Research Journal of Applied Sciences, Engineering and Technology 4(20): 4051-4054, 2012
ISSN: 2040-7467

Submitted: March 03, 2012 Accepted: March 24, 2012 Published: October 15, 2012

Using Regression in Bacterial Foraging Algorithm to Improve Robots Routing

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Abstract: Robots routing is usually one of the essential factors in robotics. A lot of algorithms have been proposed for robots routing like: Routing based on combined geometric methods, fuzzy logic and genetic algorithm. In the present study the Bacterial Foraging Algorithm (BFA) has been used for robots path planning. But the obtained path is not curve and there are some zigzag points in this path. In addition most of robots not able to turn or change the direction, suddenly. As a result, robots have to stop at some point of path for turn and change direction. It means a lot of waste of time and to reach the goal later. This study has combined mathematical models like Regression and interpolation, with BFA to change the path into curve. Therefore, robots can pass the path without any stoppage, so they can reach the goal sooner. In the simulation part of this study a robot was made by using Webots software and C language. The results show that the robot with the combined algorithm could reach the goal much sooner.

Keywords: Bacterial foraging algorithm, robots routing, regression, webots

INTRODUCTION

In recent years there has been a great attention to robots routing. Routing algorithms try to lead a robot from source to destination at the minimum time as well as obstacle avoidance.

Different methods try to solve this problem. Generally, there are two types of methods based on the characteristics of the environment which are called global routing in a static environment and sensor-based local routing in an unknown environment. Global methods use global information for routing in which the environment should be modeled exactly. This study examines global routing. The article first tackles different kind of robots routing algorithms briefly.

Then the BFA will be discussed. Finally, BFA is improved through mathematical methods for optimize robots routing.

LITERATURE REVIEW

Various kinds of ways have been presented to solve robots routing problem. Most of those common ways such as cell analysis or road map cannot solve problems in complex environments because of high amount of calculations (Lingelbach, 2004; Nichola Roy, 2009; Zheng *et al*. 2009). Artificial Potential Field (APF) is use frequently because of its easy for local routing. However, it will be unsuccessful due to local minimums problem. In recent years artificial implementation is also used due to its high coverage properties and its ability in simultaneous calculation (Shi and Zhao, 2009).

Some papers used Genetic Algorithm, Ant colony and neural networks to solve mobile robots routing and obstacle avoidance. Particle Swarm Optimization (PSO) is an algorithm proposed based on collective behavior of especial species of animal such as birds and fish. This method is used in robots routing due to its simplicity (Porta *et al*., 2009; Eberhart and Kennedy, 1995; Doctor and Venayagamoorthy, 2004; Chen and Li, 2006; Qin, 2004; Hao, 2007; Wang, 2006).

BFA is greatly similar to PSO algorithm. BFA was presented by Passino (2002). This algorithm is less used in robots routing. Lindour and Santoz (2006) combined GA and BFA to solve robots routing problem. That study edited the Passino paper on velocity-varying display. Finally the results compared with GA (Kim *et al*., 2007).

A group of researchers have used a combination of BFA and PSO for multi robot routing .This study used multiple robots instead of one robot for routing. The researchers believed that the main problem of using one robot is the loss/wasted time witch can be reduced by using multiple robots. This study tackled the problem of synchronization of multi mobile agents in a predetermined structure. This study suggested the use of a hybrid PSO along with a new method of local searching which is

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improved by means of BFA. This method will reduce the possibility of trapping PSO in local minimum (Prasanna and Saikihan, 2010).

METHODOLOGY

The use of bfa for robots routing: To use BFA for robots routing, a limited environment should be considered so that the bacteria are only able to move in this environment.

To start the routing operation the following information is given to the algorithm as inputs:

- Position of source and destination points
- Obstacles positions
- Number of bacteria
- Lifetime of bacteria
- length of movement step
- Cell to cell signaling period
- reproduction and elimination period

After setting the initial values, all the bacteria start to move in the environment from the source point. Each bacterium chooses a random direction and move one step toward it. Then, each bacterium compares its current position with its previous position with the following function. If the value of J (i, j, k, l) for the current position is lower than the previous position, the bacterium moves some steps toward that direction. Unless, it will choose another random direction.

$$J(i, j, k, l) = J(i, j, k,) + Jcc(\theta(j, k, l) + P(j, k, l) \quad (1)$$

Let J (i, j, k, l) denote the cost at the location of ith bacterium, in jth movement step, kth stage of reproduction and lth stage of elimination and dispersal. Let $Jcc(\theta'(j, k, l))$ represents cell tocell signaling.
And P(j, k, l) is defined as:

$$P(j, k, l) = \{\theta^i(j, k, l)|i = 1, 2, \ldots s\} \quad (2)$$

In wich $\theta^i(j, k, l)$ represents the location of ith bacterium. The next location will be calculated by the following function:

$$\phi^i(j+1, k, l) = \theta^i(j, k, l) + C(i)\,\phi\,(j) \quad (3)$$

In witch C(i) is the size of movement step and $\phi(j)$ will be used to define the direction of the next movement.

