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A comparative analysis of the capabilities of digital embroidery software products

Daniela Sofronova, Radostina A. Angelova

In this paper, a comparative analysis of the capabilities of four leading software products for programming of embroidery machines was made. The implemented features in each software are systematized on a modular principle, and the innovations in the machine embroidering process are highlighted.

Keywords: software, digital embroidery, Wilcom's EmbroideryStudio e4, Melco's DesignShop V10, Janome's Artistic Digitizer, Brother's PE-DESIGN

Introduction

The world's leading manufacturers of industrial embroidery machines like Melco USA, Wilcom Australia, ZKF Germany, Tajima Japan, and others are continuously improving the machine's constructions as well as their software products [1]. Besides, an improvement of the existing libraries is made, and some new features and applications are developed. For example, the web-based application in EmbroideryStudio, which enables online visualization of designs on cloth and other fabrics for client inspection before machine embroidering [1].

In the literature and the internet have been published researches on the types of stitch rows [1, 5, 6, 10], defects [3, 4, 12, 13] and techniques in machine embroidery [2, 7, 8, 9, 11], but there is lack of in-depth analysis for the software capabilities in regard to: tools for digitizing and editing the objects and contours, a variety of stitch rows, control on jump stitches, processing and/or creation of sketches, visualization and simulation of embroidery process, a variety of file formats for the machine program, work with decorative elements and etc.

The digitizing process is an essential step in embroidery production because one part of the defects is due to inaccuracies and mistakes in the object's differentiation and the type of stitch rows. Possible defects and their causes are systematized and described in detail in [4].

Therefore, the purpose of the present work is to compare the capabilities of four software products of world-leading embroidery machine manufacturers in terms of wide-ranging, fast, intuitive and precision embroidery digitizing, based on the embedded tools.

Control of embroidery automats

The control of the embroidery automats like the other types of computer numerical controlled machines is based on a microprocessor. It receives information as a sequence of instructions, called program, and sends commands to the motors for driving the carriage and the embroidery head. Separately performs feedback control by monitoring the positions of the end effectors through a sensor system and sends adjustment signals. A schematic diagram of the logic of the embroidery machine's work is illustrated in Figure 1. It can also be seen from, that the controller sends data to an output device (display), which is the communication channel with the user and provides useful information relating to the embroidering.

The program is created by software that is most often developed by the manufacturer of the embroidery machine. But unlike some other textile machines (in knitting and weaving technologies) embroidery digitization software allows generation of machine files for several different embroidery machines, which enhances the competition in the sector. Therefore, manufacturers are continually striving to develop their products, applying the latest advances in communications and software sciences.

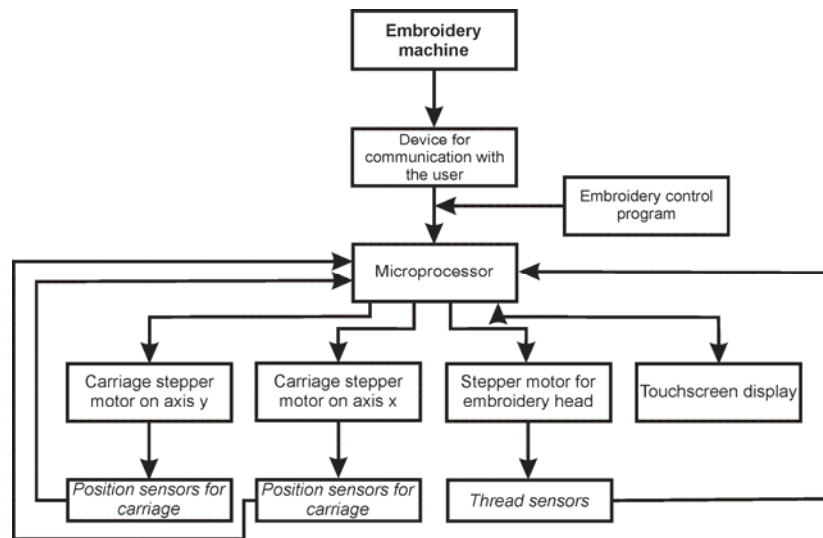


Figure1. Scheme of the work's logic in embroidery machines

Analysing state of the art in the software for digitizing embroidery

To compare the embroidery digitizing process, different software products are selected, developed for both industrial embroidery machines and machines for small production (workshops). The authors point to Wilcom's EmbroideryStudio e4, Melco's DesignShop V10, Janome's Artistic Digitizer, and Brother's PE-DESIGN, the interfaces of which are shown in Figure 2. Software packages that offer free versions on the market are not included in the research, as their capabilities are usually quite limited.

