XML-based Approach for Digital Representation of Knitting Patterns

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Abstract. This paper views the problems related to the development of knitting software for hand-made knitting. It presents an XML approach for digital representation of knitting patterns. Its purpose is to develop a uniform and platform independent description of simple graphics primitives corresponding to different types of stitches. The XML language can be built on CAD systems for handmade knitting. The users of these software applications could be: people, who are interested in knitting as a hobby; editors of knitting hobby magazines; ethnographers, who invest in the area of old traditional costumes and handmade knitting.

Keywords: CAD systems, knitting software, XML, hand-made knitting, knitting pattern, digitalization, software applications.

1 Introduction

Preservation of the world heritage is an important task and one of the priorities of modern society. This includes storage and preservation of the traditional hand crafts and home activities. Knitting is one of the most famous and widespread home activities. The preservation of this home activity as a part of the cultural heritage includes continuation of the tradition of this activity, storage samples of knitting products, as well as saving their models and the methods of their implementation. Modern technologies, including computer technologies could be successfully used for this purpose [1], [2], [3], [6]. CAD system Knitting and its second version Visual Studio for Knitting Pattern Design are examples of software applications that can be used for computer visualization and storage of patterns of knitted structures [4], [5]. As software applications they are classified as the so-called knitting software. These are systems oriented to the design of loop structure for hand knitting.

Notwithstanding the fact that the manufacturing in modern society is entirely industrial, a lot of people are interested in handmade textiles. Knitting, embroidery, tapestry and crochet as traditional home activities are a kind of hobby for them. Indeed, these people carry on the old traditions and hand crafts. They themselves are interested in ethnography and quite often they seek out and reproduce patterns of knitting and embroidery from the olden days thus keeping the tradition alive.

Knitting software or CAD systems for hand-made knitting design are of interest to people dealing with hand knitting; for magazine editors for hand knitting; companies that are engaged in production of yarn and knitting accessories. Ethnographers dealing with traditional costumes are another target group interested in this kind of software. For them, this type of software would be useful as an instrument for storing of knitting patterns. To use a CAD system for digital representation of ethnographic exhibits, it has to support specific functions related to the information about models manufacturing. In addition, it has to support data base and possibilities for exhibits classification [6].

During the process of design and implementation of knitting software for hand-knitting the way of describing loop structures is of interest for developers. Usually, different graphic symbols and primitives are used for describing of different kinds of stitches. Existing knitting software systems are equipped with image editors, contain themes of loop structures that can be modified or extended only by the developers. Sharing images, stitches and/or palettes of stitches between editors is impossible due to the lack of a unified format for graphic description of each stitch. Therefore, any editor uses an internal system of graphic description, which leads to: platform dependency; inability to reuse the created projects of different graphic editors; difficulties in modifying of existing new graphic primitives and creating new ones describing loop structures.

The paper views an approach for digital representation of knitting patterns in knitting software. XML are used for this digital representation. The purpose is to develop a uniform description of simple graphics primitives. It allows the representation of any existing knitting patterns, as well as intuitive and easy creation of new ones. The development will be used in future versions of already developed software but it can be successfully applied to other similar systems.

2 Graphic Representation of Knitting Patterns

In making knitwear different loop structures and knitting technique are used. The simplest and most commonly used technique is a ***stockinette stitch*** (knit in odd rows and purl in even ones). Knitting a stockinette stitch is easy, but it fails to have the desired aesthetic effect. Therefore, multiple colors or a combination of different types of stitches are used to give the desired effect.

Depending on whether the fibers are used with different colors or different kinds of stitches, knitted structures can be divided into:

- Patterns with multiple colors (colored patterns) – done when yarns of different colors are knitted.
- Textured patterns – realized by using combinations of different type of stitches (knit, purl, yarn over, etc.)

An example of multiple colors knitting technique is given in fig. 1. Figure 2 represents an example of knitting product with textured pattern. Both examples are old traditional Bulgarian socks.

Fig. 1. Example of multiple colors knitting technique.

