Swatch Merge

Sebastian Law
Northeastern University, Khoury Department of Computer Science
Accessible Creative Technologies Lab (ACT)
slaw@seattleu.edu

ABSTRACT

Creating swatches of different types fabric is one of the most common uses of automated knitting machines. Through the research done to make these machines more programmable, a wider range of users are able to use the knitting machines for this task. However, there currently lacks a system to combine multiple swatches of different types into one without having to drastically change the code for one of the swatches. The swatch merge system, created by PhD student, Jack Hester, will solve this issue and will use the benchmarks and demos I designed to demonstrate it's capabilities and applications.

1 INTRODUCTION

A swatch of fabric is simply a single piece of fabric created from knitting. These swatches can be of different designs, textures, colors, shapes, and materials. Through the use of advanced automated knitting machines and programming languages, such as KnitScript [1], creating swatches has become significantly easier. However a very common necessity is to be able to combine different swatches of different textures, materials, shapes, and/or designs to create one larger piece of fabric. The only way to do this is completely change the code for one of the swatches to include the necessary code to create the other swatch which is a very time consuming and over complicated process. The system created by PhD student, Jack Hester, in the ACT Lab at Northeastern University, will solve this issue. To highlight the capabilities and applications of this system, we will use benchmarks and demos designed and created by me that shows how swatches of different materials, designs, shapes and textures can be combined together to create larger and more complicated pieces of fabric using the automated knitting machines and the KnitScript language.

2 THE SWATCH MERGE SYSTEM

The system works by taking a knitout file that consists of machine code and generated when compiling a KnitScript file for a specific swatch of fabric and a knitout file of another swatch of fabric and then combining the two on a shared edge of the swatches. The system can combine swatches either vertically or horizontally and can combine multiple swatches into one larger piece of fabric.

3 BENCHMARKS

In this section, I will discuss and describe the swatches of different designs, fabrics, textures and shapes that I designed and created on the knitting machine by using KnitScript to write the code needed to generate them. These swatches will then be used for the ten different benchmarks to highlight the systems functionality.

3.1 Knits and Purls

The first benchmark will be a pattern produced using two jersey knit swatches, placed diagonally from each other, and two reverse jersey knit swatches, placed diagonally from each other in the opposite direction. Jersey is made by knitting all courses on the front bed of the machine (or knitting every row) while reverse jersey is made by knitting all courses on the back bed of the machine (purling every row).

3.2 Ribbing and Cables

The second benchmark will be a pattern produced using two 1x1 cable pattern swatches and two bamboo ribbing pattern swatches, arranged diagonally. The 1x1 cable pattern is made by knitting the loops on the back bed of the machine in between each 1x1 cable to create spacing. Then each 1x1 cable is created by taking two consecutive loops and transferring them diagonally across the other to the front bed where the two loops will stay to be knitted on the front bed of each course. When the next crossing takes place, the two loops will be transferred across to their original spot on the back bed of the machine in order to repeat the diagonal transferring process. The direction of the first loop to be transferred diagonally will create the direction of the spiral appearance of the cable (right or left). The bamboo pattern is created by repeating a 12 course pattern of knitting and purling certain loops for each course. This is done through transferring the specified loops to either the front or the back bed before knitting each course.

3.3 Lace and Ribbing

The third benchmark will be a pattern produced using two diagonal lace pattern swatches and two diagonal ribbing pattern swatches, arranged diagonally. The diagonal lace pattern swatches are created by repeating a four course pattern of purling (knitting on the back needle bed of the machine), tucking, and decreasing through transfers at specific needle positions to create the diagonal eyelets. The diagonal ribbing pattern

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swatches are created from repeating an eight course pattern of knits and purls by transferring loops to either the front or back needle bed.