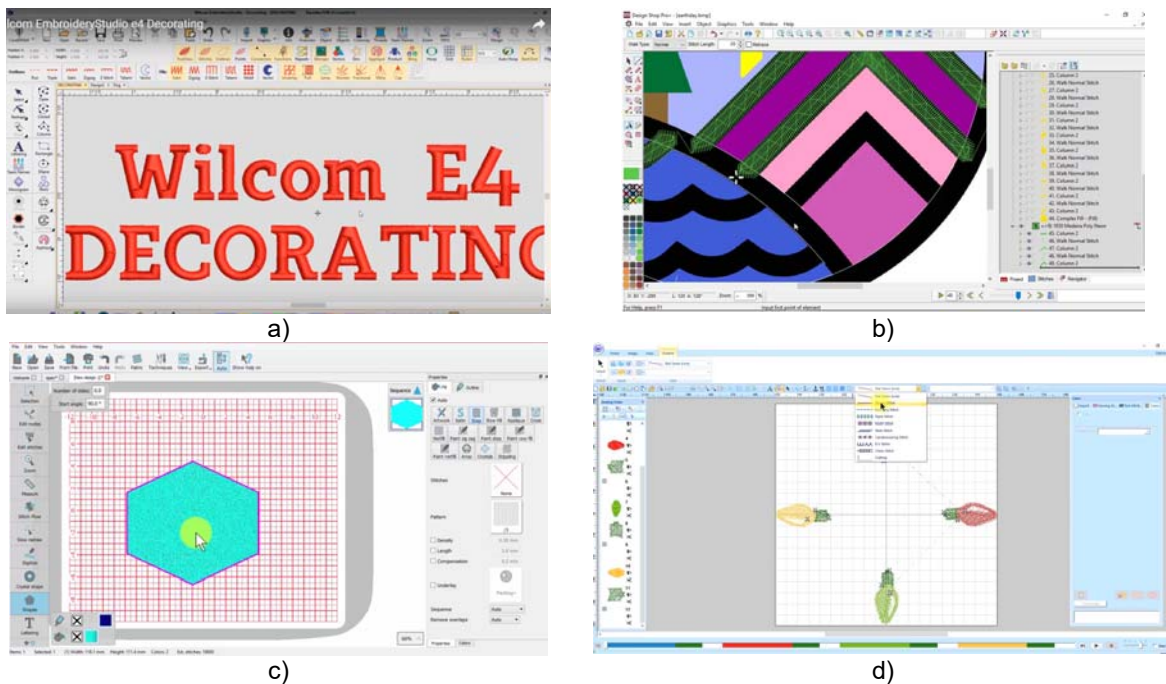


Figure 2. Interface of software for digitizing embroidery, a) EmbroideryStudio e4.2, b) DesignShop v10, c) Artistic Digitizer, d) PE DESIGN v10 [14-17]

To perform the comparison, the basic tools of the selected programs were divided into nine modules. These modules were systematized by the present authors and shown schematically in Figure 3.

Module 1: Working with raster and vector images. It aims to insert already made raster and vector images for automatic or manual digitizing with or without pre-processing, such as reducing colour, enhancing contour lines, removing the background, etc. Only in EmbroideryStudio e4.2, a CorelDraw graphics application is implemented, which makes the work easier and gives the users a high level of opportunities to develop their design ideas.

