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RESEARCH ARTICLE

Unification of Artificial Intelligence in Robot Motion and Path Planning Via Laplacian Technique

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ABSTRACT- The paper deals with Robot motion and path planning in artificial intelligence. The aim of the paper is to develop a path planning programme for mobile robots that is based on laplacian technique.
Robot path planning problem is an important combinational content of artificial intelligence and robotics. Its mission is to be independently movement from the starting point to the target point make robots in their work environment while satisfying certain conditions. The conditions may be path collision, obstacles and optimization problems.
A Robot is an electro-mechanical device that can perform autonomous or preprogrammed task.
A Robot may act as under the direct control of human or autonomously under the control of a programmed computer. Robots may be used to perform tasks that are dangerous or difficult for humans to implement directly or may be used to automate repetitive tasks that can be performed with more precision by a robot than the employment of a human (e.g. automobile production).
Robots may be controlled directly by a human, such as remotely controlled bomb disposal robots, robotic arms, or shuttles, or may act according to their own decision making ability, provided by Artificial Intelligence.
The field of robotics is closely related to AI. Intelligence is required for robots to be able to handle such tasks as object manipulation and navigation, with sub-problems of localization (knowing where you are, or finding out where other things are), mapping (learning what is around you, building a map of the environment), and motion planning (figuring out how to get there) or path planning (going from one point in space to another point, which may involve compliant motion – where the robot moves while maintaining physical contact with an object).
One of the most difficult problems in robotics applications is developing robust autonomous motion planning. In order to build a truly autonomous robot, it must have the capability to efficiently and reliably plan a route from start to the goal point without colliding with obstacles in between. We present an algorithm for path planning to a target for mobile robot in unknown environment. The proposed algorithm allows a mobile robot to navigate through static obstacles, and finding the path in order to reach the target without collision. This algorithm provides the robot the possibility to move from the initial position to the final position (target).

Keywords: Mobile robot path planning, Behaviour-Based paradigm, Laplace's equation, Explicit Group, Four Point-EGSOR iterative method, harmonic functions.

I. INTRODUCTION

Robot path planning is about finding a collision free motion from one position to another. Efficient algorithms for solving problems of this type have important applications in areas such as: industrial robotics, computer animation, drug design, and automated surveillance Mobile robots must know where they are and specify a suitable path to the goal to navigate reliably in indoor environments; this is the task of navigation and path planning to enable the robot to reach the goal point with optimal path without any knowledge about the environment, by using wireless camera as feedback sensor.

In order to build a truly autonomous mobile robot, it must have the capability to efficiently and reliably plan a route from start to the goal point without colliding with obstacles in between. The effort of providing the robot with this path planning capability is considered one of the most challenging tasks in robotics field. Path planning algorithm attempts to deal with the problem of establishing a medium of communication between start and goal point, so that the robot can traverse the field safely.

Various algorithms exist trying to solve this problem but all have shortcomings. The difficulty is due to the complexity of path planning problem, where it increases exponentially with the dimension of the configuration space. In order to ensure completeness, every point in the configuration space has to be considered in the computation. Many global path planning methods presuppose a complete representation of the configuration space. Their main drawbacks, is that at best they are computationally expensive and often intractable. Potential field and bug approaches are local methods that do not make this assumption but are not complete methods

HEAT TRANSFER ANALOGY AND ENVIRONMENT MODEL

Path planning problem for a mobile robot operating in indoor environment can be modeled as a well-known steady-state heat transfer problem. In this heat transfer problem, the heat sources come from the boundaries and the heat sink will pull the heat in. This heat conduction process produces a temperature distribution (or in robotics better known as potential values) and the heat flux lines that are flowing to the sink fill the workspace. In a well structured mobile robot environment setup, the goal point is treated as a heat sink whilst the boundary walls and obstacles are considered as heat sources that are fixed with constant temperate values. Once the temperature distribution in the workspace model is obtained, it will be used as a guide to generate path for mobile robot to move from the start point to the goal point. The idea is to follow the heat flux that will flow from high temperature sources to the lowest temperature point in the environment model. For computing the temperature distribution of the configuration space, harmonic function is used to model the environment setup.

