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A Case Study on the Defects in Industrial Manufacturing of Embroidered Textiles

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***Abstract*— The paper presents research on the defects in industrial manufacturing of embroideries. A case study was performed in a real company to assess the types and the frequency of the defects appearance. A preliminarily developed classification of the embroidery defects was applied. It was found that the most frequently found defects were related to mixed problems in the design stage and manufacturing stage. Missed trim was responsible for 45% of the defects found. The results obtained show the practical application of a theoretical classification, which can help a company to solve manufacturing problems related to embroidery of textiles.**

Keywords—embroidery; defects; textiles; classification

I. INTRODUCTION

Modern embroidery machines are fully automated and have a large number of heads (up to 56) that can operate with up to 18 needles. They include a large color display with usb interface, built-in editing software, and storage systems for the design files. Together with the creation of a unique design of various textile products, machine embroidery can be used for the embodiment of electronic components, sending messages for upcoming events, logo and trademark showing, etc.

The industrial manufacturing of embroidered textiles goes in line with production defects, which decrease the quality of the final garments. The defects' appearance in embroideries is related to factors like the textiles and the embroidery threads [1], but also the design and the finishing of the embroidery [2]. An investigation has shown that the embroidery can change even the mechanical properties of the textile macrostructure [3]. The fabric deformation due to embroidery has been studied in [1, 4] and the reasons for threads end-down has been assessed in [5]. The surface non-uniformity of the textiles, joined via embroidery, was recently investigated in [6].

In our previous research on the topic, we have developed a classification of the defects in machine embroidery of textiles [2]. Since the discovery and assessment of the defects are based on visual observation of the embroidery and its comparison with standard embroidery, a research on automatic detection of defects is also needed [7]. The authors of [7] proposed a classification of the defects as well, but it included only four types of defects.

Being it manual or automated, the recognition of defects in industrial manufacturing of embroidery of textiles requires a clear concept about the defects' type and classification. The assessment of the defects helps the management of the embroidery production, as it can clearly show where the main problems are: in the design stage, in the manufacturing stage or during finishing of the embroideries.

The aim of our case study was to perform a systematic control of the quality of embroidered textile items in real production conditions so as to analyze the distribution of the different embroidery defects and determine the most common types of them. The practical result is to specify both the exact reasons for defects' occurrence and the production stage, which is responsible for the highest quantity of defects within a single batch of orders.

II. METHODOLOGY

A. Classification of the Embroidery Defects

The classification used for assessment of the types of embroidery defects was described in [2]. It involves the following defects:

Defects in the design stage: These defects occur due to errors in the design of the embroidery:

- Incomplete (poor) overlapping between the filled object and its contour;
- Visible fabric (gapping);
- Bunching at the corners.

Defects in the manufacturing: This relatively common group of defects is due to problems with the

technology of preparation, choice of textiles, needles, thread tension, speed, etc.:

- Bobbin thread visible in the embroidery's surface;
- Fabric damage;
- Poor hopping;
- Unraveled threads;
- Separation of the textile layers in appliqué;
- Distortion of the shape of the objects.

Defects in finishing:

- Improper removal of the embroidery stabilizer - backings and toppings;
- Defect from the embroidery frame (hoop marks).

Mixed defects: they are a combination of defects, due to improper work within two or more manufacturing stages:

- Too thick embroidery;
- Incomplete coverage;
- Missed trim;
- Design different from the desired.

B. Experimental Conditions

The case study was performed in a real company in Sofia (Bulgaria), specialized in manufacturing of embroideries. The target aim was to detect 100 defect embroideries and to assess them following the classification in [2]. All defect samples were photo-captured for further classification of the defects. Figure 1 shows one of the embroidery machines, used for the embroidery manufacturing: GG 908 Feiya Group, China and MY-CEM 904 BeiJing Mayastar Machinery & Electrical Equipment Co., Ltd.

Fig. 1. The embroidery machine.

III. Results and Discussions

A. Types of Defects

Figure 2 demonstrates a sample with incomplete overlapping between the filled object and its contour. This is a common defect in the embroidery design, characterized by remaining "empty" spaces between the objects and its contour. Defect embroideries, in which the fabric is visible through the stitches and embroidery that bunches at the corners, were not found.

Several defects in the manufacturing stage were detected. The visible bobbin thread (Fig. 3) can be avoided by using a suitable needle thread, a correctly wound bobbin thread and appropriate tension between the needle and bobbin threads. A damaged fabric (Fig. 4) appears as a defect due to improper selection of the needles, too many stitches in one place, or incorrect removal of the backing after the embroidering. Poor hopping (Fig. 5) is another defect that deteriorates the appearance of the fabric. The unraveled threads defect (Fig. 6) is related to both the needle and the bobbin threads and appears due to incorrect use of needles, threads and tensions.

Fig. 2. Incomplete overlapping between the filled object and its contour.

Fig. 3. Bobbin thread visible in the embroidery's surface.

Fig. 4. Fabric damage.

Fig. 5. Poor hoping.

Fig. 6. Unraveled threads.

The distortion of the shape of the objects is shown in Fig. 7. A defect, related to the separation of the textile layers in appliqué was not detected during the case study.

When embroidering, an embroidery stabilizer (usually a non-woven tissue) is used to ensure the stability of the embroidery. If the backing is not removed completely after embroidering, the detail is classified as a faulty piece – Fig. 8. Another defect, which can be seen after finishing the embroidering process, is a visible mark of the embroidery frame – Fig. 9. It is often permanent and cannot be removed by treatment with moisture and heat.

