

Vehicle Underhood Packaging Optimization Considering Pipes, Cables, and Hoses Routing



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Objectives

The research objective is to solve a multidisciplinary multiobjective optimization problem of placing different components of a system within a container to achieve maximum compactness along with minimizing the routing of connectors between these components.

Motivation and Research Questions

- What is the most efficient and compact arrangement of several components with arbitrary shapes in a container
- How to find the optimum route of several pipes, cables, and hoses under the hood of a vehicle rather than place them manually
- The routes have different start and end points which no one has looked into before

Progress Made

- Literature review on packaging and layout optimization as well as pipe routing problems in different industries
- Running rubber band packing, a method shown in Fig. 1, and bi-level packaging with a sample result shown in Fig. 3 codes written by previous students to get results
- Proposing three methods to solve the routing problem; Medial Axis Transform (MAT) theory of computational geometry shown by medial lines in Fig.2, morphing the components as opposite of rubber band convex hulls, or through looking into adapting the Travelling Salesman Problem (TSP)

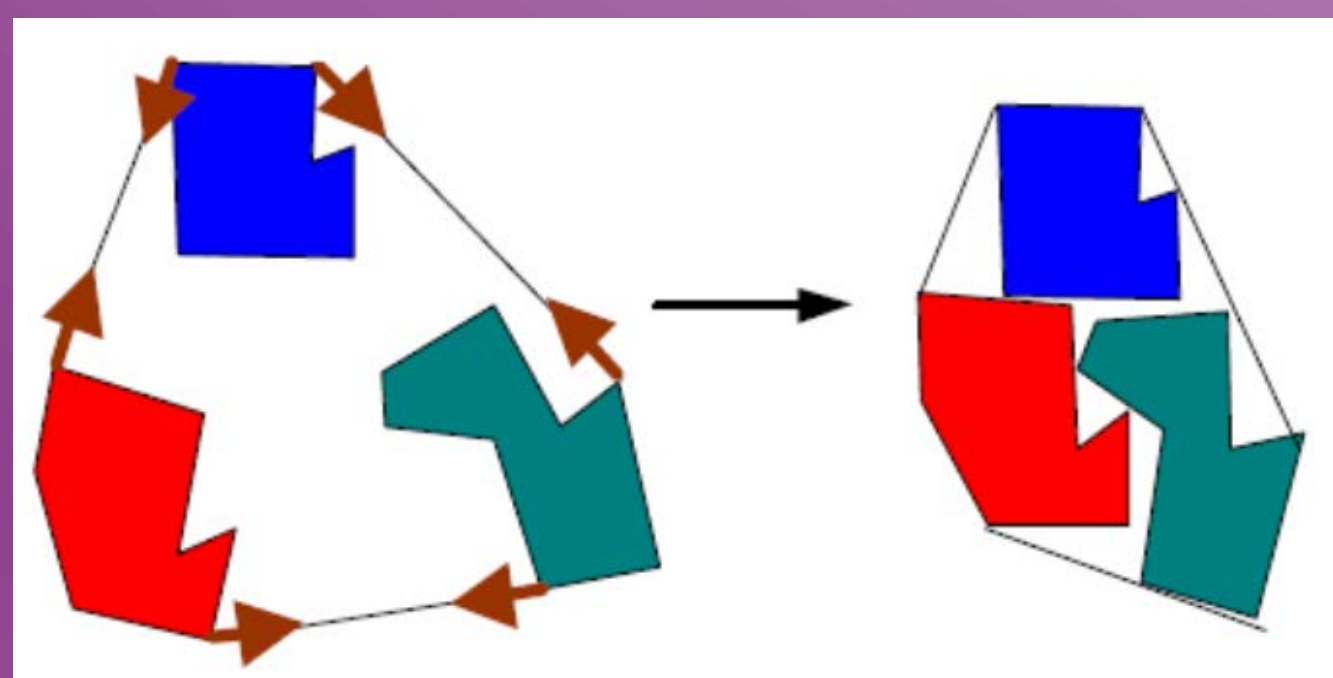
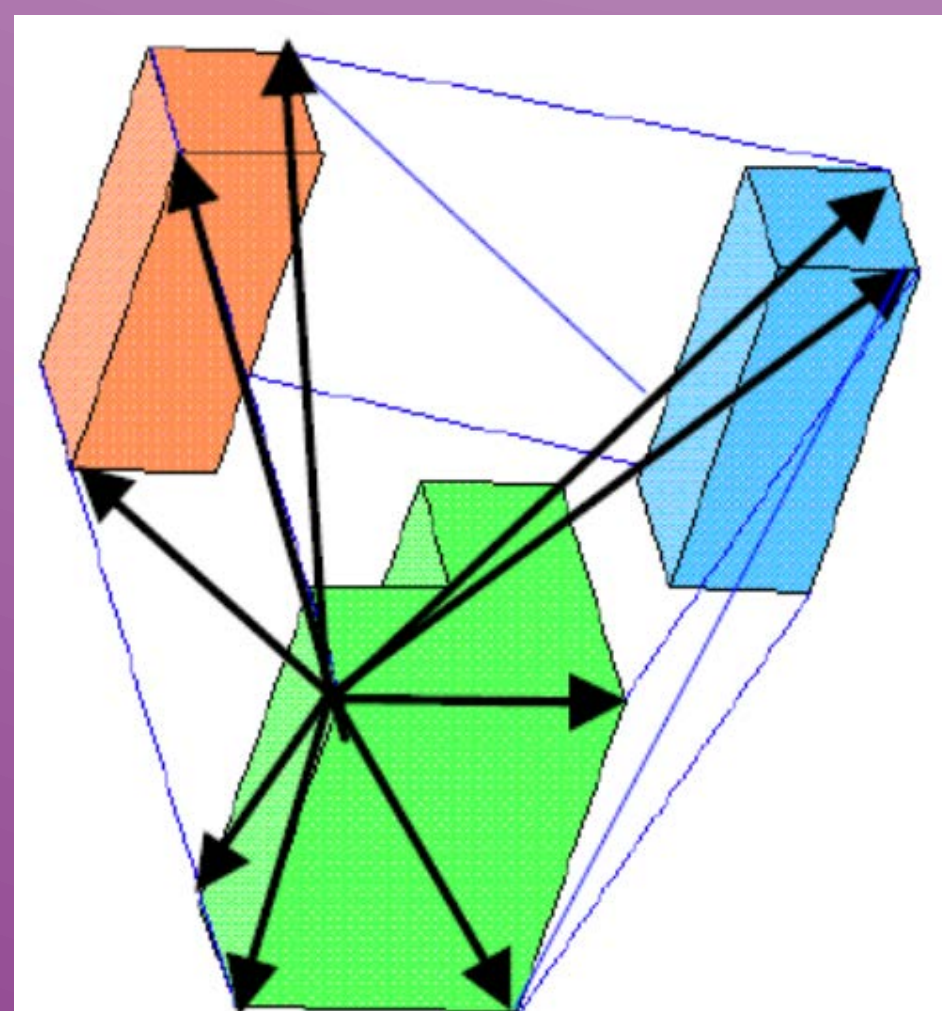


