Integration of Validation Modules into Knitting Software for Digital Representation of Traditional Costumes

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Abstract. This paper considers problems related to the development of knitting software for manual knitting. The support of error handling in knitting software is important for the users. The paper introduces an XML-based approach which allows recreating limitations due to the knitting technology. Each of them represents a Rule which contains certain conditions. One condition describes, allows or doesn't allow combinations of stitches. The XML-based limitation scheme is developed for building on CAD systems for manual knitting. The users of such software applications could be: people who are interested in knitting as a hobby; editors of knitting hobby magazines; ethnographers who deal with the area of old traditional costumes and manual knitting.

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

1 Introduction

Knitting software are Computer-aided Design systems for hand-maid knitting. Generally, CAD/CAM systems are applications widespread in up-today industrial production. They are applied in knitting industry, too. Computer-aided Design (CAD) involves creating computer models defined by different parameters. Computer-aided Manufacturing (CAM) uses data of the developed computer models to control automated machinery. Except in industrial production, Computer-aided Design could be successfully used also in handicraft sector [3]. Examples of knitting software are: DesingaKnit [7], EnvisioKnit [8], Knit Visualizer [11], Stitch & Motif Maker [14]. Some of these applications can be used for handmade knitting as well as machine knitting. For example, DesingaKnit developed by Soft Byte LTD [7].

Knitting software or CAD systems for hand-made knitting design are of interest to people dealing with hand knitting. It is important to mention that knitting is a traditional home occupation and it has a long history [6]. As hand craft or traditional home occupation, it is a part of cultural heritage. Practically, people dealing with hand knitting carry on the old traditions and hand crafts. Knitting software development assist these people, thus modern information technologies contribute to the protection of cultural heritage [1], [2].

Ethnographers dealing with traditional costumes are another target group interested in knitting software. CAD system for handmade knitting could be used to save digital representation of elements of the old traditional costumes. 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 [4].

There exist problems related to knitting software development. Such problems are digital representation of knitting structure and possibilities for error handling in digital represented knitting structure. Deciding first problem, XML- based language named PKF (Portable Knitting Format) is developed [5]. The presented paper suggests the same approach for decision of second problem – error handling in digital representation of knitting structures. XML-based restriction schema containing N rules is developed. This approach enables users to bring rules and restrictions that subsequently be respected. This facilitates their work as it leads to rapid detection and correction of any errors.

2 Peculiarities in digital representation of knitting structures.

To represent the knitting pattern in knitting software the knitting symbols are used for. Each symbol describes a different knitted stitch. The core of the knitting software is a graphics editor. A knitting pattern or so-called a pattern draft is described in a raster grid. Each item of the grid corresponds to a knitted stitch. 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 and Textured patterns – realized by using combinations of different type of stitches (knit, purl, yarn over, etc.). There is not any problem with a representation of the former knitting patterns as the hardware of computer systems has an unlimited number of colors. To presents the textured patterns, different bit-maps or symbols are used [9], [10], [16], [17]. Figure 1 represents an example of knitting product with textured pattern. A pattern draft of the knitting structure is given in fig. 2.

When working with the knitting software, editing existing or knitting pattern in the development of new, user can make a fault. These faults or errors are expressed mainly in that it is not possible to knit the pattern from a technological point of view. For example, it is not possible to knit two or more abreast yarn over (symbol O) [13].

Usually, symbols for yarn over and knit 2 stitches together appear one after another. The knitting pattern shown in fig. 2 is one such example. The alternation of two types of stitches is clearly seen.

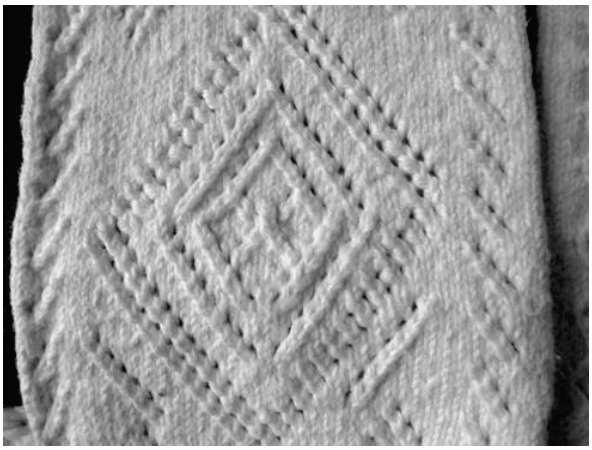

Fig. 1. Example of textured knitting technique.

