# Collision Avoidance and Trajectory Tracking for Multiple Autonomous Mobile Robots in Robot Operating System

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## Abstract

Increasing the demand for robot usage in different industries has considerably changed companies' operation and management complexity. Meanwhile, automation is a further trend to satisfy the shortage of human resources and enhance productivity. Because of the popularity of 5G technology and industry 4.0, the linkage of devices becomes more stable to connect with multiple robots simultaneously to track their location precisely. Therefore, it can boost the development of Robot Operating Systems (ROS) and the popularity of robot applications across different industries. In the current situation, the company's trend is to apply Automatic Guided Vehicle (AGV) in operation to increase the productivity and decrease human power involved. This technology is only suitable in a static environment to complete some assigned jobs with collision avoidance. AGV focuses much on repetitive work without any humans involved. The main weaknesses of AGV are not capable and flexible when applied in dynamic and unknown environments. However, Autonomous Mobile Robot (AMR) can work in these environments while it can help to achieve Human-Robot Interaction without collision avoidance. This research studies collision avoidance and trajectory tracking for multiple AMR. Adopting a path planning approach based on discrete optimization of path tracking is normally assumed in AMR in real-life scenarios. Dynamic path tracking should be investigated to solve the current issue of choosing the best path from a limited number of options while calculating vehicle acceleration and speed simultaneously. Meanwhile, the study provides a literature review to show the existing algorithm, navigation method, simulation method applied on AMR. Based on the above research, experimental results display more realistic data using a simulation modelling approach based on a real-life case study. The case study is set in different changes of the retail environment and different parameter changes of the robot to indicate how efficient the robot is, and which set of robots is suitable in an actual retail environment. Three case studies have been considered for multiple simulation scenarios, including a small convenience store, a medium-sized restaurant, and a supermarket. Gazebo software and Turtlebot 3 are used in the simulation. The service robot in a retail environment is evitable to conflict with humans while doing job tasks. The conflict resolution and human-machine cooperation are shown in simulation under complex task prioritization how the robot follows its own task-related goals while it has a conflict with humans. The results are shown with multiple parameters comparison, including the number of AMRs, different environment, types of algorithm and human involvement. The paper can conclude which method is suitably applied in multiple AMRs to achieve collision avoidance, trajectory tracking, and human-robot interaction. The findings and recommendations presented in this study can further assist with ROS effectively by implementing AMR into real-world scenarios.

## Keywords
Autonomous Mobile Robot, Robotic Operating System, Dynamic path tracking, Collision Avoidance, Trajectory Tracking

## Acknowledgements
This research is funded by the Laboratory for Artificial Intelligence in Design (Project Code: RP2-2), Innovation and Technology Fund, Hong Kong Special Administrative Region. The authors would like to the Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University for supporting the research. Gratitude is extended to the Laboratory of Artificial Intelligence in Design Limited (AiDLab) for inspiring the research (Project Code: RP2-2).

## Biography

**Cheung Ho Hin.** Thomas is a final year undergraduate student who studies in BSc (Hons) Enterprise Engineering with Management at The Hong Kong Polytechnic University. In his final year studies, Thomas conducts ROS projects focusing on navigation and AMRs in a real retail environment. The intention of studying this topic is inspired by touching with AGV during internship. He is interested in implementing robotics in enhancing current technology in order to improve operation productivity and solve complex task management issues. He intends to apply the gained knowledge into real-world industry.

**C.K.M. LEE.** Dr C.K.M. LEE is currently an associate professor in the Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hong Kong. She directs the BSc(Hons) Enterprise Engineering with Management program. The Hong Kong Polytechnic University awarded her a PhD and a BEng degree. Industrial Engineering, Enterprise Resource Planning (ERP), Logistics and Supply Chain Management, Industrial Internet of Things (IoT), Wireless Sensor and Actuator Network (WSAN), Cloud Computing, and Big Data Analytics are some of her key study interests. Dr. Lee has over 130 publications published in international journals and seminars to date. In 2019, she received a Silver Medal at the Geneva International Exhibition of Inventions and an Outstanding Paper Award from the Emerald Network Awards. Dr. Lee is also the Lab-in-Charge of the Cyber-Physical Systems Laboratory at The Hong Kong Polytechnic University's Department of Industrial and Systems Engineering.