FORMULATION OF HALF-SWEEP SOR VIA NINE-POINT LAPLACIAN

Previously, our work utilizing half-sweep iteration produced encouraging results. It was shown that iteration using 9-point formula (also known as 9-point Laplacian) performed much faster than the standard 5-point formula. Therefore, in this study we propose an improved version by employing 9-point formula into the equation. The proposed method, called Half-Sweep SOR(Successive Over Relaxation) via Nine-Point Laplacian (HSSOR9L), would not only consider half of the whole node points in the grid but would also use 9 points in its formulation. Adding more points in the formulation would produce greater accuracy in the computation, thus leads to faster convergence rate.

As shown in Figure 1(a), full-sweep iteration involves all points in the grid. Whilst in the case of half-sweep iteration, only black points are considered, see Figure 1(b).

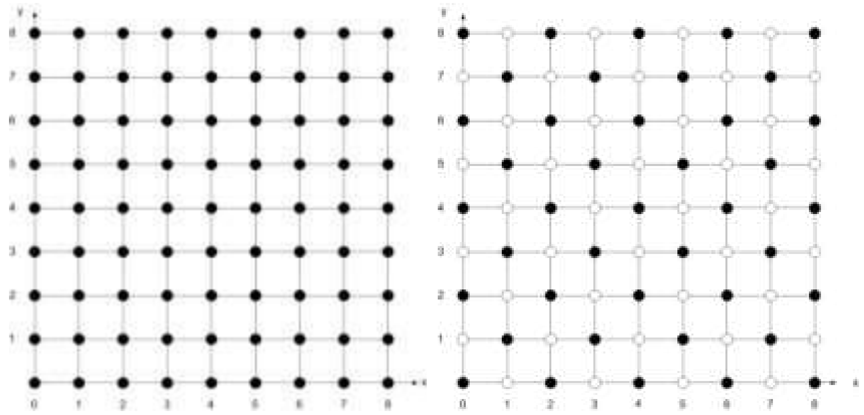

Figure 1: (a) All nodes will be considered in full-sweep iteration. (b) Only black points will be considered in half-sweep iteration.

The standard finite difference approximation of full-sweep iteration for 9-point formula uses 9-point stencil as illustrated in Figure 2(a). Meanwhile, the stencil of half-sweep iteration is essentially derived from the same 9-point stencil but rotated 45 degree as shown in Figure 2(b). This simple enhancement would lead to reduction in computational complexity since only half of the total node points are considered.

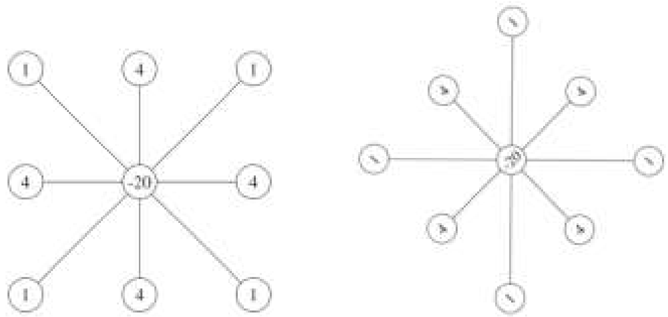

Figure 2: Stencils of 9-point formula for (a) full-sweep and (b) half-sweep iteration, respectively.

Figure 3(a) shows the five black points involve in each calculation of 5-point half-sweep iteration, whereas Figure 3(b) shows the nine black points to be considered in each calculation of HSSOR9L iterative method.

