Reinforcement Learning based Automated Path Planning in Garden Environment using Depth - 'RAPiG-D'

S. Sathiya Murthi, Pranav Balakrishnan, C. Roshan Abraham, V. Sathiesh Kumar, Srinath.B, Preethi Maha.D

Department of Electronics Engineering, MIT Campus, Anna University, Chennai-600044, Tamil Nadu, India

Introduction

- Over the years, robots have been implemented in a wide range of applications and environments and this has led to dealing with a host of environments that are increasingly dynamic and unknown. Current methods are limited by their inability to adapt to new environments.
- Path planning with reinforcement learning would aid automation of tasks with minimal human intervention and can be used to navigate and map an unknown environment and trace the best possible path between any two points.
- Stereo camera based depth mapping is better suited to identify any type of obstacle.

Reinforcement Learning

- Reinforcement learning is a machine learning technique based on rewarding desired behaviours.
- SARSA algorithm involves learning the environment by choosing actions at each state using a policy function and providing rewards for State-Action pairs.
- The algorithm is implemented in Python and an NVIDIA Jetson Nano 4GB Kit is used for hardware implementation.

Obstacle Detection

- Stereo vision is used for the computation of depth based on the binocular disparity between the images of an object in left and right eyes.
- Depth estimation is used for detecting obstacles by thresholding to identify objects within a certain distance.
- An XBOX 360 Kinect Camera is used to detect the presence of obstacles that are large enough in the immediate next cell of the testing space.

XBOX 360 Kinect Camera

Flowchart

SARSA Algorithm

Results and Conclusion

- The robot agent was allowed to explore a 3 x 3 testing space, starting at (0,0) and the destination is at (2,2).
- The agent successfully detected obstacles in adjacent cells and populated the detected obstacles and moved accurately, controlled by the MPU6050 gyro sensor.
- The agent began traversing the optimal path to reach the destination from the 5th episode.

	0	1	2	3
[0.0,0.0]	0.00	-0.010000	3.615840e-08	0.00
Obstacle	0.00	0.000000	0.000000e+00	0.00
[40.0,0.0]	0.00	0.000008	0.000000e+00	0.00
[80.0,0.0]	0.00	-0.010000	0.000000e+00	0.00
[40.0,40.0]	0.00	0.000882	-1.000000e-02	-0.01
[40.0,80.0]	0.00	0.000000	4.900995e-02	0.00
[0.0,80.0]	-0.01	0.000000	2.673090e-04	0.00
Goal	0.00	0.000000	0.000000e+00	0.00

- At the end of 10 episodes, the algorithm generates an exact map of the environment

```
The shortest route: 4
The longest route: 14
[40.0, 0.0]
[40.0, 40.0]
[40.0, 80.0]
[80.0, 80.0]
```

- Thus, a simple RL algorithm such as SARSA is used to identify an optimal path and is able to allow the robot agent to map an unknown environment.
- This implementation can be extended to larger and dynamic environments by increasing degrees of freedom.
- It can also be implemented in diversified applications ranging from garden or warehouse management, serving food at restaurants, Air crash investigations, Search and Rescue operations, and even Space exploration.

Visible Output

S. Sathiya Murthi, Pranav Balakrishnan, C. Roshan Abraham, V. Sathiesh Kumar, "Reinforcement Learning based Automated Path Planning in Garden environment using Depth - 'RAPiG-D'" in Second International Conference On Artificial Intelligence and Knowledge Processing, Woxsen University, Hyderabad (July 22-23, 2022)