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Bending Sequence Optimization of Metal Sheets

Bending Sequence | Genetic algorithms | Metal sheets

In metal sheet industries, the required shape has to be bent from a flat sheet. The process of generating an optimal bending sequence for the bending process is computationally hard. In this work, three approaches were investigated for generating bending sequences; genetic algorithms, insertion algorithm and an unfolding approach in attempt to find a good approach for generating an acceptable bending sequence.

Introduction

The goal of this project was to find an alternative algorithm to the currently exhaustive search implemented by TRUMPF GmbH, to enable computing a collision free bending sequence in tolerable time. This is due to the fact that an increase in the number of bending lines causes an explosion in the number of possible solutions, thus, making the brute force search inefficient. Genetic and insertion algorithms were implemented and evaluated using 57 real-life metal sheets, results were analysed and compared against one another, while using the brute force algorithm as a benchmark. A minor enhancement was made to the insertion algorithm obtaining the extended version.

The results proved that this algorithm outclassed the brute force, genetic and insertion algorithms.

TRUMPF GmbH has an existing program, TruTops Bend, that includes an implementation for a sequencer algorithm responsible for computing a bending sequence for a given metal sheet.

The sequencer uses a brute force algorithm. Not only does it take too long to determine a solution for some of the cases, but also the computed solution might not be a valid one (i.e. collision-free). Thus, it was required to enhance such an implementation, or come up with a new algorithm that produces a bending sequence overcoming the deficiencies in the current implementation.

For bending pieces with simple geometry, determining a suitable bending sequence is an easy task. However, the difficulty of determining such a sequence is directly proportional to the complexity of the bending piece.

The aim of this work was to enhance the methodology used to obtain a bending sequence for a metal sheet, given the bending lines, angles and tools. The goal was to find an alternative algorithm to the currently exhaustive search implemented by TRUMPF GmbH, to enable computing a collision free bending sequence in tolerable time. Genetic and insertion algorithms were implemented and evaluated using 57 real-life metal sheets, results were analysed and compared against one another, while using the brute force algorithm as a benchmark. A minor enhancement was made to the insertion algorithm obtaining the extended version. The results proved that this algorithm outclassed the brute force, genetic and insertion algorithms.