Cell to cell signaling: After every some steps, cell to cell signaling is done by all members of the population (Fig. 1). The optimal bacterium is identified by the algorithm. Then all bacteria choose their direction toward the optimal bacterium. Therefore scattered bacteria lead to the optimal bacterium wich is the nearest bacterium to the goal.

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The achieved path by BFA: Careful consideration should be given to the following issues about the achieved path by BFA:

- As mentioned before, the first bacterium that reaches the goal has travelled the shortest way in comparison with the other. Never the less, the final path is not necessarily the one that is traveled by this bacterium. So the final path is a series of optimal points that are achieved during the operation of algorithm in sequential steps.
- Since the achieved path is the result of the movements of bacteria and these movements were sometimes done with random direction, this path has a lot of breakups. By breakups, it is meant that there are some points within the path that have sudden direction shift.

In the next section, Regression will be defined and after that the way in which it is used to improve the algorithm will be explained.

Regression: Let there are some scattered points in the polar diagram. Regression is to find a curve so that the squared distance of the given points from the curve is minimum. Squared non-linear Regression is used to improve BFA. in the Fig. 2 the diagram of some scattered points are shown along with the result of the Regression on them.

The modified bfa (mbfa) with regression: Classic BFA is recalled as a function in the code of the suggested

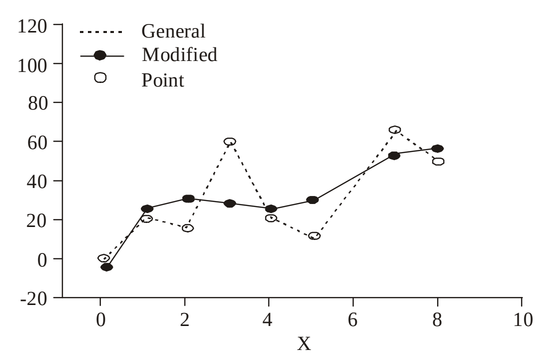

Fig. 1: Cell to cell signaling

Table 1: BFA and MBFA comparison in different environments

Algorithm	#obs	Obs 1 (m)	Obs 2 (m)	Obs 3 (m)	Obs 4 (m)	Fitness (1/t)	Length of path (m)
BFA	1	(0.8,0.9)	-	-	-	0.011	٥.0
Modified BFA	1	(0.8,0.9)	-	-	-	0.018	٣.6
BFA	2	(0.57,0.57)	(0.8,0.05)	-	-	0.012	٤.6
Modified BFA	2	(0.57,0.57)	(0.8,0.05)	-	-	0.019	٣.8
BFA	3	(0.1,0.55)	(1.1,1.05)	(0.6,1.5)	-	0.01	٤.7
Modified BFA	3	(0.1,0.55)	(1.1,1.05)	(0. 6,1.5)	-	0.021	٣.0
BFA	4	(0.57,0.57)	(1.3,1.35)	(0.9,0.75)	(0.5,1.75)	0.012	٤.7
Modified BFA	4	(0.57,0.57)	(1.3,1.35)	(1.9,0.75)	(0.5,1.75)	0.017	٤.*

algorithm. In this function the bacteria start from the source point. In each step the position of the best bacterium is saved. Once the first bacterium reaches the goal, the operation of the function will stop and the program enters second section. The pseudo code of MBFA is presented below:

// MBFA pseudo code
Main ( )
{
While(flag==true)
}
P1 Array [] [] = Original BFA function)input argument(;
P2 Array [] [] = delete dispersed point function (P1 Array) [] []

Using P2 Array [] [] to Calculate:

$$\sum_{i=1}^{n} Xi\,,\ \sum_{i=1}^{n} Xi^{2}\,,\ \sum_{i=1}^{n} Xi^{3}\,,\ \sum_{i=1}^{n} Xi^{4}\,,\ \sum_{i=1}^{n} Yi$$
$$\sum_{i=1}^{n} Xi * Yi\,,\ \sum_{i=1}^{n} Xi^{2}Yi$$

Create a system of equation with a 3*4 matrix;

[a_0, a_1, a_2] = Using gauss-elimination function (system of equation);

Set y = a_0, a_1, a_2 x_2;

For (i = 1 to n)
}

X [i] = c * n; // c is a unit to increase x, like 0.1 or 0.2 , ...
Y[i] = a0 + a1*x[i]+a2* pow)x[i], 2;

}//End of for
If (the obtained path hasn't any contact with obstacles)
Flag = false;
}//End of while

Using x[n] , y[n] to robots routing;
}

SIMULATION

In simulating this project a robot is made by Webots software that is routed from the source to the destination.

