Study on General Pattern Method to Effectively Solve Two-dimensional Blanking Problem

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Abstract. In the actual production of a wide range of applications, optimization blanking is to study how to blanking material utilization rate is the highest. Two-dimensional pattern problem is an important branch of pattern problem. This paper classifies two-dimensional pattern methods and studies several effective pattern methods commonly used at present.

Introduction

Optimization blanking is to study how to blanking material utilization rate is the highest, in the actual production of a wide range of applications. Machinery manufacturing, furniture manufacturing, clothing manufacturing and other industries have a large number of blanking problems. It is one of the effective ways to improve material utilization rate and reduce production cost. Improving material utilization rate is a system engineering problem, which needs to provide complete integrated solutions from production management, support decision, etc. Constructing effective optimization algorithm is a key link in optimizing blanking, and pattern problem has been proved to be NP difficulty problem[1].

CAN (Computer Aided Nesting) is one of the Computer Aided technologies widely used. In many industries of national economy, material segmentation problem can be encountered. The function of CAN is to generate a material segmentation and pattern scheme with high utilization rate. Therefore, CAN pattern CAN be applied in all industries that need material segmentation to save materials and reduce product cost. Clothing manufacturing industry, wood products industry, furniture manufacturing industry, metal products industry, general machinery manufacturing industry, special equipment manufacturing industry, transportation equipment manufacturing industry, electrical machinery manufacturing industry and other industries in actual production are all industries with many problems in the division of applied materials, which form the main application area of CAN. The significance of applying CAN: through saving materials, reducing the workload of pattern and simplifying the cutting process, the product cost CAN finally be reduced[2]. Rectangular pattern problem is an important branch of two-dimensional pattern problem. Rectangular pattern problem refers to the selection and pattern of several rectangular parts of small size on a rectangular plate of specified size. A new pattern method is adopted to maximize the total value of blank in the plate, so as to save the plate.

Classification of Rectangular Pattern

There are various classification criteria for the pattern of rectangular parts. The following classification is conducted according to the discharge position of the objects to be distributed and the number of species of the objects to be distributed.

According to the Discharge Position of the Object to be Distributed

According to the discharge position of the object to be cloth classified, that is, according to the requirements of the actual cutting process, limit the object to be cloth rotation Angle, rotation (also known as direction fixed) or rotation (also known as steering). Figure 1a shows two different discharge positions of the blank. In Figure 1a, all blank directions are fixed, and the length of blank is consistent with the length of plate. The blank in Figure 1b is allowed to rotate $90^\circ$. 
Classify according to the Number of Species to be Covered

According to the number of blank species allowed in the plate, it is classified into single pattern[3] and nesting pattern[4]. Single pattern means that only one kind of blank is allowed in a sheet. Nesting pattern means that different types of blanks can appear in the same sheet. Compared with nesting pattern, single pattern method has a lower blanking utilization rate, but the blanking process is simple, and the blanking can be organized separately according to each production order, the site management is simple, and the production cycle of the product can be shortened. It is more and more widely used in practice because of the complexity of cutting technology and the obvious improvement of material utilization.

Commonly Used Effective Pattern

Classical two-stage pattern has been paid attention to in pattern theory and practice. A classical two-stage method means that a plate can be cut into a blank in two stages, in which the shear lines of each stage are parallel to each other, and the shear lines of the adjacent two stages are perpendicular to each other. Figure 3 shows a classical two-stage approach in which the number represents the blank type number. In the first stage, the plate is divided into horizontal strips with the horizontal shear line as shown by the arrow. In the second stage, the strip is cut into blank with the vertical shear line.

The common three-stage pattern means that the plate can be cut into blank in three stages. In the first stage, the plate is cut into segments. In the second stage, the segment is cut into stages. The third stage is to cut the blank. Figure 4 shows various types of common three-stage pattern, with horizontal arrows representing x-direction segments and vertical arrows representing y-direction segments. Where, if it is composed of a series of x-directional segments arranged horizontally from
left to right, it is called 3stage-x three-stage pattern mode. If it is composed of a series of vertically arranged y-segment from top to bottom, it is called 3stage-y pattern mode. Therefore, it can be concluded that the pattern mode of 3stage-x pattern mode can be changed to change the length and width of the plate at the same time to determine the pattern mode of 3stage-y pattern mode $90^0$.

![Figure 3. Ordinary two-stage pattern.](image)

Conventional two-section pattern means that the plate is divided into two sections by a horizontal or vertical shear line. When the shear line is vertical, it is called 2section-x pattern (Figure 5a). When the shear line is horizontal, it is referred to as the 2section-y pattern (Figure 5b).

![Figure 4. The types of the 3Stage cutting.](image)

The common three-stage pattern is a superset of the common two-stage pattern and the common two-stage pattern. In other words, the common three-stage pattern includes the common two-stage pattern and the common two-stage pattern.

**Summary**

In many industries of national economy, material segmentation problem can be encountered. The function of CAN is to generate a material segmentation scheme with high utilization rate. Therefore, CAN can be applied in all industries that need material segmentation to achieve the purpose of material saving and product cost reduction. This paper studies the problem of two-dimensional pattern, classifies the pattern methods to solve the problem, and introduces several common and effective pattern methods.

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