Efficiently Path Optimization using Modify Plant Grow Optimization Techniques

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Abstract— Robots can be used to replace worker to finish a lot of complex works in harsh environments. Recent years, many investigates have been seen in the application field of robots. For example, robot navigation has become one of the most popular research fields. The programming of an algorithm which is complete, deterministic and able to generate an acceptable path in Realtime will permit to achieve a high level of autonomy. Which means for example that you will be able to read the newspaper when your car will autonomously drive you to your job. This paper used plant grow optimization algorithm for the selection of path in obstacle environments. The plant grow optimization algorithm is multi-objective optimization technique with multiple constraints such as growing of leaf and competition of branch. The plant grow optimization enriched the search space for the selection of path in free environments.

Keywords: Path Planning, Robotics, Obstacles, Plant Grow Optimisation.

I. INTRODUCTION

Path planning 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 starting point to destination. The problem of path planning has the characteristics of complex, more binding, and multi-objective. The traditional path planning algorithms include Dijkstra algorithm and A* algorithm[1-3]. Dijkstra algorithm is a classic path search algorithm, and it is a kind of greedy algorithm, though it can plan a optimal path, The algorithm will expand from the starting point to outside until find the destination node. Algorithm has high computational and low efficiency because of traversing the node. A* algorithm is a kind of heuristic algorithm, it determines the distance from the current point to the target point through the evaluation function. A non-ideal estimation function may lead to find a bad path in a complex environment. In recent years, the domestic and foreign experts and scholars have put forward to many bionic intelligent optimization algorithms, such as Genetic algorithm, artificial fish algorithm, leapfrog algorithm, neural network algorithm and ant colony algorithm, which have been applied to path planning[4-7]. Robot path planning 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[8-12]. In the rest part of this paper, section II-proposed work, section III-proposed model, section IV- simulation & result analysis and finally section V-conclusions & future scope.

II. PROPOSED WORK

The automatic path planning is important area of research in the field of automation. In this dissertation used plant grow optimization technique for the planning of robot path selection. The plant grow optimization algorithm is inspired by the process of development of plants. 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

\[
F(\delta) = \frac{\text{wie}(x_1, x_2, ..., x_n)}{\text{pd} + \text{fp}}, \delta = \ldots (1)
\]
Here \( F_{fd} \) is initial length and \( F_{pf} \) is final length of plant and \( w \) is set of path component of sum sets

The path components set the values of branch \( F = \{fa1, \ldots, an\} \), these branch value proceed for the estimation \textbf{Competition} condition of local leaf.

\[
F_{com} = \begin{cases} 
(T_i)^{\alpha} \left( L_i I_j S_j \right)^{\beta} & \text{if } i \notin S_j \\
\sum_{\theta \in S_j} S_j (L_{\theta} \theta S_j)^{\gamma} & \text{otherwise} 
\end{cases} \quad (2)
\]

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

\textit{Step 2. Branching condition}

Input the selected path for the Competition

1. Calculate the value of relative path of \( C_1 \) and \( C_2 \)
   \[
   RF = \frac{L_{si}}{W_{di}}\quad \text{Here } L_{si} \text{ the difference of path length.}
   \]

2. The PGO estimate the final path for selection.

\[
FS = \begin{cases} 
\max_{h=1}^{\max} \frac{(RF - F(i))}{(RF - F(s))} & \text{if } S_i \in f_j \\
0 & \text{otherwise}
\end{cases} \quad (3)
\]

3. Create the relative FS difference value of path

\[
R_d = \sum_{i=d=1}^{n} \sum_{i=f=1}^{m} (x_i - f_s) \quad \ldots \ldots \ldots \ldots \ldots \ldots (4)
\]

4. If the value of \( R_d \) is zero the path termination condition is call

\textit{step 3 Termination}

Where \( R_d \) is the relative difference of \( T(i) \); \( f_z \) is the fitness value; standard deviation \( S_2 \) and local density \( D_2 \) are defined in formula (5):

\[
R_d = \sqrt{\frac{\sum_{i=1}^{n} (x(i) - E(z))^2}{(n - 1)}}
\]

\[
f_z = \sum_{i=1}^{n} (R - r(i,j)) u(R - r(i,j))
\]

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

\[
d(z(k), z(h)) = \sqrt{(z(k) - z(h))(z(k) - z(h))}
\]

\[
= \sqrt{(z(k) - z(h))^2}
\]

\( k = 1, 2, \ldots, \ldots, N; h = 1, 2, \ldots, \ldots, N \) and finally, path is terminated.

\textbf{III. PROPOSED MODEL}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig1.png}
\caption{Proposed model of automatic robotic path selection based on plant grow optimization.}
\end{figure}
IV. SIMULATION & RESULT DISCUSSION

Figure 2: Window show that the output result when using proposed method on input map-1 in our Robot path optimization project.

Figure 3: Window show that the output result when using Leapfrog method on input map-2 in our Robot path optimization project.

Figure 4: Window show that the output result when using proposed method on input map-3 in our Robot path optimization project.

Here we were showing result of different initial points, destination points with different point of obstacle.

Table 1:
Given Table Shows That Resultant of Our Implementation Robot Path Optimization Using Leapfrog Method On 5 Cases of Map.

<table>
<thead>
<tr>
<th>Map</th>
<th>Processing Time</th>
<th>Path Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.465</td>
<td>11.03</td>
</tr>
<tr>
<td>2</td>
<td>1.683</td>
<td>10.98</td>
</tr>
<tr>
<td>3</td>
<td>1.643</td>
<td>11.00</td>
</tr>
<tr>
<td>4</td>
<td>1.4789</td>
<td>10.95</td>
</tr>
<tr>
<td>5</td>
<td>1.559</td>
<td>11.00</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Map</th>
<th>Processing Time</th>
<th>Path Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5299</td>
<td>9.0198</td>
</tr>
<tr>
<td>2</td>
<td>1.1546</td>
<td>10.965</td>
</tr>
<tr>
<td>3</td>
<td>1.1543</td>
<td>10.989</td>
</tr>
<tr>
<td>4</td>
<td>0.8575</td>
<td>10.957</td>
</tr>
<tr>
<td>5</td>
<td>1.0716</td>
<td>10.980</td>
</tr>
</tbody>
</table>
V. CONCLUSIONS & FUTURE SCOPE

This dissertation modified the optimal 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 selection of collision free path used multiple branch and leaf selection process. 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.

REFERENCES