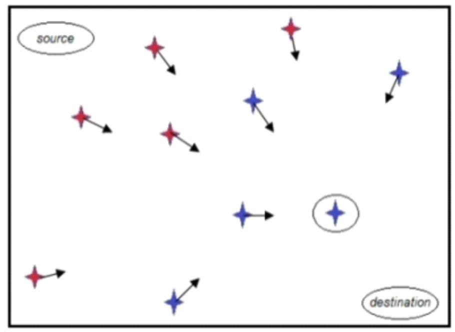

Fig. 2: General and modified path with regression

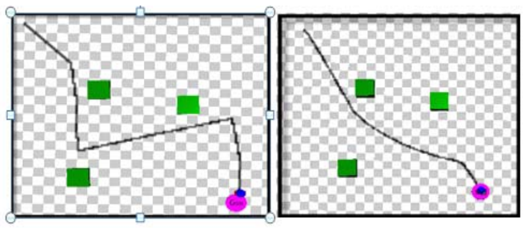

Fig. 3: The passed paths by the robots for both algorithms

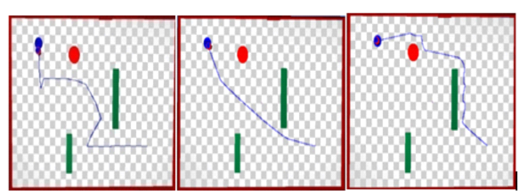

Fig. 4: The passed paths by the robots for BFA, MBFA and Q-learning

The fitness functions assumed (1/time of routing). The results from the comparison between the original BFA and MBFA are presented in Table 1.

The passed paths by the robots for both algorithms are shown in the Fig. 3.

After that we compare BFA, MBFA and Q-learning in some environment. The obtained path is show in Fig. 4

The fitness comparison between these algorithm on different environment is shown in Fig. 5.

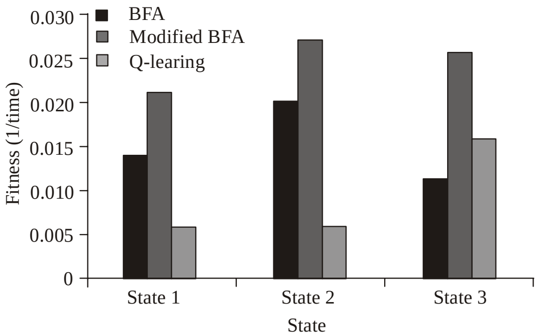

Fig. 5: Fitness for BFA, MBFA and Q-learning in 3 state

CONCLUSION

The results show that the MBFA has a better efficiency. In addition to charging the path into a curve, the algorithm also shortens the path. Moreover, it is possible to increase the length of step for bacteria's, without being concerned about the path's breakups, so that the algorithm achieves the answer faster. Finally the algorithm produces a curvilinear path.

4570 REFERENCES

Chen, X. and Y. Li, 2006. Smooth path planning of a mobile robot using stochastic particle swarm optimization. Proceedings of The IEEE International Conference on Mechatronics and Automation, pp: 1722-1727.

Doctor, S. and G. Venayagamoorthy, 2004. Unmanned vehicle navigation using swarm intelligence. Proceedings of International Conference on Intelligent Sensing and Information Processing, pp: 249-253.

Eberhart, R. and J. Kennedy, 1995. A New Optimizer Using Particle Swarm Theory. in Proceedings of The Sixth International Symposium on Micro Machine and Human Science, pp: 39-43.

Hao, Y., 2007. Real-time obstacle avoidance method based on polar coordination particle swarm optimization in dynamic environment. IEEE Conference on Industrial Electronics and Applications, pp: 1612-1617.

Kim, D.H., A. Abraham and J.H. Cho, 2007. A hybrid genetic algorithm and bacterial foraging approach for global optimization. Inf. Sci., 177 (3918-3937), ScienceDirect.

Lingelbach, F., 2004. Path planing for mobile manipulation using probabilistic cell decomposition. IEEE International Conference on Intelligent Robots System, Japan, October 2.

Nichola Roy, S.P., 2009. The belife roadmap: Efficient planing in belife space by factoring the convariance. Int. J. Robotics Res., 28(11-12): 1448-1465.

Porta, G., M.A. Montiel, O. Castillo, O. Roberto and P. Melin, 2009. Path planing for autonomouse mobile robot navigation with ant colony optimization. Appl. Soft Comput., 9(3): 1102-1110.

Passino, K.M., 2002. Biomimicry of Bacterial Foraging for Distributed Optimization and Control. IEEE Control System Magazine.

Prasanna, K. and D. Saikihan, 2010. Multiple Robot Co-Ordination Using Particle Swarm Optimisation and Bacteria Foraging Algorithm. Department of Mechanical Engineering, NIT, Rourkela.

Qin, Y.Q., 2004. Path planning for mobile robot using the particle swarm optimization with mutation operator. In Proceedings of International Conference on Machine Learning and Cybernetics, pp: 2473-2478.

Shi, P. and Y. Zhao, 2009. An efficient path planning algorithm for mobile robot using improved potential field. IEEE International Conference on Robotics and Biomimetics, pp: 1704-1708.

Wang, L., 2006. Obstacle-avoidance path planning for soccer robots using particle swarm optimization. IEEE International Conference on Robotics and Biomimetics, pp: 1233-1238.

Zheng, G., S. Ferrari and M. Qian, 2009. An information roadmap method for robotic sensor path planing. J. Intell. Robot Syst., 56: 69-98.