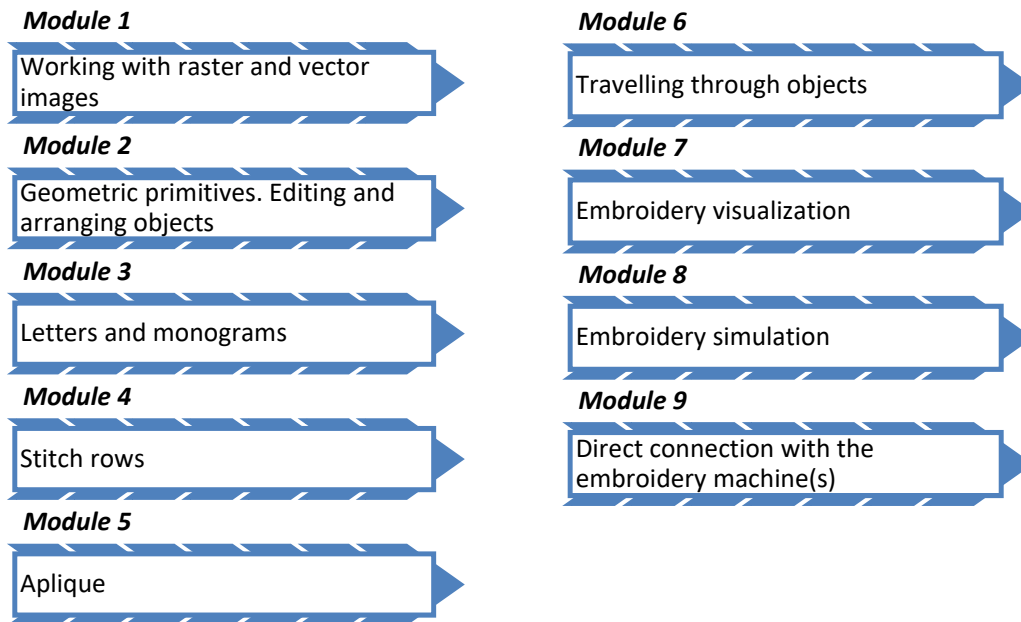


Figure 3. A block diagram with basic modules in embroidery software

Module 2: Geometric primitives. Editing and arranging objects. Digitizing the geometric primitives, setting the colors, editing and arranging them in the work field and the elaboration order are the performed activities in *Module 2*. Digitization, in general, can be divided into *automatic* or *manual* digitizing. By automated digitizing the program recognizes the object as areas and contours and assigns them default stitch rows and parameters, which should be changed subsequently. All four software products have a sufficient set of features that make digitization easy and fast. The module in all studied software has been refined by incorporating new features, borrowed from vector image editing and parametric modeling softwares, to mention only: drawing geometric auxiliary primitives without generating a stitch row; additional geometric primitives such as a star, a polygon, a trapeze, a semicircle, editing the form with adding or deleting points and / or modifying it in a Bézier curve, automatically rearranges the objects in production order, following the rule for shortest way or least jump stitches.

Module 3: Letters and monograms. The work with them is similar to that with objects. With all reviewed software the next features can be setting and editing: the direction, in which the letters are located (straight line, smooth curve line, circle, ellipse), small and/or capital letters, font selection, gradient filling, bold, height, width, spacing between the letters, a mirror image in both directions, the location of letters along the baseline (top, bottom, middle), etc. A single letter of the text or all letters together could be modified. The software products differ by the variety of art templates and fonts (over 200 for EmbroideryStudio e4.2, over 160 for DesignShop, 100 for PE Design Next, and 60 for Artistic Digitizer), as well as pre-visualization of the text for each font, which facilitates and speeds up the choice. The DesignShop has a custom font editor.

Module 4: Stitch rows. This is one of the main modules in the programs that allows choosing/changing all types of stitch rows applied in the digitization of an embroidery: fill, contour, compensatory stitches, underlay, jump and lock stitches. For all reviewed programs there is an improvement in the ability for editing and optimizing the jump stitches, automatically removing stitches when overlapping two or more objects, input of author's motifs, manually adding stitch directions, converting an area object with fill stitches into contour and vice versa, new contour stitches, new embedded motifs. With EmbroideryStudio e4.2 and DesignShop V10 the selected pattern can follow a variable width contour and can adapt its size to the current width – see Figure 4 a. There are also new strategies for filling objects: with a continuous smooth curve line, where the distance between points could be controlled together with the distance of the offset lines from the contour line; spiral, concentric, radial and filling type net with 3D effect (Figure 4 b, c, d and e).

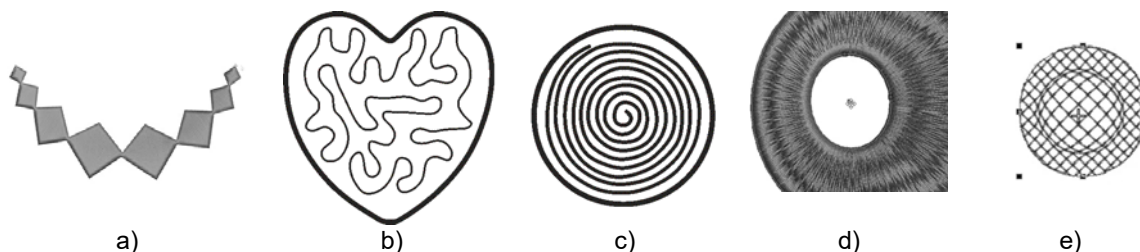


Figure 4. New stitch rows, a) motif, following contour with variable width, b) strategy of filling with a smooth curve line, c) spiral fill, d) radial fill, e) stitch-filling type net with 3D effect

In addition, all studied software packages have the offset tool, which is similar to those, used in graphics programs. EmbroideryStudio e4.2 and DesignShop also have the option of automatically shape the corners of the objects by selecting several approaches. All these innovations contribute to the faster and more accurate digitization of embroidering.

