new leaf policy
3. Termination
   Termination is final process of plant theory. The termination process gives the optimal solution of given problem

The following parameter is used for the process of path, x1, x2,…………..,xn is the path component of robot. W is the Wight factor for the path, T is the value of morphogen, c1 and c2 is contour value of path.

Step1. Define the value of path-setset S1{x1, x2,………….xn} with population

Assign the value of contour and weight of path C1=0, C2=0 and W=0

a. Morphogen selection of plant function
   $$F(s) = \frac{(Ffd - Fpf)}{Fd * fp}, wi \epsilon S(x1, x2 \ldots\ldots xn) \ldots\ldots\ldots\ldots..(1)$$

   Here Ffd is initial length and Fpf is final length of plant and w is set of path component of sum sets

The path components set the value of branch $F = \{fa1 \ldots\ldots an\}$. these branch value proceed

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for the estimation **Competition** condition of local leaf.

$$Fcom = \begin{cases} \dfrac{(T_i)^{\alpha}\left(LI_i^{S_j}\right)^{\beta}}{\sum_{g\notin s_j}(\tau_g)^{\alpha}\left(LI_g^{S_j}\right)^{\beta}} & if \quad i \notin S_j \\ 0 & otherwise \end{cases} \quad (2)$$

Here T is target value of path , and LI is the value of path difference.

Step2. Branching condition

Input the selected path for the Competition

1. Calculate the value of relative path of C1 and C2
   $\mathrm{Rf} = \frac{\mathrm{LSI}}{\mathrm{Wd}}$ Here Lsi the difference of path length.
2. The PGO estimate the final path for selection.
   $$FS=\begin{cases} \dfrac{\max\ (RF)\ -F(s)}{\max_{h=1:}(WS)} & if \ \ s_i \in f_j \quad (3) \\ 0 \quad otherwise \end{cases}$$
3. create the relative FS difference value of path
   $$\mathrm{Rd} = \sum_{\mathrm{fd}=1}^{\mathrm{n}} \sum_{\mathrm{pf}=1}^{\mathrm{m}} (\mathrm{xi} - \mathrm{fs}) \dots\dots\dots\dots\dots\dots (4)$$
4. if the value of Rd is zero the path termination condition is call

step 3 Termination

Where $Rd$is the relative difference of $T(i)$; $f_z$is the fitness value; standard deviation $S_z$and local density $D_z$are defined in formula (5):

$$\begin{cases} R_d = \sqrt{\dfrac{\sum_{i=1}^{n}(z(i) - E(z))^2}{(n-1)}} \\ f_z = \sum_{i=1}^{n}\sum_{j=1}^{n}\big(R - r(i,j)\big)\, u(R - r(i,j\,)) \end{cases} \quad (5)$$

.

Defining $d\big(z(k), z(h)\big)$as the absolute distance between the two-optimal path

$$d\big(z(k), z(h)\big) = \sqrt{\big(z(k) - z(h)\big)\big(z(k) - z(h)\big)}$$
$$= \sqrt{\big(z(k) - z(h)\big)^2}$$

$k = 1, 2, \dots\dots\dots.., N; h = 1, 2, \dots\dots\dots.., N$ and finally, path is terminated.

IV. RESULT & PERFORMANCE ANALYSIS

Table 1. Given Table Shows That Resultant of Our Implementation Robot Path Optimization Using PGO Method.

Starting coordinate	Destination coordinate	Obstacles Coordinate	Path Cost	Time (sec)
0,0	1.5,-0.4	0.8,0	0.7671	0.822457
0,0	1,1	0.8,0	0.8182	0.379877
0,0	1,1	0.8,0	0.8027	0.400567
0,0	1.5,0.5	0.8,0.5	0.9896	0.463765
0,0	1.5,-0.4	0.8,0	0.3609	0.386537
Average			0.7477	0.4786406

Table 2. Given Table Shows That Resultant Of Our Implementation Robot Path Optimization Using Proposed Method On 5 Cases Of Map.

