Design and Development of Urban Cultural and Creative Products with Segment Filling Insertion

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Abstract. Known as the essential filling insertion technology of Kesi and Yunjin, the segment filling insertion can only be inherited by handicraftsman currently, which is threatened with extinction. In the study, automatic segment filling insertion technology was introduced, and applied to produce cultural and creative woven products with urban themes. What proposed in this paper can not only promote the digital innovation of the traditional weaving process, but also incorporate into the contemporary cultural creative products.

1. Introduction

Kesi and Nanjing Yunjin wood loom hand-weaving techniques, which are characterized with segment filling insertion, have been elected as the world intangible cultural heritage and are in the UN intangible cultural heritage list of human beings in 2009 respectively. Being different from the normal filling insertion method, the wefts are separated into several segments, and each segment was controlled by weavers using different shuttles in Kesi and Yunjin hand weaving[1] (see Fig.1). As shown in Figure 2, in fabrics with segment filling insertion, each weft is composed with several different yarns of different colors to create various patterns.

Fig. 1 Segment filling insertion method on wood hand loom
Although features of Kesi and Yunjin Fabrics are precious and luxurious, their weaving process is quite time-consuming and needs high labor costs, and patterns of these intangible weaving techniques cannot meet current customers’ fashion demands. Therefore, this paper is aimed to introduce an automatic weaving method for segment filling insertions, and its applications in cultural and creative woven fabric design and development.

\section*{2. Automatic dobby weaving machine with segment filling insertion}

With improvement of automatic techniques, the segment filling insertion process can be inherited and controlled by modern machinery. According to the analysis of manual segment filling insertion process\cite{2} on the traditional fabrics, such as Kesi and Yunjin, it is necessary to hold the shuttle alternately with both hands through a clear opening in weaving, which demonstrated as segment filling insertion. On the basis of the comparison between manual segment filling insertion process and the normal filling insertion process of double rapier looms\cite{3-4}, segment filling insertion technology can be achieved by modifying the double rapier dobby loom\cite{5}. Because weft yarns need to be well controlled by the device which is similar to weaver’s hands, the rigid double rapier is utilized as a basis of the segment filling insertion device. So on the dobby loom, the width of inserted weft is varied, and determined by the movement distance of the shuttle, which is controlled by the trajectory of the rapier, that is determined by changing setting parameters.

Typically, the shuttles can be flexibly chosen and replaced in manual segment filling insertion technique, that is, the shuttles can be easily installed and changed at any time during the weaving process. In this paper, a module for storing and selecting shuttles is set up, in which the employed shuttle is grabbed by the rapier during the manufacturing process, and inserted back into the shuttle box after the segment filling insertion. Therefore, the flexible selected function of shuttle is realized.

Automatic weaving process is implemented when the computer aided manufacturing (CAM) system is used in the rapier loom. The pattern cards are generated according to the designed patterns, the selected shuttles and the corresponding distance are input as parameters into CAM system simultaneously. Automatic dobby weaving machine with segment filling insertion as follows (Fig. 3).

![Fig. 2 Segment filling insertion fabric](image)

Although the segment filling insertion fabric can be digitally weaved, dobby openings is limited by the number of heald frames, while the number of segment is restricted by the number of heald frames.
Thus, traditional dobby loom is suitable for the weaving patterns with small repeats. The reason why the designed fabric can be divided into 8 segments at most is that the machine only has 16 pages of heald frames, therefore, the color bar element is extremely significant in pattern design. The machine has 4 shuttle boxes, then up to 4 colors can be set in each row (see Fig. 4).

![Fig. 4 Figure of shuttles and shuttle boxes](image)

### 3. Design of urban cultural and creative products

This study explored application of segment filling insertion technology in design and development of cultural and creative products. In the paper, the cultural and creative products were inspired by Urban elements of Beijing and Shanghai. Incorporated filling insertion technology into the urban cultural creative products [6-7].

Known as the world’s most populous capital city, Beijing is the political, educational and cultural center in China, with a rich history dating back three millennia. The forbidden city is a place complex in central Beijing, and it was the former Chinese imperial palace and state residence of the emperor from the Ming dynasty to the end of the Qing dynasty. The pattern in the “Beijing” theme was inspired by the wall of the Forbidden City after snow. As shown in Fig. 5, red color represents the Forbidden City’s walls, blue is for the sky, golden is for the carved roof of the palace. The pattern design was restricted by the numbers of heald frames and shuttle boxes, and was characterized with some color blocks. According to technical limitations and weaving stability, the designed pattern of urban cultural and creative fabrics was divided into 6 parts. As shown in Fig.6, plain weave structures were used to realize maximum numbers of segments and ensure woven fabrics straight, flat, shape-retaining and wear-resistant.