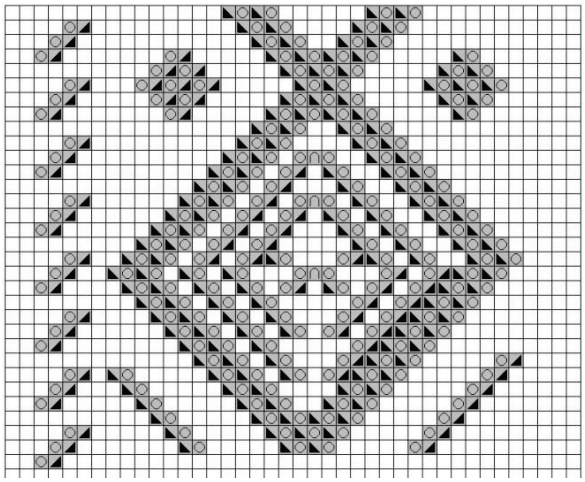

Fig. 2. Digital representation of a pattern draft.

It has to be mentioned that the yarn over stitch leads to widening of the knitted section. Each yarn over increases the next knitted row with a stitch. In contrast, knit 2 (or 3) stitches together leads to reduction in the number of stitches in a knitted next row. Accordingly, there is a narrowing of the knitted section. Using these types of stitches the size of the knitted section is achieved.

If the knitted section's width must be maintained, than the number of the yarn over symbols has to be equal to the number of knit 2 stitches together symbols. In other words, for each knit 2 stitches together symbol must have a yarn over symbol and for each knit 3 stitches together symbol must have two symbols yarn over. Summarizing, it should be noted that the presence of each other knitting symbols *yarn over* always a mistake. The presence of more than *yarn over* symbols k*nit 2 stitches* together and vice versa, in some cases may be treated as an error, but not in others.

3 Application of XML for error handling in digital represented knitting structure

This paper introduces XML description for error handling [15], [18]. As has been already mentioned, there are limitations related to knitting techniques, which are used. The goal of this paper is to suggest XML-based restriction schema. The restrictions schema is presented with a following program code:

```
<Restrictions>
 <Rule id="" name="" type="warning/error">
  <Left>
    <Element id=""/>
    <Elements ids=""/>
    <Or/>
    <And/>
  </Left>
  <Condition>
    <MustExistOn row="above/current/below/every/none"/>
    <MustNotExistOn
row="above/current/below/every/none"/>
    <MustBeAfter row="above/current/below/every/none"/>
    <MustBeBefore row="above/current/below/every/none"/>
    <MustBeStraightAfter
row="above/current/every/below/none"/>
    <MustBeStraightBefore
row="above/current/every/below/none"/>
    <MustNotBeAfter
row="above/current/below/every/none"/>
    <MustNotBeBefore
row="above/current/below/every/none"/>
    <MustNotBeStraightAfter
row="above/current/below/every/none"/>
    <MustNotBeStraightBefore
row="above/current/below/every/none"/>
    <Or/>
    <And/>
  </Condition>
  <Right>
    <Element id=""/>
    <Elements ids=""/>
    <Or/>
    <And/>
  </Right>
 </Rule>
</Restrictions>
```

Developed restriction schema contains N rules. Every rule contains the following items:

- Left part (Required) – Contains element(s) which will be participate in the rule. It is possible to create complex elements definition using operators Or/And.
- Condition (Required) – Contains at least one condition of the following:

