A mathematical model for 3D Bin Packing in Robotic Mobile Fulfillment Systems

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Abstract. Robotic mobile fulfillment systems have received increased attention in high throughput supply chain solutions. These systems are complex and require understanding of the single components and their interaction. Components include picking, replenishing, stock keeping unit allocation and task allocation. This paper focuses on the component of stock keeping unit allocation which is an NP-Hard combinatorial optimization problem and belongs to the cutting & packing problems. The problem is defined via a mathematical model which is the first bin packing model for pods with compartments in RMFS. The resulting mixed integer programming model is then solved for small instances via Gurobi, a state-of-the-art solver for mathematical programming. The model is verified with a small-scale example. To obtain a solution for larger instances, we develop a simulated annealing approach and compare it to the exact model. Different operators are compared and evaluated on heterogeneous toy-examples of different size. Finally, a packing case with stock keeping units and pods derived from an industrial case is explored, which demonstrated the application of our packing algorithm to large instances in the industrial environment.

Keywords. Optimization, robotic mobile fulfilment systems, mathematical model

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