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Imagine the following situation. You give your favorite robot, named Pippi, the task to fetch a parcel that just arrived at your front door. While pushing the parcel back to you, she must travel through a door. Unfortunately, the parcel she is pushing is blocking her camera, giving her a hard time to see the door. If she cannot see the door, she cannot safely push the parcel through it.

What would you as a human do in a similar situation? Most probably you would ask someone for help, someone to guide you through the door, as we ask for help when we need to park our car in a tight parking spot. Why not let the robots do the same? Why not let robots help each other? Luckily for Pippi, there is another robot, named Emil, vacuum cleaning the floor in the same room. Since Emil can view both Pippi and the door at the same time, he can guide Pippi through the door, enabling her to deliver the parcel to you. The goal of this thesis is to endow robots with the ability to help each other in a similar way.

More specifically, we consider distributed robot systems in which: each robot includes modular functionalities for sensing, acting and/or processing; and robots can help each other by offering those functionalities. A functional configuration of such a system is any way to allocate and connect functionalities among the robots. Different functional configurations can be used to make the same set of robots perform different tasks, or to perform the same task under different conditions.

In this thesis, we propose an approach to automatically generate, at run time, a functional configuration of a distributed robot system to perform a given task in a given environment, and to dynamically change this configuration in response to failures. Further, we show how automatic configuration can be integrated with task planning to address tasks that require more than one step. We also propose an approach to merge configurations, which enables concurrent execution of configurations. The approach is demonstrated on a real distributed robot system.



Doctoral Dissertation

Robots that Help Each Other: Self-Configuration of Distributed Robot Systems

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Technology