PhD Proposal 2017

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Title: Container Relocation Problem.
Scientific field: Logistics / Operation Research
Key words: Dynamic Optimization, Stochastic problem, Mathematic Modeling, Reactive scheduling, Safety, Petri net model.

Details for the subject:

Background, Context:

Containerized cargo constitutes more than 50% of the world sea borne trade in fiscal terms (UNCTAD, 2014). Drastic changes in emerging technologies such as increased speed and size of vessels drive container terminals to transfer larger amounts of cargo than hitherto. Especially, the introduction of mega container vessels requires well managed container terminal operations. The container terminal area consists of two parts: quay side and yard side. Quay side operations include berth allocation, quay crane assignment and scheduling, and vessel storage planning. Yard side operations consist of transferring containers from quay side, yard crane scheduling, and storing and handling of containers at the yard storage area.

Research subject, work plan:

The importance of yard side operations is usually dismissed by terminal operators since they mostly charge liner shipping companies according to the number of containers handled with quay cranes. However, the success of quay side operations is highly interrelated with the efficiency of yard side operations.

Containers are stored in blocks in the yard storage area. Each block contains several yard-bays and each yard-bay consists of container stacks aligned next to each other. Container stacks are also denominated as “columns” in which containers are placed on top of each other. Hence, container stacks contain multiple tiers (or “rows”) of containers. A container occupies a space called as a “slot” which is defined with the position of its column and row in the yard-bay. The yard-bay is usually served by a yard crane which access containers from top of a column. Therefore, to reach a target container that is buried under other container(s), the yard crane should first clear the container(s) above the target container.

Such a container is defined as a “blocking container” which prevents direct access of the yard crane to a target container. To reach the target container, a blocking container is taken by a yard crane and repositioned in another stack. This repositioning operation of a yard crane is termed as “relocation”. Further, a container that is repositioned within the yard-bay is called as a “reshuffling container”. A container is an “arrival container” when it joins the yard-bay. Similarly, a “retrieval container” is defined as a target container that should be immediately removed from the yard-bay. We refer to the works by Steenken et al. (2004) and Stahlbock and Voβ (2008) as excellent surveys on container terminal operations.

In this context, we focus on a problem which arises in the yard side of the container terminals, labeled “Container Relocation Problem (CRP)”. This problem, which is known to be NP-hard, was firstly, introduced by Kim and Hong (2006), and then, it was intensively studied in literature (Exposito et al, 2015, Jin et al, 2015, Zehender et al, 2015, Zhang et al, 2016). Nevertheless, several aspects of this problem are still not considered or/and solved (e.g. Dynamic aspect, Stochastic aspect...).

In order to optimize the logistic operations in the yard side, we propose to minimize the total number of performed relocations, and for this aim we have to focus in the following issues:

- Model the Container Relocation Problem (CRP) by a Petri Nets.
- Define a generic mathematical model for the considered problem.
- Propose novel optimization techniques to solve the problem.

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