

 [Download PDF](#)

A New Mobile Robot Toolbox for Matlab

Journal of Intelligent & Robotic Systems

pp 1–16

Authors Authors and affiliations

Suat Karakaya, Gurkan Kucukyildiz, Hasan Ocak

Article

First Online: 28 January 2017

DOI (Digital Object Identifier): 10.1007/s10846-017-0480-2

Cite this article as:

Karakaya, S., Kucukyildiz, G. & Ocak, H. J Intell Robot Syst (2017).

doi:10.1007/s10846-017-0480-2

Support
download

Abstract

In this study, a wheeled mobile robot navigation toolbox for Matlab is presented. The toolbox includes algorithms for 3D map design, static and dynamic path planning, point stabilization, localization, gap detection and collision avoidance. One can use the toolbox as a test platform for developing custom mobile robot navigation algorithms. The toolbox allows users to insert/remove obstacles to/from the robot's workspace, upload/save a customized map and configure simulation parameters such as robot size, virtual sensor position, Kalman filter parameters for localization, speed controller and collision avoidance settings. It is possible to simulate data from a virtual laser imaging detection and ranging (LIDAR) sensor providing a map of the mobile robot's immediate surroundings. Differential drive forward kinematic equations and extended Kalman filter (EKF) based localization scheme is used to determine where the robot will be located at each simulation step. The LIDAR data and the navigation process are visualized on the developed virtual reality interface. During the navigation of the robot, gap detection, dynamic path planning, collision avoidance and point stabilization procedures are implemented. Simulation results prove the efficacy of the algorithms implemented in the toolbox.

Keywords

Autonomous mobile robots Navigation Collision avoidance Gap detection Point stabilization

Download to read the full article text

References

- Support
1. Gerecke, U., Wagner, B.: The challenges and benefits of using robots in higher education. *Intelligent Automation & Soft Computing* **13**, 29–43 (2007)
[CrossRef](http://dx.doi.org/10.1080/10798587.2007.10642948) (<http://dx.doi.org/10.1080/10798587.2007.10642948>)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=The%20challenges%20and%20benefits%20of%20using%20robots%20in%20higher%20education&author=U.%2c43&publication_year=2007) (http://scholar.google.com/scholar_lookup?title=The%20challenges%20and%20benefits%20of%20using%20robots%20in%20higher%20education&author=U.%2c43&publication_year=2007)
 2. Stormont, D.P., Chen, Y.Q.: Using mobile robots for controls and mechatronics education. *International Journal of Engineering Education* **2**, 1039–1042 (2005)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=Using%20mobile%20robots%20for%20controls%20and%20mechatronics%20education&author=DP.%20Stormon1042&publication_year=2005) (http://scholar.google.com/scholar_lookup?title=Using%20mobile%20robots%20for%20controls%20and%20mechatronics%20education&author=DP.%20Stormon1042&publication_year=2005)
 3. Chen, C., Chai, W., Roth, H.: A single frame depth visual gyroscope and its integration for robot navigation and mapping in structured indoor environments. *J. Intell. Robot. Syst.* **80**, 365–374 (2015)
[CrossRef](http://dx.doi.org/10.1007/s10846-014-0167-x) (<http://dx.doi.org/10.1007/s10846-014-0167-x>)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=A%20single%20frame%20depth%20visual%20gyroscope%20and%20its%20integration%20for%20robot%20navi374&publication_year=2015) (http://scholar.google.com/scholar_lookup?title=A%20single%20frame%20depth%20visual%20gyroscope%20and%20its%20integration%20for%20robot%20navi374&publication_year=2015)
 4. Dean, E., Nair, S., Knoll, A.: User-friendly Matlab-toolbox for symbolic robot dynamic modeling used for control design. In: Proceedings of the IEEE International Conference on Robotics and Biomimetic. Guangzhou, China (2012)
 5. Yoshida, K.: The SpaceDyn: A Matlab toolbox for space and mobile robots. In: Proceedings of the IEEE International Conference on Intelligent Robots and Systems. Sendai, Japan (1999)
 6. Shokraneh, K.M., Masehian, E.: Planning robot navigation among movable obstacles (NAMO) through a recursive approach (2016). doi:[10.1007/s10846-016-0344-1](http://dx.doi.org/10.1007/s10846-016-0344-1) (<http://dx.doi.org/10.1007/s10846-016-0344-1>)
 7. Zhengcai, C., Yingtao, Z., Qidi, W.: Genetic fuzzy + PI path tracking control of a non-holonomic mobile robot. *Chin. J. Electron.* **20**, 31–34 (2011)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=Genetic%20fuzzy%20%2B%20PI%20path%20tracking%20holonomic%20mobile%20robot&author=C.%20Zhengcai&author=Z.%20Yingtao&author=W.%20Qidi&journal=Chin.%34&publication_year=2011) (http://scholar.google.com/scholar_lookup?title=Genetic%20fuzzy%20%2B%20PI%20path%20tracking%20holonomic%20mobile%20robot&author=C.%20Zhengcai&author=Z.%20Yingtao&author=W.%20Qidi&journal=Chin.%34&publication_year=2011)
 8. Carlos, E.J., Federico, P.E., Gabriel, R.J.: The exact Euclidian distance transform: A new algorithm for universal path planning. *Int. J. Adv. Robot. Syst.* **10**, 1–10 (2013)