Fig. 7. Distortion of the shape of the objects.

Fig. 8. Improper removal of the padding.

Fig. 9. Defect from the embroidery frame.

There is also a group of defects, which presents a combination of defects, obtained as a result of two or more stages of the embroidery's manufacturing. An embroidered detail with very big thickness can be obtained due to improper design (too many stitches per unit area) and selection of a very thick stabilizer in the manufacturing stage. The incomplete coverage and missed trim appear again due to defects in the design and manufacturing stages. Any deviation of the final embroidery from its desired design in terms of color, position, size, etc. is classified as a defect.

B. Summary of the Defects

To reach the goal of detecting 100 embroideries with flaws, a total of 2889 embroideries were checked for quality. The result was that 3.46% of the total manufactured embroideries were classified as defect ones.

The classification used allowed us to establish the frequency of appearance of each of the defects. Figure 10 visualizes the distribution of the ten defects, which were found during the quality check. The results from the analysis showed that the top three defects were due to missed trim (45%), incomplete coverage of the objects' surface (19%), and unraveled threads (12%).

The grouping of the defects in accordance with the stage of the manufacturing is shown in Fig. 11. Following the classification, the mixed defects, which appearance was due to more than one stage (usually a combination between the design and manufacturing), dominated over the others. Only 2% of the detected defects were due to design faults only and 5% - due to finishing errors only. The results in Fig. 11 also show that the manufacturing of the embroideries is the most problematic stage, as 93% of the defects are related to it (in a combination with another production stage or not).

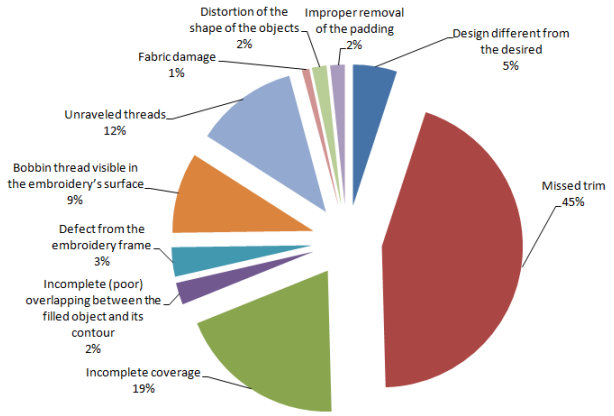

Fig. 10. Distribution of the embroidery defects.

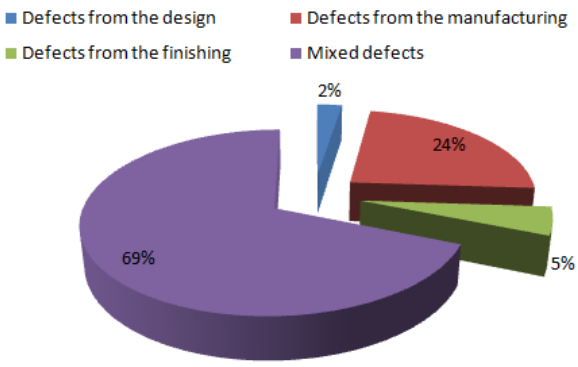

Fig. 11. Distribution of the defects according to the stage of manufacturing.

The performed case study allowed assessing the share of faulty embroideries with one or more defects. It resulted that 83% of the embroideries had 1 defect,

16% presented a combination of 2 defects and only 1 had three defects.

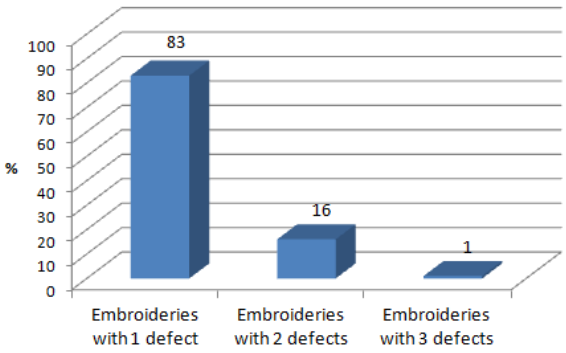

Fig. 12. Embroideries classified according to the number of the defects.

IV. CONCLUSIONS

The performed case study on the embroidery defects in a real company for the production of embroidered textiles showed that the systematic check of the quality of the embroideries and their assessment, using the applied classification, can be very useful to specify the production stage where the most of the defects are produced.

In our case study, the most frequently seen defects were related to mixed problems in the design stage and manufacturing stage. Missed trim (45% of the defects) is obtained when changing threads with different colors or when moving between objects, placed at a distance one from the other. To avoid this defect it is necessary to precisely specify the sequence in the elaboration of the embroidery during the process of digitalization.

The defect “incomplete coverage” (19% of the defects) can be minimized or eliminated in the design stage by selecting the appropriate stitches, the density of the stitches and very good outline of the objects in the embroidery. In the manufacturing stage, the proper selection of an embroidery stabilizer can also contribute to the elimination of this type of defects.

Unraveled threads (12% of the defects) can be related to both the bobbin thread and the needle thread and is due to the process of manufacturing of the embroidery. It can be avoided via using threads with proper linear density and needles with the necessary number. The tension between the needle and bobbin thread needs to be carefully set as well.

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