  MustExistOn row="above/current/below/every/none"
  MustNotExistOn row="above/current/below/every/none"
  MustBeAfter row="above/current/below/every/none"
  MustBeBefore row="above/current/below/every/none"
  MustBeStraightAfter row="above/current/every/below/none"
  MustBeStraightBefore row="above/current/every/below/none"
  MustNotBeAfter row="above/current/below/every/none"
  MustNotBeBefore row="above/current/below/every/none"
  MustNotBeStraightAfter row="above/current/below/every/none"
  MustNotBeStraightBefore row="above/current/below/every/none"

- Every condition is self-descriptive and can be related to particular row. The possible choices are: above/current/below/every/none. "None" means that the stitch(es) can be placed everywhere into the raster grid. It is possible to create complex conditions definition using operators Or/And.
- Right part (Not required) – Contains element(s) which will participate in the rule. It is possible to create complex elements definition using operators Or/And.

Every rule can be defined as warning or error. An error means that it is not possible knitting of the relevant combination of stitches. A warning determines that combination of stitches is realizable but it is likely to be wrong.

To present the application of the scheme rules, some examples are developed. First of all, let assume that there are elements with ids 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

Example 1: Assume that you have knitting schema which describes a white sock which contains a few ornaments. Every row contains background color - element with id 10. The restriction scheme is a following program code:

```
<Restrictions>
 <Rule id="2" name="background" type="warning">
  <Left>
    <Element id="10"/>
  </Left>
  <Condition>
    <MustExistOn row="every"/>
  </Condition>
 </Rule>
</Restrictions>
```

Example 2: Assume that stitch 1 must be straight after stitch 0 if they exist on the same row. The restriction scheme of that rule is represented with a following program code:

```
<Restrictions>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="1"/>
  </Left>
  <Condition>
    <MustBeStraightAfter row="current"/>
  </Condition>
  <Right>
    <Element id="0"/>
  </Right>
 </Rule>
</Restrictions>
```

Example 3: Assume that you have raster grid which contains rows with the following requirements: If one row contains stitches ides' 1 and 2 then they should be in the following order: 121212121212 AND the next row should contains only stitch 0:

row0 -> 1212121212121212
row1 -> 0000000000000000
row2 -> 5555556833337474
row3 -> 9999999999999999
row4 -> 1212121212121212
row5 -> 0000000000000000

The restriction scheme of that rule is presented with a following program code:

```
<Restrictions>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="2"/>
  </Left>
  <Condition>
    <MustBeStraightAfter row="current"/>
  </Condition>
  <Right>
    <Element id="1"/>
  </Right>
 </Rule>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="1"/>
  </Left>
```

```
  <Condition>
    <MustBeStraightAfter row="current"/>
  </Condition>
  <Right>
    <Element id="2"/>
  </Right>
 </Rule>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="0"/>
  </Left>
  <Condition>
    <MustBeStraightAfter row="below"/>
  </Condition>
  <Right>
    <Elements id="1"/>
  </Right>
 </Rule>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="0"/>
  </Left>
  <Condition>
    <MustBeStraightAfter row="below"/>
  </Condition>
  <Right>
    <Elements id="2"/>
  </Right>
 </Rule>
 <Rule id="0" name="rule0" type="error">
  <Left>
    <Element id="0"/>
  </Left>
  <Condition>
    <MustBeStraightAfter row="current"/>
    <And>
    <MustBeStraightBefore row="current"/>
  </Condition>
  <Right>
    <Element id="0"/>
  </Right>
 </Rule>
</Restrictions>
```

4 Conclusion

Hand-made knitting is one of the most famous and widespread traditional home activities, which has a long history. Traditional home activities as well as handicrafts are a part of the cultural heritage. 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 to support the traditional handicrafts and home activities. 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.

There exist problems related to knitting software development. Error handling is one of these problems. The presented paper suggests an XML approach for decision of the problem with error handling in digital representation of knitting structures. XML-based restriction schema containing N rules is developed. This approach enables users to bring rules and restrictions that subsequently be respected. This facilitates their work as it leads to rapid detection and correction of any errors. The XML restriction schema is developed to be built on CAD systems for handmade knitting. It is a part of the whole project for knitting software development.

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