LAYOUT OF 2D IRREGULAR OBJECT CLUSTERS

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Abstract. *A layout problem of clusters of irregular 2D objects is considered. This research is initially motivated by a container-loading problem. A mathematical model is introduced and formulated as a nonlinear continuous problem. A solution algorithm to search for a local optimal layout of 2D irregular clusters is proposed. Computational results are provided.*
Key words*: layout, irregular objects, clusters, rectangular container, balancing conditions, phi-function technique, nonlinear optimization*

A two dimensional packing problem has various important applications, e.g. in logistics. In many cases the objects are not independent and have to be grouped in a number of certain clusters of non-overlapping objects. This is typical, for example, for a container loading problem [1], where the objects in a large maritime container may form various clusters according to a type of objects (similar shapes, parts of the same machine). Similarly, clusters can be formed according to a supplier or a client (final destination) to facilitate loading/unloading the container. While the composition of the cluster (number of objects and their shapes) is typically predefined, the overall shape of the cluster is frequently not specified. Bearing in mind a cluster as a number of objects placed in a flexible sack we define the shape of a cluster as a convex hull of the objects in the cluster. Note that the objects are non-overlapping and the shape of the cluster (convex hull) depends on the layout of the objects in the cluster. The number of clusters as well as the number of objects and their shapes and sizes are given. Constructing convex hulls for circular objects is considered in [2]. Concerning optimized packing of clusters, different objectives can be used. For example, we may look for the

"densest" layout fixing one dimension of the rectangular container and minimizing the other subject to feasibility of the clusters layout. On the contrary, we may fix both dimensions of the container and look for a "sparsest" layout maximizing a certain "distance" between the clusters. This objective is motivated by the need of more space between clusters to facilitate access for their loading/unloading and is used in this work. A layout problem for a number of clusters composed by irregular 2D objects is formulated. The clusters have to be placed inside a given container subject to non-overlapping between objects within a cluster. Each cluster is represented by the convex hull of irregular objects that form the cluster. Two clusters are said to be non-overlapping if their convex hulls do not overlap. A cluster is said to be entirely in the container if so is its convex hull. All objects in the cluster may have different irregular shape (different sizes are allowed) and can be continuously translated and rotated. The objective is constructing a maximum sparse layout for clusters subject to non-overlapping and containment conditions for clusters and objects. In addition a balancing conditions are considering. New quasi-phi-functions and phi-functions to describe analytically placement constraints for clusters are introduced based on the defenitions of phi-function and quasi-phi-function for a pair of objects 3, 4]. The layout problem is formulated as a nonlinear nonconvex continuous problem. A novel algorithm to search for locally optimal solutions is developed. Computational results are provided to demonstrate the efficiency of our approach.

References

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