3.4 Lace and Cables

The fourth benchmark will be a pattern produced using two mesh lace pattern swatches and two honeycomb ribbing pattern swatches, arranged diagonally. The mesh lace pattern is created by repeating a four course pattern of alternating increases using tucks and decreases through transfers for the first and third row, and knitting every needle for the second and fourth row. The honeycomb cable pattern is created using the similar diagonal transfer approach as with the the 1x1 cable pattern, however with this pattern, at each row where the diagonal transfers take place, two needles are cross diagonally in one direction and the next two are crossed diagonally in the opposite direction to create the beginning of the honeycomb pattern. Then two course of knitting all needles takes place before the reverse of the initially diagonal crossing takes place to finish the honeycomb pattern. These four courses are repeated until the desired length is reached.

3.5 Welts and Ribbing

The fifth benchmark will be a pattern produced using two 2x2 welts pattern swatches and two 2x2 ribbing pattern swatches, arranged diagonally. The welt pattern resembles a horizontal ribbing pattern and scrunches in on itself vertically. It is created by repeatedly knitting every loop on the front needles for 2 rows, then transferring all loops to the back needles and then knitting (purling) on all loops on the back needles for two rows. The 2x2 ribbing pattern creates vertical ribbing and scrunches in on itself horizontally. It is created by alternating knitting two loops on the front bed and purling two loops on the back bed for each course until the desired length is reached.

3.6 Knits/Purls and Colorwork

The sixth benchmark will be a pattern produced using two seersucker pattern swatches and two fleur de lys colorwork pattern swatches, arranged diagonally. The seersucker pattern is created by an eight course repeating pattern using transfers to either knit on the front bed or back bed (purling) for certain loops at each course. The fleur de lys colorwork pattern is created by utilizing the fair isle colorwork technique. On the knitting machine, this is done by using two carriers, each with a different yarn, and switching between knitting using the different carriers at the appropriate loops to create the colored diamond design.

3.7 Knits/Purls and Colorwork

The seventh benchmark will be a pattern produced using two lattice seed pattern swatches and two checkerboard colorwork pattern swatches. The lattice seed pattern uses an 18 course repeating pattern of knitting or purling at different needle locations for each course through transfers to create the basket weave/grid appearance. The checkerboard colorwork pattern uses the fair isle colorwork technique to create the design. This is done on the knitting machine by using two carriers each loaded with a different color yarn, and alternating knitting on the front bed with the different carriers every 5 needles, creating the design on the front of the pattern but leaving alternating floats on the back side of the pattern. This is repeated for 5 courses and then the needle locations for knitting using each color are swapped. This repeats until the desired length is reached.

3.8 Cables and Colorwork

The eighth benchmark will be a pattern produced using two 1x1 cable pattern swatches and two striped colorwork pattern swatches, arranged diagonally. The 1x1 cable pattern is created the same way as mentioned above. The striped colorwork pattern is made with the same fair isle technique as with the grid colorwork. Two carriers, each loaded with a different color yarn, alternate knitting on the front bed with the different carriers every 4 needles, creating the design on the front of the pattern but leaving alternating floats on the back side of the pattern. This repeats for each course until the desired length is reached.

3.9 Short Rows

The ninth benchmark will be a pattern produced by layering different swatches each produced using a knitting technique called short rows. Short rowing consists of knitting more courses for certain needles than others, causing the fabric to bend in a certain direction. To create each of the swatches, two yarns on separate carriers are used to eliminate floats on the back side of the fabric and to allow for more short rowing to occur without needles being dropped. One is used to knit the base of the swatch while the other is used to knit more courses in the middle needles of each swatch than the outside which gives the resulting bend in the fabric forming the trapezoid shape.

3.10 Intarsia Squares

The tenth benchmark will be a pattern produced using four square swatches that are divided diagonally by two separate colors to create a square diamond of one color in the center when the four swatches are combined. Each swatch is created using a colorwork technique called intarsia where you begin knitting each course on the front bed using a carrier loaded with one color of yarn and then switch to knitting the next needle on the front bed using a different carrier, loaded with a different color, at the appropriate spot to create the colorwork design.

