
“Operation Management of Urban Service Robots & Assistance Infrastructure in Dynamic Environment”

Robots have functionalities to be fulfilled. These functionalities are fulfilled with the help of product components which consume energy. Meanwhile, for assisting the robots in fulfilling their tasks autonomously, assistance infrastructure might be needed. One such use-case is the robot [MURMEL](#) (Mobiler Urbaner Roboter zur Mülleimerentleerung), which aims to autonomously emptying the litter-bins on the streets of Berlin. To assist the fleet of MURMELs in accomplishing their tasks efficiently, assistance infrastructure such as smart dustbins (Information providing capabilities on the filling levels of the litter-bins) & mothership (A vehicle for transporting MURMELs, assisting with garbage emptying when MURMELs garbage storing capacity has been reached, and charging possibilities) are required. The goal of the whole operation is to utilize minimum possible energy during operation, this is possible with route planning¹. Till now, the route planning defines the routes before the operation starts. But in real world scenario, the actual situations at the service event area (SEA) might demand in change of the routes during the operation. This thesis aims to lay down the foundation work for such an operation management. The tasks to be completed during this project work are as following:

Research:

- Which standards combine the development and utilization of the autonomous service agents (mechatronic products) and their assistance infrastructure?
- Which frameworks allow incorporating the functionalities of the autonomous agents and their assistance infrastructure in a simulative world for monitoring the operation status and involved product and assistance infrastructure status?
- Which functionalities play vital role in such a framework or a framework to be developed for the use-case MURMEL and its assistance infrastructure?
- How might these functionalities have an influence with changing conditions during the actual operation, and how can the changes be monitored in terms of dynamic route planning?

Development & Validation:

- Developing a conceptual method that incorporates change possibilities and their impact on the functionalities and properties of the autonomous service agents and their assistance infrastructure during the operation for the use-case MURMEL.
- Laying down the requirements of the first concept for the framework to be developed in terms of dynamic route planning.
- Comparison of the requirements fulfilled for the operation management against the previous researched methods.
- Developing a graphical user interface, with the help of which the operation can be managed dynamically on the basis of route planning.

¹ Gupta, Abhishek; van der Schoor, Michel Joop; Brautigam, Jacob; Justo, Valeria Bladinieres; Umland, Tobias Fritz; Göhlich, Dietmar: **Autonomous Service Robots for Urban Waste Management - Multiagent Route Planning and Cooperative Operation**. IEEE Robot. Autom. Lett. 7 (4), S. 8972–8979. 2022 <https://doi.org/10.1109/LRA.2022.3188900>

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