[CrossRef](http://dx.doi.org/10.5772/56581) (<http://dx.doi.org/10.5772/56581>)

[Google Scholar](http://scholar.google.com/scholar_lookup?) (http://scholar.google.com/scholar_lookup?

title=The%20exact%20Euclidian%20distance%20transform%3A%20A%20new%20algorithm%20for%2ouniversal%20j10&publication_year=2013)

9. Wu, Z., Feng, L.: Obstacle prediction-based dynamic path planning for a mobile robot. *International Journal of Advancements in Computing Technology* **4**, 118–124 (2012)
[Google Scholar](http://scholar.google.com/scholar_lookup?) (http://scholar.google.com/scholar_lookup?
title=Obstacle%20prediction%E2%80%93based%2odynamic%2opath%2oplanning%20for%2oa%20mobile%2orobot&124&publication_year=2012)
10. Silić, H.: Inverse matching-based mobile robot following algorithm using fuzzy logic. *Int. J. Robot. Autom.* **29**, 369–377 (2014)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=Inverse%20matching-based%20mobile%2orobot%20following%20algorithm%20using%20fuzzy%20logic&author=H.%20Silić&journal=Int.377&publication_year=2014) (http://scholar.google.com/scholar_lookup?title=Inverse%20matching-based%20mobile%2orobot%20following%20algorithm%20using%20fuzzy%20logic&author=H.%20Silić&journal=Int.377&publication_year=2014)
11. Ssebaza, L., Pan, Y.J.: DGPS-based localization and path following approach for outdoor wheeled mobile robots. *Int. J. Robot. Autom.* **30**, 13–25 (2015)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=DGPS-based%20localization%20and%2opath%20ofollowing%20approach%20for%20outdoor%20wheeled%20mobile%2orobot%25&publication_year=2015) (http://scholar.google.com/scholar_lookup?title=DGPS-based%20localization%20and%2opath%20ofollowing%20approach%20for%20outdoor%20wheeled%20mobile%2orobot%25&publication_year=2015)
12. Alejo, D., Cobano, J.A., Heredia, G., Ollero, A.: A Reactive method for collision avoidance in industrial environments. *J. Intell. Robot. Syst.* (2016). doi:[10.1007/s10846-016-0359-7](http://dx.doi.org/10.1007/s10846-016-0359-7) (<http://dx.doi.org/10.1007/s10846-016-0359-7>2016)
13. Sun, S., Cui, P.: Path tracking and a practical point stabilization of mobile robot. *Journal of Robotics and Computer-Integrated Manufacturing* **20**, 29–34 (2004)
[CrossRef](http://dx.doi.org/10.1016/S0736-5845(03)00052-8) ([http://dx.doi.org/10.1016/S0736-5845\(03\)00052-8](http://dx.doi.org/10.1016/S0736-5845(03)00052-8))
[Google Scholar](http://scholar.google.com/scholar_lookup?title=Path%2otracking%20and%20a%2opractical%20point%2ostabilization%20of%20mobile%2orobot&author=S.%20Integrated%20Manufacturing&volume=20&pages=29-34&publication_year=2004) (http://scholar.google.com/scholar_lookup?title=Path%2otracking%20and%20a%2opractical%20point%2ostabilization%20of%20mobile%2orobot&author=S.%20Integrated%20Manufacturing&volume=20&pages=29-34&publication_year=2004)
14. Alves, J.A.V., Lages, W.F.: Real-time point stabilization of a mobile robot using model predictive control. In: Proceedings of the 13th IASTED International Conference of Robotics and Applications. Würzburg, Germany (2007)
15. Kühne, F., Lages, W.F., Silva, J.M.G.: Point stabilization of mobile robots with nonlinear model predictive control. In: Proceedings of the IEEE International Conference on Mechatronics and Automation. Niagara Falls, Canada (2005)
16. Pazderski, D.: Waypoint following for differentially driven wheeled robots with limited velocity perturbations. *J. Intell. Robot. Syst.* (2016). doi:[10.1007/s10846-016-0391-7](http://dx.doi.org/10.1007/s10846-016-0391-7) (<http://dx.doi.org/10.1007/s10846-016-0391-7>)
17. Corke, P.: A robotics toolbox for Matlab. *IEEE Robot. Autom. Mag.* **3**, 24–32 (1996)
[CrossRef](http://dx.doi.org/10.1109/100.486658) (<http://dx.doi.org/10.1109/100.486658>)
[Google Scholar](http://scholar.google.com/scholar_lookup?) (http://scholar.google.com/scholar_lookup?
title=A%2orobotics%2otoolbox%2ofor%2oMatlab&author=P.%20Corke&journal=IEEE%2ORobot.%20Autom.%20Mag.32&publication_year=1996)
18. Mirats, J.M., Pfeiffer, C.F.: Mobile robot design in education. *IEEE Robot. Autom. Mag.* **13**, 69–75 (2006)