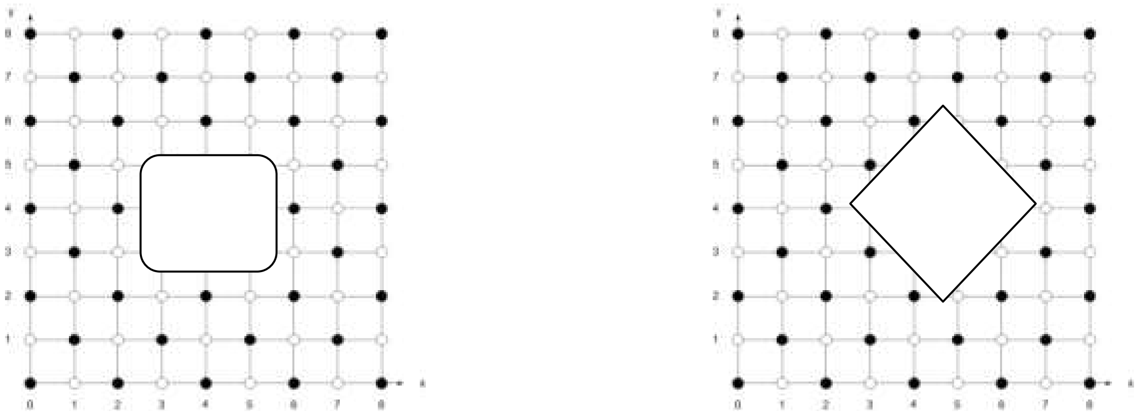

Figure 3: (a) Fives black points for each calculation of 5-point formula implementation. (b) For 9-point formula computation, nine black points are used.

II. LITERATURE SERVEY

1) Laplacian Behaviour-Based Control (LBBC) for the Path Planning of Mobile Robot Via Four Point-EGSOR
Azali Saudi, Jumat Sulaiman

- ✓ This paper proposed a behaviour-based paradigm approach known as Laplacian Behaviour-Based Control (LBBC) for solving path planning problem for a mobile robot operating in a structured indoor environment.

2) **Numerical Solution of Laplace Equation**

- ✓ This paper illustrate the numerical solution of the Laplace equation we consider the distribution of temperature in a two-dimensional. Here example is taken on temperature. But we can have good result out here so can be implanted in out thesis.

3) Applications of Harmonic Functions to Robotics

Christopher I. Connolly and Roderic A. Grupen

- ✓ Harmonic functions are solutions to Laplace's equation. Such functions can be used to advantage for potential field path planning, since they do not exhibit spurious local minima. Harmonic functions are shown here to have a number of properties which are essential to robotics applications.

4) **Navigation and path planning for robotics**

Avadhanula, Vamshi Krishna, Lingala, Narsing Mudhiraj

- ✓ In this paper we primarily concentrate on control architectures for robot navigation. We classify these architectures into three parts, deliberative – which stores configured space information to determine appropriate path across the configured space, reactive system – which have no information about space (i.e. world space) and uses sensors and set of rules for safe navigation and neural network systems that make use of neural network to determine the navigation path.

5) Real-Time Randomized Path Planning for Robot Navigation

James Bruce, Manuela Veloso

- ✓ The path-planning problem is as old as mobile robots, but is not one that has found a universal solution. Specifically, in complicated, fast evolving straints, these methods suffer from the lack of lookahead, which can lead to highly non-optimal paths and problems with oscillation.

6) Highly Automated Driving on Highways based on Legal Safety

Benoit Vanholme

- ✓ The legal safety concept proposes to base driving system design on traffic rules. This allows fully automated driving in traffic with human drivers, without necessarily changing equipment on other vehicles or infrastructure. The driving system uses traffic rules to predict legal or non legal trajectories of objects in its perception zone and worst-case objects outside its perception zone.

7) **Computational Geometry and Geometric Computing**

Vera Bazhenova

- ✓ Find a sequence of valid configurations that moves the robot from the source to destination.

