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RESEARCH ARTICLE

Motion Planning Based on RRT for Autonomous Road Vehicles: A Review.

Sharad Pandey andDr. K.K. Singh.
Department of Electronics and Communication Engg. , Amity University, Uttar Pradesh.

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Corresponding Author

Sharad Pandey.

Abstract

The Rapidly-exploring Random Tree is an algorithm which is used in motion planning for autonomous vehicles which have a defined starting point and a defined ending point. The positive point in this algorithm is that it is probabilistically complete that is even in the constrained areas we get a random tree and may find a path through that area. It is very fast as compared to other algorithms such as Genetic Algorithm. There are different kinds of RRT for different application and optimization purposes. This paper compares the simple RRT algorithm with the more optimized RRT* algorithm for autonomous cars.

Introduction: -

As the times have been moving on so is the problem of driving cars and the accident due to human errors. There are more and more cars in the on the road and thus more and more traffic and this problem is nowhere going to reduce in future because the number of cars on the road is increasing day by day and will keep on increasing in future. Autonomous road vehicles came first into being in and around 1980s. Nowadays Google driverless car has been allowed testing and self-driving on Michigan'sroads according to the legislation [15].

Both of these algorithms have been very helpful in motion planning for autonomous road vehicles. As seen in the picture above the autonomous vehicle detects the object on the road and has set a new path to avoid collision with the object. Some well-known planning algorithms such asDijkstra, A*, D* and Potential Field method can plan

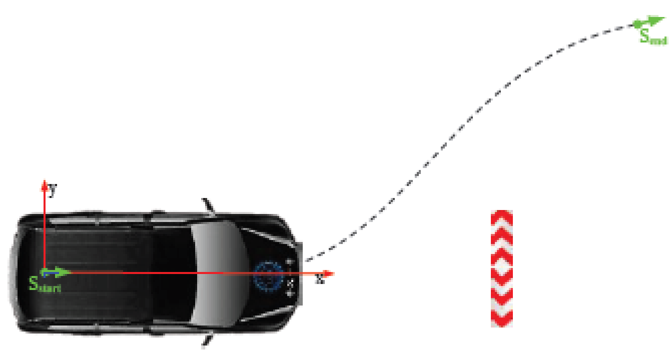

Figure 1: The motion planning of autonomous road vehicle [15]

paths and avoid the obstacles, but it is difficult to consider thecomplex dynamic and differential constraints of the vehicle [citation]. Thus in many ways RRT is a better algorithm than other but it still has its drawbacks which are being removed in current research works.

Comparison of Algorithms: -

Basic RRT: -

The basic RRT is not optimized and the branching of the nodes is randomly in all directions thus the iterations of the loop has to be increased in order to reach the goal and this eventually takes more time. The algorithm is:

- The start point and the end point is decided and since the end point is decided we know the direction of the vehicle to start with.
- Then the RRT starts the sampling of space with nodes by forming a binary tree in the space.
- Tis process goes on till on node reaches the goal.
- As the goal is reached then the program finds the shortest path to reach the goal.

These are the steps followed in the basic RRT.

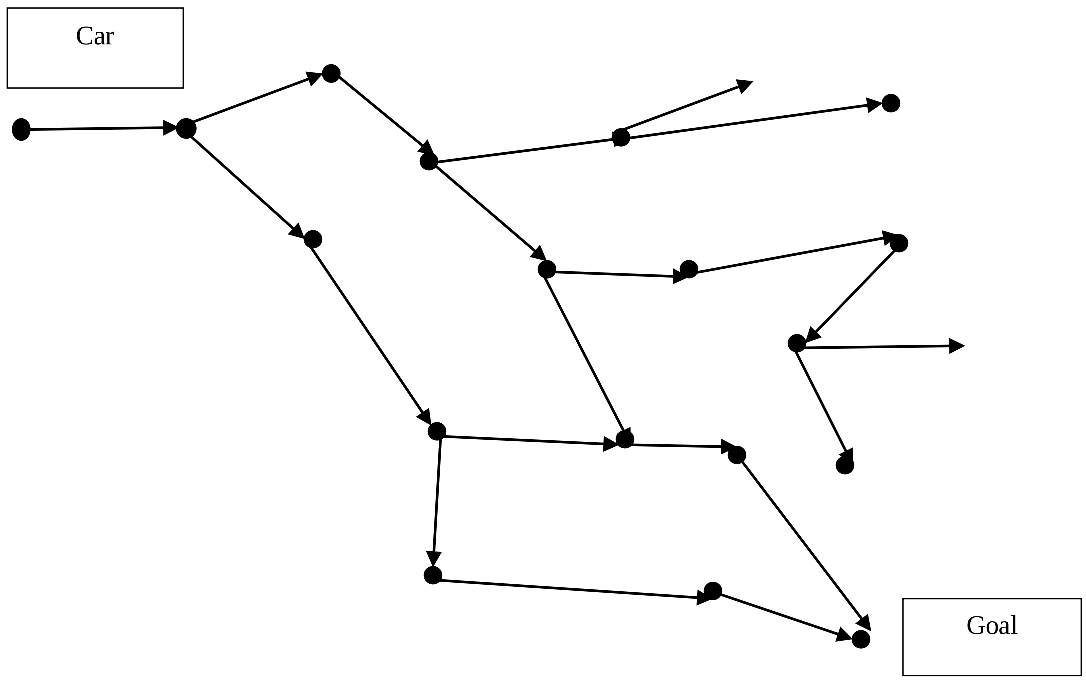

Figure 2: Basic RRT Algorithm

There are few drawbacks in this algorithm as to:

- It does not find the optimal path i.e. it might not be the shortest path.
- The path discovered may be difficult to traverse.
- The path planned by RRT is often jagged andmeandering due to the growth way of the tree. Although lots of work were presented for smoothingthe path planned by RRT, lessened meanders mightstill exist in connects of two edges. For instance, lanekeeping is the most common maneuvers for vehicleson road when without obstacles. Using the RRT isdifficult to plan a trajectory shaped like a straight linefor the lane keeping [15].

RRT* algorithm: -

The RRT* algorithm is an incremental samplingbasedmotion planning algorithm for planning in configurationspaces, and extended to handle more complex dynamicsin. In this section, the RRT* algorithm is introduced asdescribed in after slight modifications [16]. RRT* is much better than RRT algorithm as it tries to smoothen the branches of the tree and thereby creating a path which can be easily traversed by the vehicle.

It has been mathematically proved that as the number of the nodes reach infinity the tree grown in the RRT* is much more smoothened as compared to the RRT.

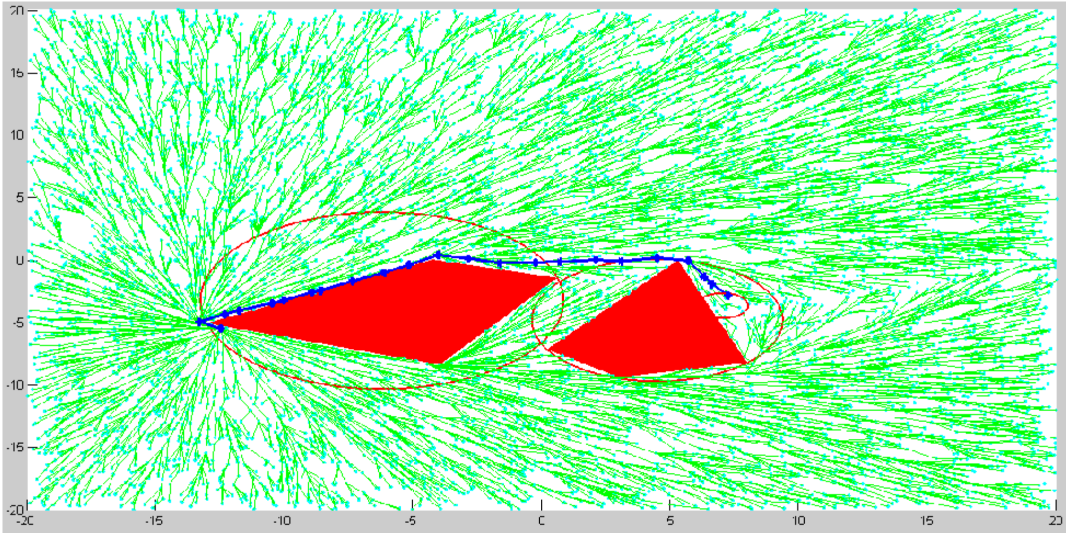

Figure 4:RRT* algorithm branching [1]