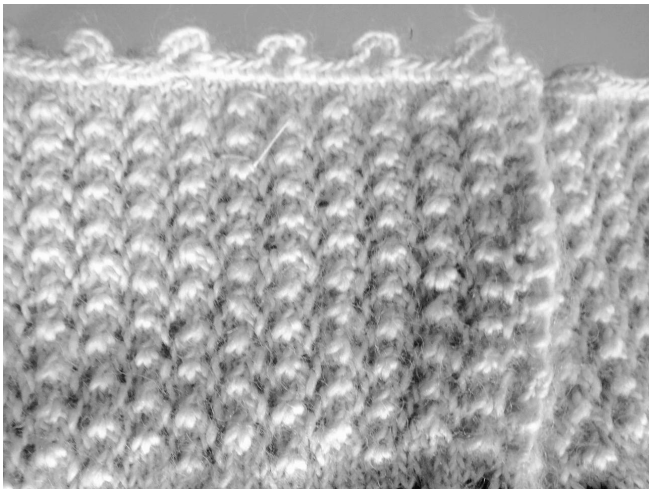


Fig. 2. Example of textured knitting technique.

Graphic representation of the knitting pattern, the so-called pattern draft or rap-port is described in a raster grid. Each item of the grid corresponds to a knitted stitch. The description of the color knitwear is easier and cleaner than the textured ones. In multiple colors knitting patterns each raster square is colored in the corresponding stitch color. To present a pattern draft of the textured pattern, different graphic symbols and primitives are used. Each of these symbols corresponds to a stitch type. An example of pattern draft of textured knitted structure is shown in fig. 3. It should be noted that in many cases, pattern draft of the color knitting is also presented by graphic symbols and primitives like textured knits. This way of description is required when the de-

scription of the knitting pattern is printed as a black and white image. The example of such image is given on fig. 4.

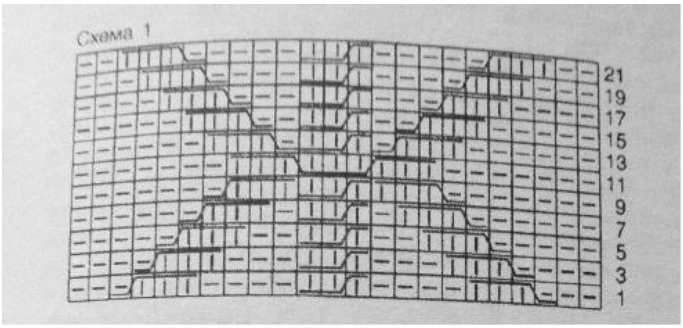


Fig. 3. Pattern draft of textured knitted structure

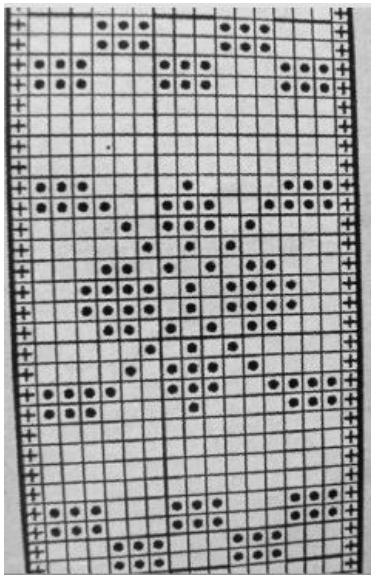


Fig. 4. Pattern draft of two colored knitting technique

Since the subject of this paper is related to the description of textured knitting patterns the focus will be placed on the ways of their representation. Generally, there is not a standard for describing of different types of knit stitches. Usually, every one of the magazines for hand knitting uses a different set of graphic symbols to describe the types of stitches [8], [9], [12], [18]. The same type of stitch can be found described in several different graphic symbols. Moreover, it could be found within the same pattern draft. For example, knit stitch can be described with □ (blank square) or described with symbol | (vertical bar). For the description of the purl stitch □ (blank square) or symbol – (hyphen) are used. Generally, a blank square (□) is used to pre-

sent uppermost stitches in the knitting pattern. If knit stitches are preventive in the knitting pattern, a blank square is used for the description of knit and vice versa - if the purl stitches are preventive, a blank square describes the purl. A legend with used symbols is added to each pattern draft. Despite the lack of a standard there is some tendency for equal representation of the types of stitches. For example, the symbol – (hyphen) almost everywhere presents a purl stitch [8], [9], [12], [18].

