Evolutionary Cellular Automata for Optimal Path Planning of Mobile Robots

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Abstract

This poster paper summarizes a simple neural network structure of cellular automata which perfoms optimal path planning for autonomous moblie robot navigation. Primarily, the structure of cellular automata is well known for the properties of complex behaviors at the edge of chaos and distributed features. We address that a slight modification of each cell in 2D cellular automata into a winner-take-all mechanism of neural networks could achieve optimality in mobile robot path planning. The cell state of the evolutionary cellular automata contains direction and distance information which propagates through the grid connected lattice structure from start point to goal one. The evolutionary cellular automata is applied to optimal path planning of autonomous mobile robots and maze problems.

1 AN AUTONOMOUS MOBILE ROBOT

An autonomous mobile robot (AMR) carries out the given job by itself. In this paper, the AMR has the object to plan the shortest path from the start to the goal, and is considered on the physical hypotheses: 8 sensors 2 wheeled, constant speed, restricted angle to 45 degrees, relative coordinate system, and fixed sensing radius. Under these hypotheses, the AMR creates a road map avoiding the obstacles in given area. The road map is in the form of 2D cellular automata (CA) with 8 neighbor cells and each cell contains the information on the CA environment whether it is obstacle or not. A cell knows the direction of signal propagated from the start one and the distance between it and the start cell.

2 OPTIMAL PATH PLANNING

In this paper, CA based neural networks finds the optimal path by applying the winner-take-all mechanism of neural networks (Hagan et al., 1996) to the cell of a 2D CA road map which the AMR mentioned previously has created in advance. In a road map, every cell except the obstacles is considered as a neuron. It shows a basic clue that the optimal path can be acquired according to the local rule including the winner-take-all mechanism. Once the start and the goal are given, the signal propagates from the start to the neighbor cells and the process goes on. Every cell except the obstacles checks every neighbor which has the signal propagated from the start. It weighs the signal propagation distances of neighbors, then determines its signal direction and distance according to the winner, i.e the neighbor that has the shortest signal propagation distance. That is a very simple rule, so decreases the complexity of CA. For saving memories and accurate calculation, the distance information is stored as the 2 counting numbers of orthogonal and diagonal direction that the signal flowed, then converted to actual distance in real value. After the signal reaches the goal, we can obtain the optimal path easily by tracing the direction information backward from the goal to the start.

3 CONCLUSION

We applied the evolutionary CA to the AMR's optimal path planning and the maze problems. The simulations show that it can produce reliable and efficient results rapidly. Moreover, it deals with the change of environment actively to establish a new optimal path plan.

References

M. T. Hagan, H. B. Demuth, and M. Beale (1996), Neural Network Design, PWS Publishing Company.