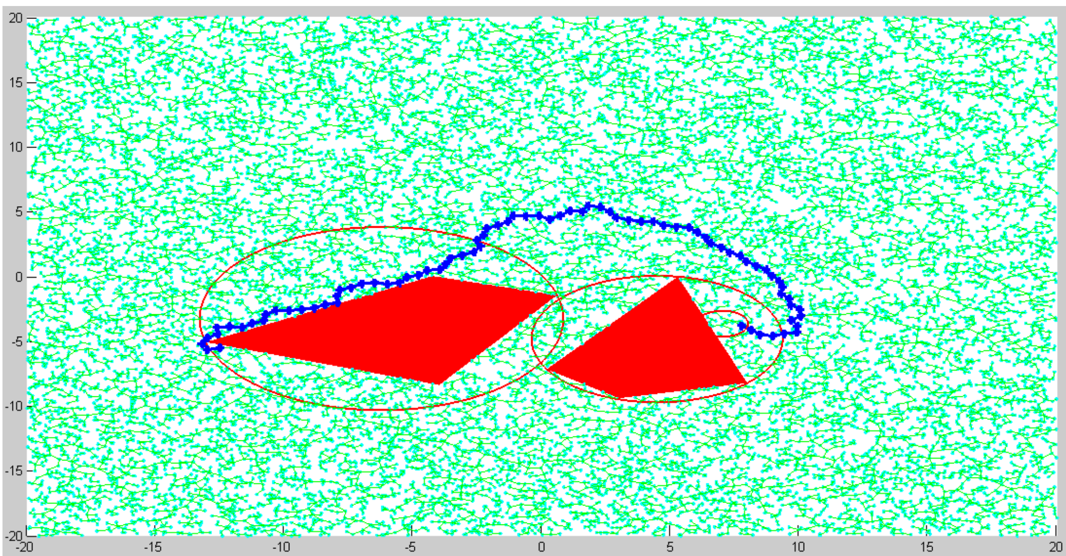

Figure 3:RRT algorithm branching [1]

Conclusion: -

As we can clearly see that the branching of RRT* is much better and smoothened by RRT and it also has a shorter route. Thus RRT* is better option then RRT for programming autonomous vehicles.

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Refrences:-

1. OlzhasAdiyatov and HuseyinAtakanVarol. Rapidly-exploring random tree based memory efficient motion planning. *In Mechatronics and Automation (ICMA), 2013 IEEE International Conference on*, pages 354–359, 2013.
2. L. Figueiredo, I. Jesus, J. T. Machado, J. Ferreira, and J. M. Carvalho*,"Towards the development of intelligent transportation systems,"*inProc. 14th IEEE Int. Conf. Intelligent Transportation Systems,Washington D. C., 2001, vol. 88, pp. 1206–1211.
3. H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, andImplementation. Springer, 2011, pp. 3–5.
4. T. M. Howard, M. Pivtoraiko, R. A. Knepper and A. Kelly,*"Model-Predictive Motion Planning,"* IEEE Robotics &AutomationMagazine. 2014, pp. 64–73.
5. J. C. Latombe, *"Motion planning: A journey of robots, molecules,digital actors, and other artifacts,"* International Journal of Robotics Research, vol. 18, no.1, 1999, pp. 1119–1128.
6. J. J. Kuffner and S. M. LaValle, *"RRT-connect: An efficient approachto single-query path planning,"* in Proc. 2000 IEEE Int. Conf. onRobotics and Automation, San Francisco, 2000, vol. 2, pp. 995–1001.
7. H. Long, Q. H. Do and S. Mita*, "Unified path planner for parking anautonomous vehicle based on RRT,"* in Proc. 2011 IEEE Int. Conf. onRobotics and Automation, Shanghai, 2011, pp. 5622–5627.
8. J. Bruce and M. Veloso, *"Real-time randomized path planning forrobot navigation,"* in Proc.2002 IEEE/RSJ Int. Conf. on IntelligentRobots and Systems, Zurich, 2002, vol. 3, pp. 2383–2388.
9. C. Urmson and R. G. Simmons, *"Approaches for heuristically biasing RRT growth,"* in Proc.2003 IEEE/RSJ Int. Conf. on Intelligent Robotsand Systems, Las Vegas, 2003, pp. 1178–1183.
10. J.P.M. Hendrikx, T.J.J. Meijlink, and R.F.C. Kriens. Application ofoptimal control theory to inverse simulation of car handling. VehicleSystem Dynamics, 26:449–461, 1996.
11. D. Casanova, R. S. Sharp, and P. Symonds. Minimum time manoeuvring:The significance of yaw inertia. Vehicle System Dynamics,34:77–115, 2000.
12. [4] EfstathiosVelenis, Panagiotis Tsiotras, and Jianbo Lu. Optimalityproperties and driver input parameterization for trail-braking cornering.European Journal of Control, 4:308–320, 2008.
13. EfstathiosVelenis, Emilio Frazzoli, and Panagiotis Tsiotras. Steadystatecornering equilibria and stabilization for a vehicle during extremeoperating conditions. Int. Journal of Vehicle Autonomous Systems, 8(2-4):217–241, 2010.
14. TimurKaratas and Francesco Bullo. Randomized searches andnonlinear programming in trajectory planning. In Proceedings of the40th IEEE Conference on Decision and Control, December 2001.
15. Liang Ma, JianruXue, Kuniaki Kawabata, Jihua Zhu, Chao Ma, Nanning Zheng*, "A Fast RRT Algorithm for Motion Planning of Autonomous RoadVehicles*",*IEEE 17th International Conference onIntelligent Transportation Systems (ITSC)October 8-11, 2014. Qingdao, China, pp 1033-1038, 2014.
16. Jeonghwan, Jeon SertacKaraman, Emilio Frazzoli, "*Anytime Computation of Time-OptimalOff-Road Vehicle Maneuvers using the RRT**", 50th IEEE Conference on Decision and Control andEuropean Control Conference (CDC-ECC), pp 3276-3282, 2011