4 DEMONSTRATIONS

In this section, I will discuss and describe the swatches of different designs, fabrics, textures and shapes that I designed and created on the knitting machine by using KnitScript to write the code needed to generate them. These swatches will then be used for the three different demos to highlight the different applications of the system.

4.1 Maze Game

In this demonstration, we will produce a 10x10 maze game by using four, 5x5 unique maze swatches I created, each connected by their start/end openings. A knitted maze is created by knitting in the round as if creating a tube, but instead uses

transfers and tucks to create the walls of the maze. Each swatch was generated by a KnitScript program that I designed and created that can create a unique maze of different sizes with a start and end opening on either the top or sides, specified by the user. The program uses the mazelib python library to generate a maze grid represented by a 2D list of ones (wall) and zeros (path). The KnitScript program then goes through the maze grid, in an iterative bottom up fashion, interpreting the value of either a 1 or a 0 at each position to either knit, transfer, or tuck at the proper needle positions to create the knitted maze. A marble can then be pushed through the paths of the maze, starting at the swatch with one of the two openings, and eventually reaching the end at the swatch with the other opening.

4.2 Customizable E-Textile Circuit

In this demonstration, we will produce a custom circuit board that consists of different swatches with conductive traces, a swatch with an embedded LED, and a knitted pressure sensor that activates the circuit to light up the LED, each that I created. There are a total of seven options of swatches that each have a unique conductive trace design that can be combined together to create the circuit. These include a swatch with a vertical conductive trace, a horizontal conductive trace, a L shaped conductive trace, a backwards L shaped conductive trace, a upside-down L shaped conductive trace, a backwards and upside-down L shaped conductive trace, and a cross shaped conductive trace. Each swatch is created using the same machine knitting technique called platting to knit the conductive traces. Platting is when you knit a course in a direction using two yarns each on a separate carrier but have one carrier slightly in front of the other resulting in the course being knitted with two yarns at a time where the yarn slightly in front of the other is visible on the front side of the fabric. In this case, the carrier with the conductive yarn is the carrier slightly in front of the other. Each swatch begins with knitting using the non conductive yarn until it gets to the needle/course where the conductive trace begins. The conductive trace is then knitted using the plating technique for four courses and/or four needles wide. Since the conductive yarn that we used was very thin, we loaded the carrier with with two separate conductive yarns to reduce the resistance. The swatch where the LED is sown into the conductive traces was created using the same technique. The knitted pressure sensor and sensor trace was created based off the designs used in the Knit UI paper [2]. The conductive portions of the Knit UI sensor/trace were knitted with the double loaded conductive yarn carrier as well to make the sensor more sensitive and effective. The different swatches can be arranged in many different ways using the swatch merge system to create different circuit designs.

4.3 Stim Board

In this demonstration, we will produce a stim board using six different swatches with either stimulating textures or aspects that I designed and created. These include a swatch with the bobble stitch pattern, alternating textured ridges, a knitted bubble switch stim toy, the brick stitch pattern, a knitted finger trap, and an array of i-cords. The bobbles are created by a combination of transfers, tucks, and knits at the location of each bobble to add in more fabric into the swatch which creates the bobble. The alternating ridge swatch is created by knitting on the back bed of the knitting machine and then splitting ten stitches to the front bed at the desired location of each ridge. The front bed loops are then knitted for four courses and then transferred back to the back bed. The process is then repeated for the desired amount of ridges. The bubble swatch stim toy is created by short rowing. More courses are knitted at the needles at the location of each "bubble" which causes the fabric to protrude outwards and take on the shape of the bubble. The brick stitch swatch is created by a combination of knits and purls that results in a textured pattern. The knitted finger trap swatch is created by knitting in the round on the machine to create a tube but with elastic yarn at the beginning and end of the tube. The i-cord array swatch is created by starting with knitting a tube and then transferring the needles between each cord diagonally. Then each icord is created by knitting in the round for a width of three each with a different carrier to eliminate floats between the icords.

REFERENCES

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