[CrossRef](http://dx.doi.org/10.1109/MRA.2006.1598055) (<http://dx.doi.org/10.1109/MRA.2006.1598055>)

[Google Scholar](http://scholar.google.com/scholar_lookup?) (http://scholar.google.com/scholar_lookup?)

title=Mobile%2orobot%2odesign%2oin%2oeducation&author=JM.%2oMirats&author=CF.%2oPfeiffer&journal=IEEE 75&publication_year=2006)

19. Zahedi, K., Twickel, A.V., Pasemann, F.: Yars: A physical 3D simulator for evolving controllers for real robots. Lecture Notes in Computer Science, 75–86. Springer (2008)
20. Awaad, I., Len, B.: Xpersim: A simulator for robot learning by experimentation. Lecture Notes in Computer Science, 5–16. Springer (2008)
21. Freese, M., Singh, S., Ozaki, F., Matsuhira, N.: Virtual robot experimentation platform V-Rep: a versatile 3D robot simulator. In: Proceedings of the 2nd International Conference on Simulation, modelling and Programming for Autonomous Robots. Berlin, Germany (2010)
22. Barner, S., Geisinger, M., Buckl, C., Knoll, A.: EasyLab: Model-based development of software for mechatronic systems. In: Proceedings of the IEEE International Conference on Mechatronic and Embedded Systems and Applications. Beijing, China (2008)
23. Pons, C., Perez, G., Giandini, R., Baum, G.: A model-driving approach to constructing robotic systems. *J. Comput. Sci. Technol.* **14**, 1–8 (2014)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=A%20model-driving%20approach%20to%20constructing%20robotic%20systems&author=C.%20Pons&author=G.%20Perez&author=8&publication_year=2014) (http://scholar.google.com/scholar_lookup?title=A%20model-driving%20approach%20to%20constructing%20robotic%20systems&author=C.%20Pons&author=G.%20Perez&author=8&publication_year=2014)
24. Gucwa, K.J., Cheng, H.H.: RoboSim for Integrated Computing and STEM Education. In: Proceedings of the 121st ASSE Annual Conference & Exposition. Indianapolis, IN, USA (2014)
25. Ivaldi, S., Padois, V., Nori, F.: Tools for dynamics simulation of robots: a survey based on user feedback. Tools for Dynamics Simulation of Robots-Extended Report, 1–15 (2014)
26. Karakaya, S., Ocak, H., Küçükyıldız, G.: A bug-based local path planning method for static and dynamic environments. International Symposium on Innovative Technologies in Engineering and Science. Valencia, Spain (2015)
27. Chen, S.Y.: Kalman filter for robot vision: a survey. *IEEE Trans. Ind. Electron.* **59**, 4409–4420 (2012)
[CrossRef](http://dx.doi.org/10.1109/TIE.2011.2162714) (<http://dx.doi.org/10.1109/TIE.2011.2162714>)
[Google Scholar](http://scholar.google.com/scholar_lookup?title=Kalman%20filter%20for%20robot%20vision%3A%20a%20survey&author=SY.%20Chen&journal=IEEE%20Trans%204420&publication_year=2012) (http://scholar.google.com/scholar_lookup?title=Kalman%20filter%20for%20robot%20vision%3A%20a%20survey&author=SY.%20Chen&journal=IEEE%20Trans%204420&publication_year=2012)
28. Karakaya, S., Küçükyıldız, G., Ocak, H.: A hybrid indoor localization system based on infra-red imaging and odometry. International Conference of Computer Vision and Pattern Recognition. Las Vegas, NV, USA (2015)
29. Kim, J., Chung, W.: Efficient placement of beacons for localization of mobile robots considering the positional uncertainty distributions. *Int. J. Robot. Autom.* **30**, 119–127 (2015)

[Google Scholar](http://scholar.google.com/scholar_lookup?title=Efficient%20placement%20of%20beacons%20for%20localization%20of%20mobile%20robots%20considering%20127&publication_year=2015) (http://scholar.google.com/scholar_lookup?title=Efficient%20placement%20of%20beacons%20for%20localization%20of%20mobile%20robots%20considering%20127&publication_year=2015)

Copyright information

© Springer Science+Business Media Dordrecht 2017

About this article



Check for
updates

Publisher Name

Springer Netherlands

Print ISSN

0921-0296

Online ISSN

1573-0409

[About this journal](#)

[Reprints and Permissions](#)

Support

SPRINGER NATURE

© 2017 Springer International Publishing AG. Part of [Springer Nature](#).

Not logged in · ANKOS Consortium (3000090549) - Kocaeli University Kutuphane ve Dok. Dai. Bsk. (3000165078) - Tubitak Ulakbim OJA (3000526817) - TUBITAK EKUAL (3001744230) · 194.27.72.8