![Fig. 5 Pattern design of Beijing](image)
Located on the southern estuary of the Yangtze, Shanghai is a global center for finance, innovation and transportation. Being described as the ‘showpiece’ of the booming economy of China, Shanghai gathers people from all over the world and its culture makes it diverse in people's exchanges. The pattern designed in “Shanghai” theme was inspired by the renowned Bund scenery, where the skyscrapers along the Bund are rising up to the sky and lined up. A variety of colors are used to fill the buildings, which presents the inclusiveness and flexibility of Shanghai, where blue for the innovation and high-tech industries, golden for prosperity on economy and finance, purple for unlimited possibilities. The pattern design designed for Shanghai can be depicted in Fig. 7. Due to the limitation of the machine, the weaving pattern needs cross connections at the intersection points connected with different shuttles.

4. Development of urban cultural and creative products

To develop the fabrics with segment filling insertion, the study investigated the weaving process of designed patterns on the automatic dobby machine with segment filling insertion. Yarn specifications, machine settings, woven fabrics, finished urban cultural and creative products are presented in the section.

4.1. Weaving parameters

The main characteristic of the segment filling insertion fabric is the obvious distinction on color among the weft yarns. In order to distinguish the difference between the warp yarn and the weft yarn in finished product, the applied warp yarn’s fineness is opt to 30tex and color is white, while the fineness of the weft yarn is 333.3tex.

The pattern design of Beijing can be divided into three parts (see Fig .8), where contains of four different colors.
Fig. 8 Division of the pattern design (horizontal)

In fabric parameters table of Beijing and Shanghai, as illustrated in Table. 1, the warp and weft density of the fabric, the information of the yarns, and the length of pattern card are included. The principle of the pattern design division of Shanghai is similar to that of Beijing.

Table. 1. Fabric parameters of Beijing and Shanghai

|          | Warp density | Weft density | Width | Yarn material | Color | Pattern card length |
|----------|--------------|--------------|-------|---------------|-------|---------------------|
| Beijing  | 120 /10cm    | 140 /10cm    | 13.5cm| cotton        | 10    | 250                 |
| Shanghai | 120 /10cm    | 140 /10cm    | 13.5cm| cotton        | 7     | 650                 |

The applied fabric parameters of Beijing and Shanghai should be input into the CAM system, including the start point, the selected shuttle information, and the methods of shuttle picking. Typically, the methods of shuttle picking consist of left picking and right picking, the one determined is considered to avoid entanglement among yarns. Part of the pattern card and machine parameters of Beijing and Shanghai is shown in Fig. 9 and Fig. 10.

Fig. 9 Part of the pattern card and machine parameters—Beijing

Fig. 10 Part of the pattern card and machine parameters—Shanghai

4.2. Finished fabrics and products
The designed fabric is subsequently formed on the basis of proposed process, the reverse view together with the front view of fabric, and details of the segment weaved are presented in Fig. 11-13. Urban fashion arts element is incorporated into the finished products, and the inheritance of traditional handicrafts is advanced as well.

(a) “Beijing” theme                     (b) “Shanghai” theme
Fig. 11 Fabric reverse view

(a) “Beijing” theme                     (b) “Shanghai” theme
Fig. 12 fabric front view

(a) “Beijing” theme                     (b) “Shanghai” theme
Fig. 13 fabric front view

The woven fabrics with segment filling insertion were used to make some cultural and creative handbags. As illustrated in Fig.14, some decorated strips with similar colors and patterns were produced in digital printing to match the woven fabrics. These printed strips and woven fabrics with segment fillings were sewn on the canvas bags. The finished handbags are shown in Fig.15.
5. Conclusion
There exists tremendous application of automatic dobby weaving machine with segment filling insertion in urban cultural creative products, which will enlighten the cultural creative products and fashion arts. In this paper, automatic dobby weaving machine with segment filling insertion was introduced, and a case study of designing and developing cultural creative products was explored. The design was inspired by urban elements of Shanghai and Beijing, and fabrics with segment wefts were formed on the modified machine and then were used in canvas bags. The work validated technical feasibility of automatic dobby weaving machine with segment filling insertions, which made traditional weaving techniques into partly automatic weaving. This will definitely reduce weaving time of woven fabrics with segment wefts and provide more possibilities in cultural and creative product design. In the study, the pattern design was restricted by the numbers of healds on the dobby machine, and it was only characterized by color blocks. With the development of weaving technology, various products on fashion arts could be created with automatic segment filling processes. Findings in this study can not only promote the digital innovation of the traditional weaving process, but also incorporate into the contemporary cultural creative products.

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