3 Digital Representation of Patterns

Actually, the computer presentation of knitting patterns in CAD/CAM system for designing knitting products and, as well is in knitting software a digital version of the already-known description of the pattern drafts. Pattern drafts are created and modified by using an image editor. Knitting structure is represented in a raster grid as each element of the grid corresponds to a stitch from knitting. There is not any problem when presenting the colorful knits as the hardware of computer systems has an unlimited number of colors. To presents the textured patterns, different bit-maps are used. In this are a problem arises - what bit-map images will be used for different types of stitches. For instance, CAD system *Visual Studio for Knitting Pattern Design* are equipped with a bit-maps palette, which is borrowed from the presentation of the stitch structure in the Verena knitting magazine [18]. The main window and bit-maps palette of CAD system *Visual Studio for Knitting Pattern Design* are shown in fig. 5.

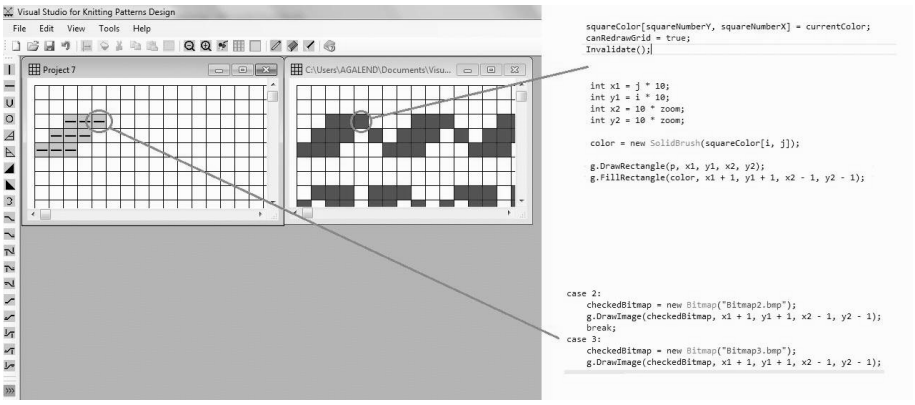


Fig. 5. *Visual Studio for Knitting Pattern Design* CAD system – main window

Different libraries exist, which can be successfully used for digital representation of graphic primitives. The examples of such libraries are as follows:

- OpenGL (Open Graphics Library) is a cross language, multiplatform application pro-gramming interface (API) for rendering 2D and 3D vector graphics. The API is typi-cally used to interact with a graphics processing unit (GPU), to achieve hardware-accelerated rendering [14].

- Windows GDI+ is a class-based API for C/C++ programmers. It enables applications to use graphics and formatted text on both the video display and the printer. Applica-tions based on the Microsoft Win32 API do not access graphics hardware directly. Instead, GDI+ interacts with device drivers on behalf of applications. GDI+ is also supported by Microsoft Win64 [11].
- Direct2D is a hardware-accelerated, immediate-mode, 2-D graphics API that provides high performance and high-quality rendering for 2-D geometry, bitmaps, and text. The Direct2D API is designed to interoperate well with GDI, GDI+, and Direct3D [10].

The existing knitting applications are created by different technologies. For example, Microsoft Foundation Classes (MFC) [13], Windows Forms [19], Windows Presentation Foundation (WPF) [20] and so on. Each technology has a set of classes which can describe, visualize and serialize the structure of stitches. An example for drown bitmap images and colored structures using *Visual Studio for Knitting Pattern Design* is the figure 5.

Windows Forms is the technology used for creating Visual Studio for Knitting Pattern Design. The graphic editor uses Graphics classes from the System.Drawing namespace [15]. The editor visualizes the graphic primitives (structure of stitches) according to the classes for visualization, provided by the graphic application programming interfaces. Serialized data are adapted according to the given classes. Similarly, the applications *Knitting* and *Visual Studio for Knitting Pattern Design* use specific technologies and classes for visualizing and serializing of the structure of stitches [4], [5]. The none-unified way of description of the structure of stitches makes the serialized data between the applications impossible to share.

