PATH PLANNING OF MOBILE ROBOT USING PSO ALGORITHM

Heena Momin* and Annu Abraham**

* Electronics Engineering Department, K. J. Somaiya College of Engineering, Mumbai 400077
E-mail: momin.g@somaiya.edu
** Electronics Engineering Department, K. J. Somaiya College of Engineering, Mumbai 400077
Ph.No. 8975887279, Email: annuabraham@somaiya.edu

ABSTRACT: One of the most essential tasks to be performed by a mobile robot is to find a collision-free and smooth path. This paper presents path planning of mobile robot in known and static environment. The optimization PSO algorithm is used to find the collision free safe and shortest path from starting point to the goal point. The main purpose of optimization is to minimize the resultant path length. This algorithm is motivated from social behavior of bird flocking [1].

KEYWORDS: robot path planning, PSO algorithm, static environment, optimization.

INTRODUCTION

The mobile robot are used in various environment where so many people are working or in many hazardous industries where it is difficult for people to move, in such case robot has to find the safe path from starting point to the goal point is an essential requirement [2]. The main problem is path planning from start sate to the goal state regarding to some optimization criteria. The path planning is classified into two categories: global path planning and local path planning. In global path planning robot is traveling in known environment and in local path planning the information about environment is unknown [3]. In this paper we are using global path planning.

There are many algorithms for global path planning such as potential field method [4], visibility graph method [5], cell decomposition method [5], voronoi diagrams [6], etc. but all these are classical methods and they all have their own drawback. To avoid the drawback such as high computational cost and time the heuristic technique grab the attention in path planning techniques.

Particle Swarm Optimization (PSO) is a heuristic search method. It means algorithm update the information at each iteration. Particle Swarm Optimization was developed in 1995 by James Kennedy and Russell Eberhart which is a Swarm Intelligence based stochastic optimization technique [1]. Swarm intelligence is emerging research area which is similar to genetic algorithm. Swarm intelligence used to solve optimization and cooperative problems among intelligent agents.

PSO has many advantages such as easy to implement as it requires few parameters to be tuned, fast convergence and easy to understand.

PARTICLE SWARM OPTIMIZATION

The working process of PSO is same as working process of birds, ant or fish, when bird or ant looking for food they always look for good path to the food i.e. shortest and safe path. It immediately passes on the information to the whole swarm and thus the whole swarm slowly converges towards the food [2].

In PSO, the particles of swarm are initialized by random position and velocity in a given problem space. The fitness function is calculated with these particles. The personal best of each particle is store in P_{best} and global best of each swarm is store in $G_{best.}$ In the next iteration these particles are then move to next position using (1) and (2).

$V_i^{k+1} = \omega V_i^k + C_1 r_1 (P_{best} - X_i^k) + C_2 r_2 (G_{best} - X_i^k)$ (1)

$X_i^{k+1} = X_i^k + V_i^{k+1}$ (2)

Where ω is the inertia weight. Generally, ω is equal to 1; PSO has the biggest speed of convergence when ω is between 0.8 and 1.2. C_1 and C_2 are two positive constant, usually $C_1 = C_2 = 1.2$; r_1 and r_2 are the random functions in the range [0, 1]. i =1, 2… N, N is the size of the population; k=1, 2… K. K is the maximum number of iterations [1].

PSO ALGORITHM STEPS

1. Initialize the environment which contain start point, goal point and random obstacles, particles are initialized with random position and velocity P_{best} and G_{best}.
2. Calculate the fitness value-Euclidean distance from the robot to the target, for each particle suppose z is the target coordinate and x is the current coordinate of the individual robot. y is intermediate position to go from x to z.
   Fitness= Euclidean (x,y) + Euclidean (y,z)
3. The particle fitness is compared with it's previous best fitness P_{best} for every iteration to determine the next possible coordinate position for robot in the search environment. The next possible velocity and position of each robot are determined according to (1) and (2) where v_{ibest} and x_{ibest} represent the velocity and position of the robot at k+1iteration.
4. If the next position comes into the influence of obstacle then obstacle is avoided by violation.
   Violation=violation + mean (V)
   V=max (1.2-*d*/R, 0)
   Where d is Euclidian distance between obstacle and robot, R is the size of obstacle.

If obstacle is not present robot has to move to the next position. The p_{ibest} with the best fitness for the entire swarm is determined and the global best G_{best}. P_{best} is updated with this P_{ibest}. Until convergence is reached, repeat step 2 to 5.