8) Laplacian Behaviour-Based Control for Robot Path Planning using Full-Sweep Successive Over-Relaxation via Nine-Point Laplacian (FSSOR9L)

Azali Saudi, Jumat Sulaiman

- ✓ This paper proposed a behaviour-based paradigm approach to the path planning problem of a mobile robot utilizing fast iteration technique to compute the configuration space rapidly. The technique employs Laplacian Behaviour-Based Control (LBBC) for robust exploration of the configuration space of the robot. The LBBC relies on Laplace's equation that constraint the potential function in the configuration space of the robot

9) Path Planning for Indoor Mobile Robot using Half-Sweep SOR via Nine-Point Laplacian

Azali Saudi1, Jumat Sulaiman

- ✓ The solutions of Laplace's equation also called harmonic functions that represent temperature values distribution in the configuration space will be used to simulate the generation of path for mobile robot motion. In the past, various approaches had been used to obtain harmonic functions, but the most common method is via numerical techniques due to the availability of fast processing machine and their elegant and efficiency in solving the problem

10) Real-Time Path Planning for Humanoid Robot Navigation

Jens-Steffen Gutmann Masaki Fukuchi Masahiro Fujita

- ✓ Path-planning is one of the fundamental problems in mobile robot navigation. It has been shown long before that the problem of moving an object through space is PSPACE-hard with a time complexity exponential in the degrees of freedom of the object

11) Path planning of Autonomous Mobile robot

O.Hachour

This present work, we present an algorithm for path planning to a target for mobile robot in unknown environment. The proposed algorithm allows a mobile robot to navigate through static obstacles, and finding the path in order to reach the target without collision. This algorithm provides the robot the possibility to move from the initial position to the final position (target). The proposed path finding strategy is designed in a grid-map form of an unknown environment with static unknown obstacles. The robot moves within the unknown environment by sensing and avoiding the obstacles coming across its way towards the target.

12) Cubic Spline Solutions For Two-Point Boundary Value Problems Using Quarter-Sweep SOR Method

N.I.M. Fauzi and J. Sulaiman

- ✓ In this paper, iterative methods particularly a family of Successive Over Relaxation (SOR) methods are used to solve system of linear equations generated from discretization of second-order two-point boundary value problems through cubic spline approaches

13) Probabilistic Path Planning

P. Svestka and M. H. Overmars

- ✓ The robot path planning problem, which asks for the computation of collision free paths in environments containing obstacles, has received a great deal of attention in the last decades. In the basic problem, there is one robot present in a static and known environment, and the task is to compute a collision-free path describing a motion that brings the robot from its current position to some desired goal position. Variations and extensions of this basic problem statement are numerous.

III. PROPOSED WORK

We are using much method earlier for robot path planning. Earliest we use Grid-Based Search, Interval-Based Search, Sampling-Based Algorithms etc. All have fine accuracy but its path is not smooth. EGSOR ITERATIVE METHOD USING four -POINT LAPLACIAN to make it path smoother. But somehow there need smoother path. For more smooth movement of robots we need higher level of calculation required. We are using **NINE-POINT LAPLACIAN**. It give much smoother path for Robots.

IV. RESEARCH METHODOLOGY

Laplacian Behaviour-Based Control

Traditional approach robot programming assumes the availability of a complete and accurate model of the robot and its environment, relying on planners to generate actions [16]. Unfortunately, this approach has several disadvantages. One main drawback is that they require huge amounts of computational resources. This drawback is much obvious for an autonomous mobile robot that must carry its own computational resources. Secondly, this approach must be based on highly accurate model, thus it requires a number of high-precision sensors which are also often expensive.

In this work, inspired by the behaviour-based paradigm approach to robotics control, the searching algorithm employs Laplacian Behaviour-Based Control (LBBC) for robust space exploration of the configuration space. The LBBC comprises four core behaviours:

1. Keep-forward,
2. Follow-wall,
3. Avoid-obstacle,
4. Find-slope.

All these core behaviours make use of the potential values represented by temperature distribution in the configuration space which are computed numerically to provide guidance during search exploration.