4 Application XML for Description of Knitting Patterns

The present paper offers a XML-based approach for describing and serializing of the bitmaps corresponding to different types of stitches. The Extensible Markup Language (XML) was originally envisioned as a language for defining new document formats for the World Wide Web. XML is derived from the Standard Generalized Markup Language (SGML), and can be considered to be a meta-language: a language for defining markup languages. SGML and XML are text-based formats that provide mechanisms for describing document structures using markup tags (words surrounded by '<' and '>'. Besides being able to represent both structured and semi-structured data, XML has a number of characteristics that have caused it to be widely adopted as a data representation format. XML is extensible, platform-independent, and supports internationalization by being fully Unicode compliant. The fact that XML is a text-based format means that when the need arises, one can read and edit XML documents using standard text-editing tools. [16].

XML allows unification and a platform-independent way for the description of the structure of stitches. The present paper suggests the description of the structure of stitches to be done by a XML document. The way for drawing a single stitch or a whole structure of stitches could be described by this XML document. This will allow

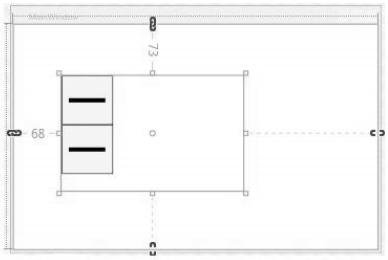
a unified visualization of the structure of stitches regardless the technology used. XML serialization of the data makes the import/export process of the structure of stitches from the different knitting applications easy.

There are many XML-based languages for the description and visualization of the graphic primitives:

- Vector Markup Language (VML) is an XML-based exchange, editing, and delivery format for high-quality vector graphics on the Web that meets the needs of both productivity users and graphic design professionals. XML is a simple, flexible, and open text-based language that complements HTML [17].
- SVG is a platform for two-dimensional graphics. It has two parts: an XML-based file format and a programming API for graphical applications. Its key features include shapes, text and embedded raster graphics, with many different painting styles. It supports scripting through languages such as ECMAScript and has comprehensive support for animation. SVG is used in many business areas including Web graphics, animation, user interfaces, graphics interchange, print and hardcopy output, mobile applications and high-quality design [7].
- XAML is a declarative markup language. As applied to the .NET Framework programming model, XAML simplifies the creation of a UI for a .NET Framework application. You can create visible UI elements in the declarative XAML markup, and then separate the UI definition from the run-time logic by using code-behind files, joined to the markup through partial class definitions. XAML directly represents the instantiation of objects in a specific set of backing types defined in assemblies. This is unlike most other markup languages, which are typically an interpreted language without such a direct tie to a backing type system. XAML enables a workflow where separate parties can work on the UI and the logic of an application, using potentially different tools [21].

Those XML-based languages describe not only the graphic primitives but also the way for their visualization. They do not depend on concrete application programming interface. This leads to the platform-independent way for description and visualization.

All stitches can be described by using basic graphic primitives (as dot, line, rectangle, ellipse etc.). XML-based graphic languages allow the description of all kinds of stitches because of the existing description of all basic graphic primitives as dot, line, rectangle, ellipse, etc. Apart from the existing opportunity for drawing graphic primitives, those languages allow drawing of controls, animation, etc. Their rich functionality makes them inappropriate for describing the structure of stitches because full functionality is not needed. This raises leads to the creation of XML-based language for describing the structure of stitches which can be easily implemented by using the existing graphic application programming interfaces. For example, the XML description of the structure of stitches with two stitches is shown in fig. 6.




```
<Stitches HorizontalAlignment="Left" Height="164" Margin="68,73,0,0" VerticalAlignment="Top" Width="258">
    <Stitch Fill="#FFF4F4F5" Height="70" Stroke="Black" Width="73">
        <Line X1="10" Y1="35" X2="62" Y2="35" Stroke="Black" StrokeThickness="6"/>
    </Stitch>
    <Stitch Fill="#FFF4F4F5" Height="70" Stroke="Black" Width="73" Stitches.Top="70">
        <Line X1="10" Y1="35" X2="62" Y2="35" Stroke="Black" StrokeThickness="6" Stitches.Top="70"/>
    </Stitch>
</Stitches>
```

Fig. 6. Example of the XML description of the structure of stitches

The new XML-based language will allow not only a platform-independent description but also an easy way to create custom stitches. The new stitches will be visualized in each graphic editor which uses XML-based language without recompiling the application because every graphic application programming interface contains built in classes which describe the basic graphic primitives (as dot, line, rectangle, ellipse etc.).