RESULTS

Simulation is done in MATLABR2013a.

1. Simulation output when Inertia weight is constant = 1.

Table 1. Simulation Result 1

C_1=C_2 constant value	Inertia weight (ω)	Best Cost
1.5	1	7.4717
1.2	1	7.4706
0.9	1	7.4778

Table 1 shows that Best Cost value for $C_1=C_2 = 1.2$ is best. So, in next simulations we will take $C_1=C_2 = 1.2$ and change the value of inertia weight (ω).

2. Simulation output when $C_1=C_2$ constant = 1.2.

Table 2. Simulation result 2

C_1=C_2 constant value	Inertia weight (ω)	Best Cost
1.2	0.8	7.4976
1.2	0.6	8.9331
1.2	1.2	7.4871

Table 2 shows that for $C_1=C_2 = 1.2$ and inertia weight (ω) = 1, gives the best cost value. So, these values are used to find the best cost path in PSO algorithm.

Simulation Remark

As $C_1=C_2$ increases or decreases from 1.2 the best cost value increases.

Similarly, as Inertia weight (ω) increases or decreases from 1 the best cost value increases.

Results

1. Path planning without obstacle

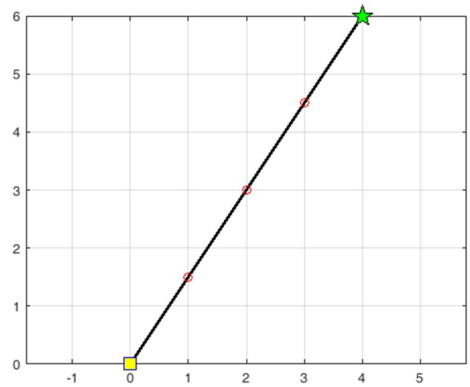

Figure 1. path planning without obstacles

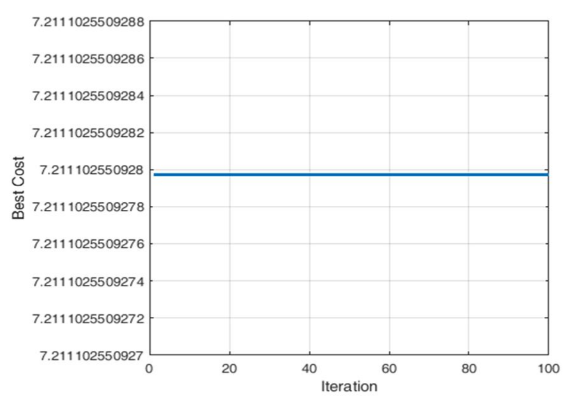

Fig.ure 2. best cost v/s iteration graph without obstacles

2. C_1=C_2 = 1.2, ω = 1, Best Cost = 7.4706

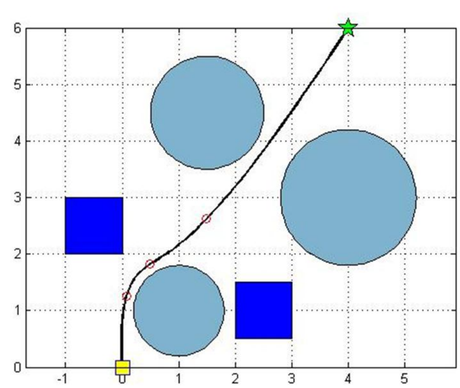

Figure. 3. path planning with obstacles

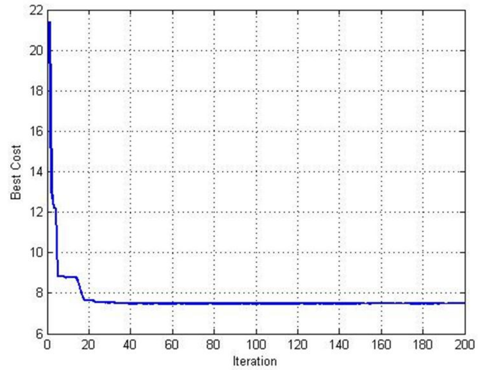

Figure 4. Best cost v/s iteration graph when obstacles present

CONCLUSION

Finding of path in static environment is done successfully using PSO algorithm. From various simulation results the proper value of process parameters i.e. constant C_1, C_2 and inertia weight value are taken. Different path planning methods are studied.

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