V. ALGORITHM

1. Initialize velocity vectors $\mathbf{c}(i,j) = 0$ for all (i,j).

2. Let k denote the number of iterations. Compute values u^k, v^k for all pixels (i,j)

$$u^k(i,j) = \overline{u}^{k-1}(i,j) - f_x(i,j)\frac{P(i,j)}{D(i,j)}$$
$$v^k(i,j) = \overline{v}^{k-1}(i,j) - f_y(i,j)\frac{P(i,j)}{D(i,j)}$$

The partial derivatives f_x, f_y, f_t can be estimated from the pair of consecutive images.

3. Stop if

$$\sum_i \sum_j E^2(i,j) < \varepsilon$$

where ε is the maximum permitted error; return to step (2) otherwise.

VI. MATHEMATICS USED

- Probability
- Laplacian Technique
- Iterative Method

VII. PROGRAMMING

Matlab codes for programming

CONCLUSION

We use various algorithms exist trying to solve this problem but all have shortcomings. The difficulty is due to the complexity of path planning problem, where it increases exponentially with the dimension of the configuration space. We use Nine point laplacian method to get appreciable result and path complexity is been reduced. Here we also use of some geometrical analysis to reduce its path complexity . NINE-POINT LAPLACIAN TECHNIQUE .It give much smoother path for Robots. It proved to be very fast compared to the previous iterative methods

REFERENCES

1. Kamran H. Sedighi, Kaveh Ashenayi, Theodore W. Manikas, Roger L. Wainwright, Heng-Ming Tai. , 'Autonomous Local Path- Planning For a Mobile Robot Using a Genetic Algorithm', Vol.2, 2004, Page(s): 1338 - 1345,IEEE.
2. Anand Veeraswamy, 'Optimal Path Planning Using an Imported A* Algorithm for Homeland Security Applications ', February 2006, AIA'06: Proceedings of the 24th Lasted international conference on Artificial intelligence and applications.
3. Andrew N. Hand, Jagruthi Godugu, Kaveh Ashenyi, Theodore W. Manikas, Roger L. Wainwrightb. 'Benchmarking Robot Path Planning ', ANNIE 2005.
4. James Bruce, Manuela Veloso Real-Time Randomized Path Planning for Robot Navigation.
5. Benoit Vanholme
Highly Automated Driving on Highways based on Legal Safety. Intelligent Transportation Systems, IEEE Transactions on (Volume:14 , Issue: 1)
6. Vera Bazhenova. Computational Geometry and Geometric Computing.
http://en.wikipedia.org/wiki/Computational_geometry.
7. Saudi, A. & Sulaiman, J. 2012. Laplacian Behaviour-Based Control for Robot Path Planning using Full-Sweep Successive Over-Relaxation via Nine-Point Laplacian (FSSOR9L). International Journal of Applied Science and Technology, Vol. 2 No. 3; March 2012, pp: 255 - 261. ISSN 2221-0997.
8. Azali Saudi1, Jumat Sulaiman. Path Planning for Indoor Mobile Robot using Half-Sweep SOR via Nine-Point Laplacian. IOSR Journal of Mathematics (IOSR-JM) ISSN: 2278-5728. Volume 3, Issue 2 (Sep-Oct. 2012), PP 01-07.
9. Jens-Steffen Gutmann Masaki Fukuchi Masahiro Fujita. Real-Time Path Planning for Humanoid Robot Navigation. (http://www.ijcai.org/papers/0974.pdf).
10. O.Hachour Path planning of Autonomous Mobile robot. International Journal of Systems Applications , Engineering & Development Issue 4, Volume 2, 2008
11. N.I.M. Fauzi and J. Sulaiman Cubic Spline Solutions For Two-Point Boundary Value Problems Using Quarter-Sweep SOR Method.