Map	Map 1	Map 2	Map 3	Map 4	Map5
Proces s-ing Time	1.2250	0.0144 9	0.3187	0.1241	0.9697
Path Length	11.019	10.960	10.989	10.957	10.980

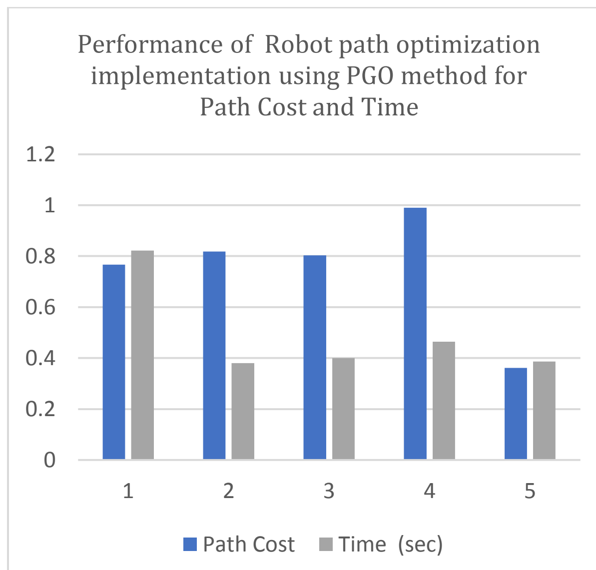

Figure 1. Graph window shows that the robot path optimization using PGO method for resultant value of Path Cost and Time in seconds.

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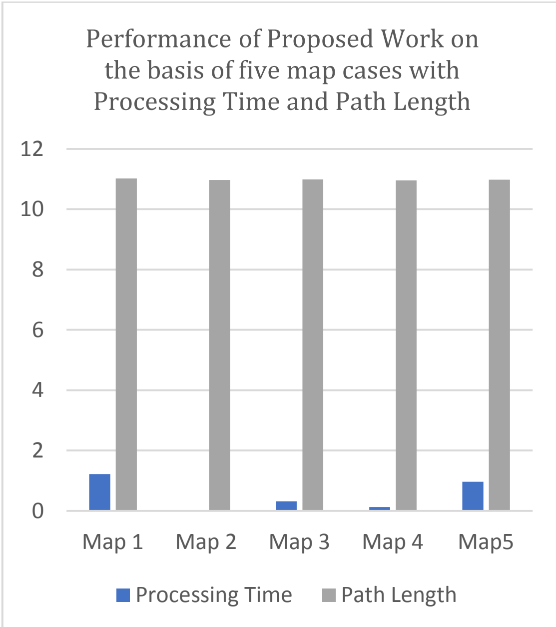

Figure 2. Graph window shows that the on the basis of five different map cases with their resultant value of Processing Time and Path Length.

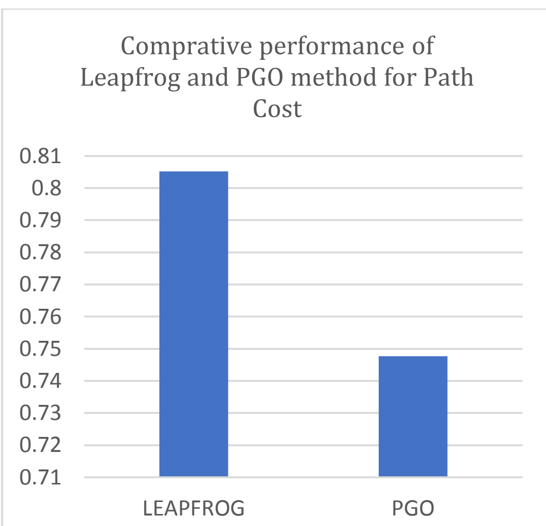

Figure 3. Graph window shows that the path finding using Leapfrog and PGO method for resultant value of Path Cost.

V. CONCLUSIONS

This dissertation modified the optimum path selection using plant grow optimization algorithm. The plant grow optimization algorithm is multi-objective function for the selection of multiple path with obstacle space. The choice of cost function is an important element that has a major effect on the optimal path. While a minimum branch is desired, some level of efficiency should be included, particularly when dealing with multiple obstacle. A cost function that includes both a minimum time element and a measure of minimizing effort is desirable. The modified path selection algorithm validated in to simulation scenario one is image obstacle and fixed path, free space path selection with single obstacle. In all two scenarios, the value of path length is optimal instead of leapfrog path selection algorithm. Obstacle avoidance was included by defining path constraints that consisted of the minimum distance between the manipulators' links. Using parametric equations to define each link, an optimization problem was formulated and simultaneously solved to determine the minimum distance between each link and any potential obstacle. In some cases, the obstacles come in path and increase the value of path cost. In the process of plant theory optimization also reduces the path selection time instead of leapfrog algorithm.

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