

Calculation of stacking sequence

Vanderlande provides automated material handling systems and services that focus on improving customers' logistics processes and increasing their logistics performance throughout the entire life cycle. *Automated Case Picking* is one of such systems.

Case picking is the process of gathering products on a pallet before they are shipped out. Conventionally, case picking is performed manually. There is significant skill required from the employee to make a good stack of products. Key requirements are the following: boxes should not be damaged, the available volume on a pallet should be well utilized, boxes are quick to assemble and last but not least, a pallet load is stable.

The conventional operating poses limitations on the process and make it very human dependent. A complete warehouse automation system can drastically reduce the workforce required to run a facility, with human input required only for a few tasks. For instance, an automated storage and retrieval systems, which simply use cranes to store and retrieve identified cases or pallets, typically into a high-bay storage system which would be unfeasible to access using fork-lift trucks or any other means.

Automatic case picking enables fully automated order picking of a wide variety of products. It provides the answer to the most important challenges of today's retail distribution. Here is the link to the video that describes the entire process: <http://www.youtube.com/watch?v=j8N0gVFoGTU>

At the heart of this system lies a component Load Forming Logic (LFL), which is responsible for planning how an order is handled. This component is responsible for answering the questions:

- *Which item goes on which pallet?*
- *What will the stacks look like?*
- *How are the stacks built?*



A *stack* is a complete list of products details, product positions, product sizes and orientations that describe the products on a carrier.

An order is a request from a store that contains quantities of different products, for which LFL has to create recipes.

Your tasks / responsibilities

In order to answer the question “How are the stacks built?” a stacking sequence should be determined. For that, a stack and a set of constraints put on the stacking process are needed. The process of determining the sequence is based on the exploration of stacking possibilities looking at limited number of steps ahead. Such a technique is the core of the receding horizon algorithm, which is currently used in LFL. It allows selection of an optimal sequence, based on a pre-determined cost function.

In some situations our current algorithm requires improvements, for stability and performance reasons, or it may fail to calculate a stacking sequence altogether. Therefore, the goal of this assignment is to improve upon our current algorithm. The new algorithm should at least come up with a valid stacking sequence, whenever such a sequence exists.

- The input for the task is a set of stacks. Vanderlande will provide a set of reference stacks to be used in the assignment for testing and evaluation purposes.
- The expected output is an algorithm which can determine a better stacking sequence. The quality of the stacking sequence should be evaluated by several criteria, one of which is to ensure low height differences during each stacking step. Usually, not every criterion can be optimized simultaneously, therefore an optimal solution does involve trade-offs. The development of this measure for evaluation is also a goal of this assignment. The measure should be used for comparison between our current stacking sequences and the new stacking sequences.

Vanderlande will provide an implementation of the receding horizon algorithm for comparison purposes.

For this assignment, some affinity with search algorithms (e.g. best-first search, A*) and knowledge of C# is desirable.

Please contact j.h.v.pinxten@tue.nl for more information about this assignment.