# Voronoi-based trajectory optimization for UGV path planning

Magid E., Lavrenov R., Afanasyev I.

*Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia*

## Abstract

© 2017 IEEE. Optimal path planning in dynamic environments for an unmanned vehicle is a complex task of mobile robotics that requires an integrated approach. This paper describes a path planning algorithm, which allows to build a preliminary motion trajectory using global information about environment, and then dynamically adjust the path in real-time by varying objective function weights. We introduce a set of key parameters for path optimization and the algorithm implementation in MATLAB. The developed algorithm is suitable for fast and robust trajectory tuning to a dynamically changing environment and is capable to provide efficient planning for mobile robots.

## Keywords

optimization criteria, path planning, Unmanned Ground Vehicle (UGV), voronoi diagram

## References

[1] L. Bombini, A. Coati, J. S. Medina, D. Molinari and A. Signifredi, A General Purpose Approach for Global and Local Path Planning Combination, IEEE Int. Conf. on Intelligent Transportation Systems, IEEE Computer Society, USA, 2015, pp. 996-1001.

[2] M. A. Contreras-Cruz, V. Ayala-Ramirez and U. Hernandez-Belmonte, Mobile robot path planning using artificial bee colony and evolutionary programming, Applied Soft Computing, vol. 30, 2015, pp. 319-328. doi: 10. 1016/j. asoc. 2015. 01. 067

[3] E. Magid, D. Keren, E. Rivlin and I. Yavneh, Spline-Based Robot Navigation, " IEEE/RSJ Int. Conf. on Intelligent Robots and Systems, 2006, pp. 2296-2301.

[4] J. R. Andrews and N. Hogan, Inpedance Control as a Framework for Implementing Obstacle Avoidance in a Manipulator, Control of Manufacturing Processes and Robotic Systems, 1983.

[5] O. Khatib, Real-Time, Obstacle Avoidance for Manipulators and Mobile Robots, Int. J. of Robotics Research, Springer, New York, 1986, pp. 396-404.

[6] L. Tang, S. Dian and G. Gu and K. Zhou, A novel potential field method for obstacle avoidance and path planning of mobile robot, IEEE Int. Conf. on Computer Science and Information Technology, vol. 9, 2010, pp. 633-637.

[7] T. Simeon, J.-P. Laumond and C. Nissoux, Visibility based probabilistic roadmaps for motion planning, Advanced Robotics, vol. 14 (6), 2000, pp. 477-493.

[8] Y. Liu and S. Arimoto, Path planning using a tangent graph for mobile robots among polygonal and curved obstacles, The Int. J. of Robotics Research, vol. 11 (4) 1992, pp. 376-382.

[9] S. M. LaValle, Rapidly-exploring random trees: A new tool for path planning, Iowa State University, 1998

[10] L. E. Kavraki, P. Svestka, J.-C. Latombe and M. H. Overmars, Probabilistic roadmaps for path planning in high-dimensional configuration spaces, IEEE Transactions on Robotics and Automation, vol. 12 (4), 1996, pp. 566-580.

[11] H. Choset and J. Burdick, Sensor Based Motion Planning: The Hierarchical Generalized Voronoi Graph, Advanced Robotics, 1997.

[12] B. Lau, C. Sprunk and W. Burgard, Improved Updating of Euclidean Distance Maps and Voronoi Diagrams, IEEE/RSJ Int. Conf. on Intelligent Robots and Systems, 2010, pp. 281-286.

[13] R. Gonzaleza, C. Mahuleaa and M. Kloetzerb, A Matlab-based Interactive Simulator for Teaching Mobile Robotics, IEEE Int. Conf. on Automation Science and Engineering, 2015, pp. 310-315.

[14] I. Kamon and E. Rivlin, A new range-sensor based globally convergent navigation algorithm for mobile robots, IEEE Int. Conf. on Robotics and Automation, vol. 1, 1997, pp. 429-435. C

[15] H. Choset, K. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. Kavraki and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations, Cam-bridge, MA, 2005.

[16] E. Magid, and E. Rivlin, CautiousBug: a competitive algorithm for sensory-based robot navigation, IEEE/RSJ Int. Conf. on Intelligent Robots and Systems, vol. 3, 2004, 2757-2762.

[17] I. Ulrich and J. Borenstein, VFH+: Reliable Obstacle Avoidance for Fast Mobile Robots, IEEE Int. Conf. on Robotics and Automation, vol. 2, 1998, pp. 1572-1577.

[18] M. Likhachev and S. Koenig, D lite, 8th National Conf. on Artificial intelligence, 2002, pp. 1282-1289.

[19] B. Lau, C. Sprunk and W. Burgard, Efficient Grid-Based Spatial Representations for Robot Navigation in Dynamic Environment, Robotics and Autonomous Systems, 61 (10), 2013, pp. 1116-1130.

[20] M. Sokolov, R. Lavrenov, A. Gabdullin, I. Afanasyev, E. Magid, 3D modelling and simulation of a crawler robot in ROS/Gazebo, 4th Int. Conf. on Control, Mechatronics and Automation, ACM Publishing, Dec. 2016, pp. 61-65.