5 Conclusion

Traditional home activities are a part of the cultural heritage. Hand-made knitting is one of the most famous and widespread home activities. Its preservation as a part of the cultural heritage includes continuation of the tradition of this activity, storage samples of knitting products, as well as saving their models and the methods of their implementation. The computer technologies could be successfully used for that purpose. CAD systems for designing hand-made knitting and the so-called knitting software are examples of software applications which can be used to help the people who are interested in hand knitting and ethnographers who invest in the area of old traditional costumes and hand-made knitting.

One of the problems related to the development of CAD systems for designing knitting is the digital representation of knitting patterns and particularly, the representation of different types of stitches. This paper suggests an XML approach for digital representation of knitting patterns. The purpose is to develop a uniform and platform independent description of simple graphics primitives corresponding to different types of stitches. The XML language can be built on CAD systems for handmade knitting. The main advantages of this XML language are the platform independency and the ability for creating and modifying graphic primitives' sets describing knitted stiches.

References

1. James Abello, Peter Broadwell, Timothy R. Tangherlini, Computational Folkloristics, Communications of the ACM, Vol. 55 No. 7, Pages 60-70
2. Tangherlini, Timothy R., The Folklore Macroscope: Challenges for a Computational Folkloristics, Academic journal article from Western Folklore, Vol. 72, No. 1, Winter 2013
3. Trievedi S., Amod Tiwari, Aurobinda Chatterjee, Vinay Pathak, Sanjay G., Dhande, Durg S., Chauhan, Application of CAD, Rapid Prototyping and Reverse Engineering in Handicrafts Sector – A Success Story, 9th Intern. Conf. on Engeneering Education, July 23-28, 2006, San Juan, PR.
4. Zaharieva-Stoyanova E. , St. Bozov, CAD Module for Knitting Patterns Design, Intr. Conf. on Computer Systems and Technologies - CompSysTech'11, 15-16 June 2011, Vienna, Austria.
5. Bozov St., E. Zaharieva-Stoyanova, Development Of CAD System For Knitting Pattern Design, International Conference "Automatics and Informatics'12", 3-7 October, 2012, Sofia, Bulgaria.
6. Zaharieva-Stoyanova E., St. Bozov, Digital Representation of Knitting Patterns in Traditional Costumes, Int. conf. Digital Representation and Preservation of Cultural and Scientific Heritage DiPP 2013, 18-21 September 2013, Veliko Tarnovo, Bulgaria.
7. About SVG, http://www.w3.org/Graphics/SVG/About.html, 2014.
8. All Fiber Arts, Knitting, http://www.allfiberarts.com/cs/knitting.htm, 2014.
9. Coats Bulgaria, http://www.coatsbulgaria.bg/,2014.
10. Direct2D, http://msdn.microsoft.com/en-us/library/windows/desktop/dd370990(v=vs.85).aspx, 2014.
11. GDI+, http://msdn.microsoft.com/en-us/library/windows/desktop/ms533798(v=vs.85).aspx, 2014.
12. Knitting Stitch Patterns, Knitting On The Net, http://www.knittingonthenet.com/stitches.htm, 2014.
13. MFC Desktop Applications, http://msdn.microsoft.com/en-us/library/d06h2x6e.aspx, 2014.
14. OpenGL, http://en.wikipedia.org/wiki/OpenGL, 2014.
15. System.Drawing namespace, http://msdn.microsoft.com/en-us/library/system.drawing(v=vs.110).aspx, 2014.
16. Understanding XML, http://msdn.microsoft.com/en-us/library/aa468558.aspx, 2014.
17. Vector Markup Language (VML), http://msdn.microsoft.com/en-us/library/ee384217(v=vs.85).aspx, 2014.
18. Verena, Europes's top knit magazine, http://www.verenaknitting.com/, 2014.
19. Windows Forms, http://msdn.microsoft.com/en-us/library/dd30h2yb(v=vs.110).aspx, 2014.
20. Windows Presentation Foundation, http://msdn.microsoft.com/en-us/library/ms754130(v=vs.110).aspx, 2014
21. XAML Overview (WPF), http://msdn.microsoft.com/en-us/library/ms752059(v=vs.110).aspx, 2014.