Published in H.-D. Haasis, H. Kopfer, and J. Schönberger (eds.), Operations Research Proceedings 2005, 97-102 (2006). © Springer, doi:10.1007/3-540-32539-5_16

Simulating Dispatching Strategies for Automated Container Terminals

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1 Introduction

The practical relevance of container terminal logistics has led to an enormous scientific interest in this field. Publications cover not only optimization algorithms (e.g., for equipment scheduling and vehicle routing) and decision problems (e.g., for finding grounding positions for containers in the yard) but also simulation models to study such approaches in a realistic dynamic environment. Recent literature surveys have been given by Steenken et al. [3] and Vis and Koster [4]. In this paper, we consider a highly automated terminal with quay cranes, automated guided vehicles, and automated stacking cranes. Such a terminal configuration is sketched in Figure 1.

Arriving containers are stored in the terminal for a certain period of time until they are picked up either on the landside by trucks or trains or on the seaside by vessels. The stacking area is divided into blocks. Each of them is served by one or more rail mounted gantry cranes (RMG). The RMGs put arriving containers into the stack, remove containers from the stack when they are picked up, and carry out so-called shuffle moves, i.e., move containers to another position within the stack if they stand on top of containers that have to be moved out of the stack.

Vessels are served by quay cranes (QC). They either discharge containers from vessels or load them onto vessels. This has to be done according to a given stowage plan. The latter imposes precedence relations on some of the containers. This leads to a partial order in which containers to be loaded have to arrive at a QC.

The transportation of containers between RMGs and QCs is done by automated guided vehicles (AGV). AGVs are unmanned vehicles that are unable to load and unload themselves, thus quay cranes and stacking cranes have to load and unload them. The AGV area can be divided into lanes alongside the quay (which are also used as handover lanes at the quay cranes), lanes alongside the stacking area, lanes connecting quay and stacking area, and handover lanes at each RMG stack. At each QC, some lanes are used as a buffer area where AGVs wait either because another AGV with a predecessor container has to pass or because the handover position is still occupied by another AGV.

Terminals with this type of configuration exist in Rotterdam, Netherlands (Delta Terminal of Europe Container Terminals, ect) and Hamburg, Germany (Container Terminal Altenwerder, CTA). This study has been carried out in cooperation with CTA. The focus of this paper is on the simulation of scheduling strategies for AGVs. First, we describe a simulation model for testing those strategies. Subsequently, we propose two specific strategies, employ them in our model and present first results.