Fig. 1 Convex Hulls of Rubber Band Packing for 2D and 3D



Intellectual Merit and Broader Impacts

- The research will introduce a mathematical tool to solve cable and pipe routing problems for vehicles underhood
- It will enable automotive and aircraft industries to not only pack the underhood components but also route the cables and hoses in the optimum way rather than manually
- By this routing mechanism one can place pipes and cables among the components of a container without any collisions or intersections
- The route found will be the shortest path with the minimum number of turns

Research Plan

- Running the codes on the Palmetto Cluster to test their accuracy
- Evaluating the three methods of solving the routing problem of 2D (planes and surfaces) and 3D (space and volumes) types
- Comparing the efficiency of the three methods of MAT, morphing and TSP

Illustrative Figures

- ✓ Voronoi Diagrams of Medial Axis Transform

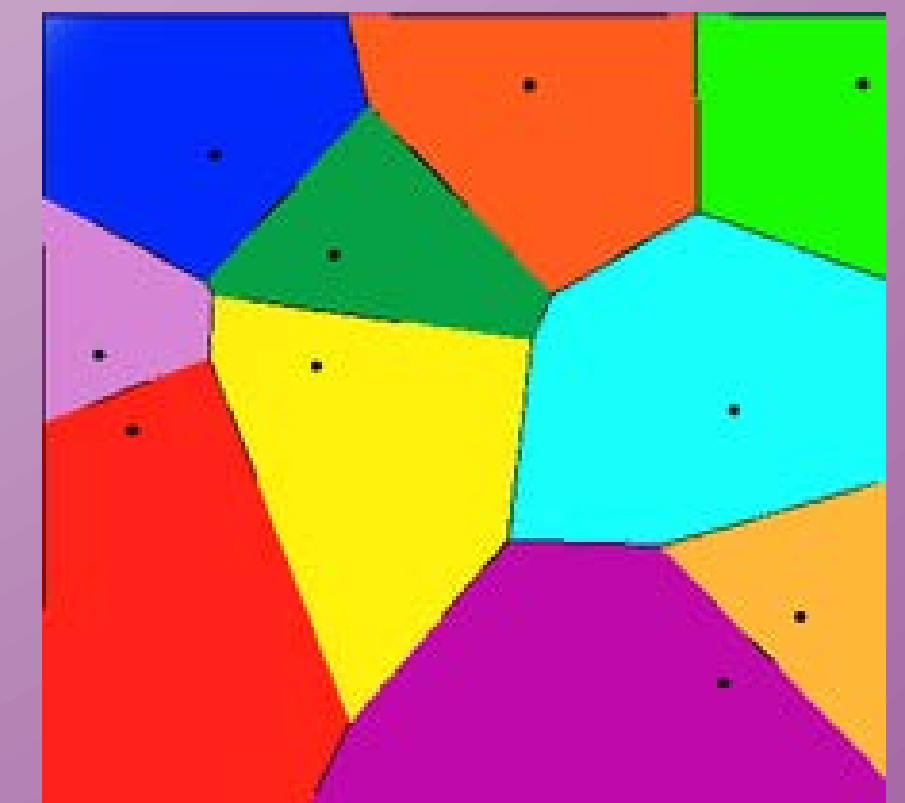


Fig. 2 Voronoi Diagram

- ✓ Vehicle underhood components packed through Bi-level packing method

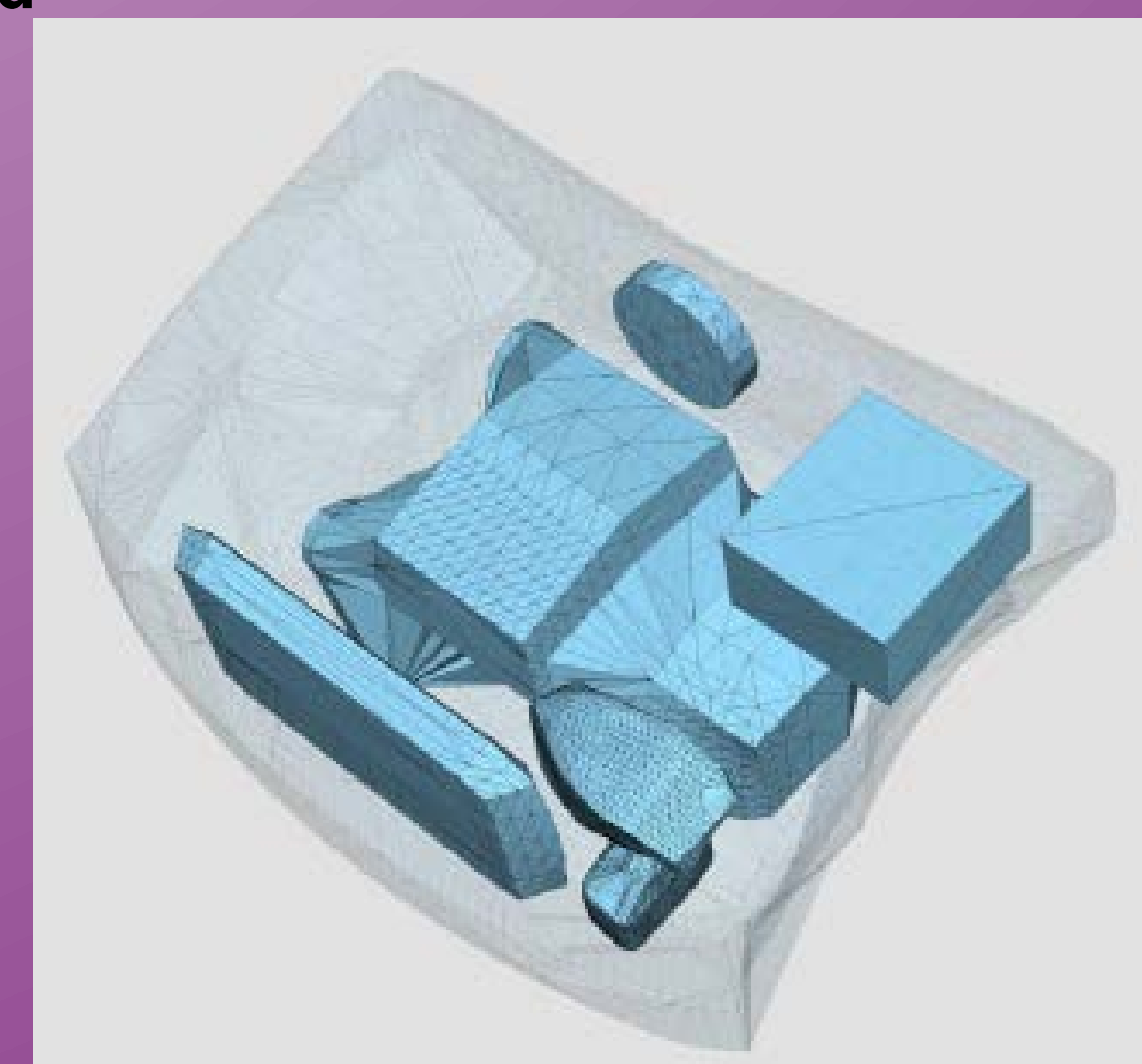


Fig. 3 Packaging Results for a Vehicle Underhood

Conclusions

This research has a background of component packaging optimization and is an attempt to solve the routing problem of components connectors in the most efficient way with the least computational effort.