Chapter 26
Distributed Robots Path/Tasks Planning on Fetch Scheduling

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ABSTRACT

A highly concurrent task-planner for distributed multi-robot systems in dynamical industrial feed-lines is presented in this chapter. The system deals with two main issues: a) a path-planning model and b) a robotic-tasks scheduler. A set of kinematic control laws based on directional derivatives model the dynamical robots interaction. Distributed wheeled mobile robots perform the execution of autonomous tasks concurrently and synchronized just in time. A planner model for distributed tasks to autonomously reconfigure and synchronize online change priority missions by the robotic primitives—sense, plan, and act—are proposed. The robotic tasks concern carry-and-fetch to different goals, and dispatching materials. Numerical simulation of mathematical formulation and real experiments illustrate the parallel computing capability and the distributed robot's behavior. Results depict robots dealing with highly concurrent tasks and dynamical events through a parallel scheme.

INTRODUCTION

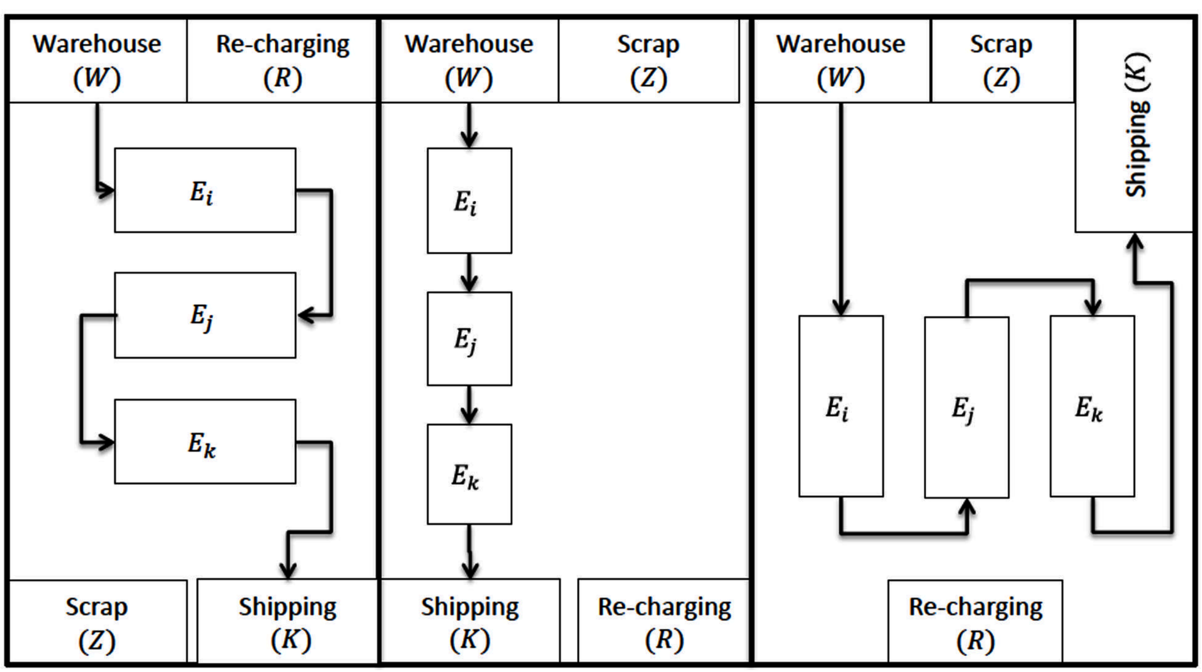
Nowadays it is common to meet robotic systems in a diversity of workplaces, both in industry and everyday life. According to Habib (2007), true interdisciplinary work occurs when researchers from two or more disciplines pool their knowledge, experience, and techniques and have open and transparent interaction, so that their synergized ideas and thinking are better suited to solve the problem at hand. We may find field robots in warehouses (Guizzo, 2008; Helleboogh, Holvoet, and Berbers, 2006), electrical substation inspection (Shengfang and Xingzhe, 2006), air cargo terminals (Zhaowei, Guojun, Rui, and Fan, 2008), and even as assistants for the elderly (Meng and Lee, 2006). In (Martinez-Garcia et al., 2014) an industrial application based on directional fields with a solution for mobile robot search planning was reported. In the present work, robotic transporters are considered in planning analysis. These

DOI: 10.4018/978-1-4666-7387-8.ch026

transporters have been designed to help industries achieve high productivity at minimum cost. For the sake of planning and control of industrial transportation systems, it is important to consider a diversity of task scenarios such as traffic congestion peaks, orders arrival during the execution of tasks and order modifications. Currently, one of the most important qualities of the new production systems is flexibility. Flexibility must be able to adapt to timing and facilities adjustments. It is necessary to perform several geometric configurations (see Figure 1). These changes imply a constant modification of the material handling systems. When the system is modified, the flow of material during the process differs from the previously used routes. The recollection of scrap and defective units will take place in different zones. Also, long-term activities featured autonomous robots may include the shifting of the number of interacting elements performing tasks. If the material transport system used is too rigid, then modifications by each configuration mode will have a high cost. The ability of the system to adapt to changes means that it must be capable to change its strategy movements. In this case, the problem resides on the global planning of the pathways of a mobile robot in a changing or partially known environment that involves constant changes in the configuration and mobile obstacles that can change the arrival time of the robot. Without an optimal path planner, the robot will not be capable to reach scheduled goals, bottlenecks will form, supply failures, and therefore a decrease in the production volume. The purpose of this work is to develop an automatic planning system using multiple mobile robots to manage materials supply. Let's say, rubbish recollection, and faulty units from production lines, but lead to an efficient manner.

The structure of this document is briefly described in the following manner. The Background section introduces some preliminaries and related work. The Robot's Motion Model section presents a four-wheel driving kinematic model describing the system robotic platforms. In section Robot Acceleration Models, a description of navigational models in terms of accelerations for the messenger robot is pre-

Figure 1. Target facilities scenario spatial configuration: a) serial stations, warehouse, and shipping opposite located; b) work stations, warehouse, and shipping zones aligned; c) wider-space stations



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