Module 5: Applique. The four software products also offer a programming module for applique without any significant differences. The type of applique, both type and parameters of the stitch rows could be set in all of them.

Module 6: Travelling through objects. All software products offer an option to go through the embroidery design in various ways: following one side to the end, through selected objects, sections or colours, jump stitches, through 1000, 100, 10 and 1 stitch.

Module 7: Embroidery visualization. The visualization of the embroidery has also been developed further and has comparatively equal opportunities in all reviewed programs. The embroidery design can be represented in four different ways: realistic (3D), with stitch rows (2D), with lines (no stitches), and with puncture points of the needle. Design visualization as a line is applied to evaluate the value of the compensatory stitches, and the choice of needle puncture points is appropriate, for example, by dividing the object into components. In addition, visualization only for object selections is feasible, all other objects being invisible. Display only for objects with the same colour is also possible, which allows easy colour change with a single button press (EmbroideryStudio e4.2). A useful feature is also the visualization of jump stitches, an example of which is presented in Figure 5. Thus, the user is more oriented in the embroidering process itself and can control the location and number of jumps, which is a prerequisite for achieving higher embroidery quality.

Only EmbroideryStudio e4.2 has a visualization of the embroidery design on a textile product, but all of the reviewed software products have visualization on a fabric.



Figure 5. Visualization of jump stitches with EmbroideryStudio e4.2 [14]

Module 8: Embroidery simulation. Besides the visualization of the embroidery design, the programs can also simulate the embroidering process itself. Thus, the user gets a complete picture of the sequence of machine motions. In turn, it makes it easier to detect faults in the digitization step.

Module 9: Direct connection with the embroidery machine. In all four software products, the program can be loaded in three different ways: directly with cable connection, directly via a wireless connection, and indirectly with portable memory USB. Besides, the programs generate an embroidery design report that includes information about the number of stitches, machine time, number and type of colours, number of colour shifts, etc.

Table1.

Comparison of the capabilities of the embroidery software products

Capabilities about		Software	Wilcom	Melco	Janome	Brother
Digitizing	processing speed		VVV	VVV	VV	VV
	variety of stitch rows		VVV	VVV	VVV	VVV
	variety of motifs		VVV	VVV	VVV	VVV
	processing of images		VVV	VVV	VV	VV
	creating images		VVV	VV	-	-
	variety of fonts		VVV	VVV	VV	VV
	creating your own motifs and fonts		VV	VVV	-	-
sequins, stones, etc. decorative elements		VVV	VVV	VV	VV	
Visualization			VVV	VVV	VV	VV
Simulation			VVV	VVV	VVV	VVV
Connection with machines	direct with cable connection		VVV	VVV	VVV	VVV
	direct with Wi-Fi		VVV	VVV	VVV	VVV
	indirectly with portable memory USB		VVV	VVV	VVV	VVV
	barcode scanner		VVV	VVV	-	-
	embroidery data sheet		VVV	VVV	VVV	VVV
variety of machine type files		VVV	VVV	VVV	VVV	
Preparation of order document	detailed order sheet and preview of embroidery design on textile product		VVV	-	-	-
Training	blog, news and video lessons in software		VVV	VVV	-	-
	blog, news and video lessons in internet		VVV	VVV	VVV	VVV

Legend: VVV - excellent, VV – well-developed, V - medium-developed, - not yet developed

Table 1 presents the evaluation result of the capabilities of the four software products in terms of digitization, visualization of designs, simulation of the embroidering process, connections with the machines and generation of embroidery reports and order documents. It shows that the reviewed software has achieved a relatively equal level of features, but EmbroideryStudio e4.2 of Wilcom and DesignShop of Melco show slightly higher capabilities in the process of digitizing objects, as well as in the preparation of embroidery orders and consumer training.

Conclusions

The comparison of four global digital embroidery software products shows that their latest versions are significantly evolving towards digitizing objects, approaching the sketch graphics capabilities. Even Wilcom has integrated CorelDraw into the EmbroideryStudio e4.2. New stitch rows are included, options to create designer's motifs and letter fonts are presented. The programs feature control over jump stitches, visualization, and training that greatly facilitates user's work and helps minimize the probability of trials and errors. Only on some of the criteria set in the study, Janome and Brother's software retreat to these of Wilcom and Melco.

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Senior Assist. Prof. Daniela Sofronova, MSc, PhD, Technical university of Sofia, Department of Textiles, phone +359 2 965 39 21, e-mail: dcholeva@tu-sofia.bg

Assoc. Prof. Radostina A. Angelova, MSc, PhD, DSc, Technical University of Sofia, Department of Textiles, phone +359 2 965 29 04, e-mail: radost@tu-sofia.bg