Knit Stim

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ABSTRACT
Advanced automated knitting machines have the capability to greatly impact many areas of research. With the creation and research of new scripting languages for these machines, this is becoming a reality. Two areas of research that could be greatly benefited are e-textile research and custom accessible clothing research. While research in these areas is starting to increase, there has been little research done on the possible application of machine knitting in the creation of accessible stimming devices and clothing for people who identify as neurodivergent. Our study will be exploring this specific application.

1 INTRODUCTION
The technology needed for advanced automated machine knitting already exists and is widely used in the clothing and textile industries. Many other areas of research could drastically benefit from these machines such as in the area of e-textiles using conductive yarns [2]. However, a big issue has made these machines not very applicable to other sub fields in recent time. The problem is the machines lack of programmability. For a long time, the only way to program these machines was to write code in a specific machine language that made code reuse difficult and required someone with high expertise in programming skills, especially with machine languages, to be able to write and read the code [3, 1]. However now with the development of new scripting languages for these machines such as KnitScript [4], someone with less coding experience will be able to program these machines and read the code.

These machines have the ability to drastically boost the research capabilities in areas of research such as e-textiles which uses conductive yarns and embedded sensors/actuators [2] to make circuits in the fabric along with the area of making custom disability friendly, accessible clothing. In our study, we will be exploring the intersection and applicability of advanced automated machine knitting with these two areas of research, specifically working with people who identify as neurodivergent.

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2 METHODOLOGY
The focus of the research is to identify the possible application of advanced automated machine knitting in the creation of stimming devices that are either integrated into clothing or stand-alone for people who identify as neurodivergent. We will also be using the tenets for social accessibility [5] in the probe design process and during the user study to tackle the issues of social accessibility with common stimming devices. On top of this, we will be exploring the possible new engineering aspects of knitted objects [2, 3, 1] and testing the capabilities of automated knitting machines through the design and creation process of the stimming device probes for the user study.

3 USER STUDY
Participants for this study must identify as neurodivergent and will be recruited through emails, flyers, online postings such as social media posts, and verbal announcements. When participants register for the knit stimming study, they will be required to complete an online survey that will gather information on their personal experience/usage with stimming devices or toys, and gather basic demographic information.

After they complete the survey, participants will take part in a one hour, one session video and audio recorded in person study. The session will begin with a 15-minute introductory phase where the participants will first be given a brief background on the research goals and a description of the different phases of the study. They will then be shown various knitted materials that range from different shapes, textures, e-textiles along with additional knitted fabric stimming device prototypes. They will also be given information about each presented material. Participants will be given time during these 15 minutes to ask questions about the discussed information and provided materials if needed. Once the introductory phase is complete, participants will now move on to the 35-minute design phase. Participants will be given their task of designing and creating a rough prototype of their ideal stimming device or toy that they can choose to be stand alone or integrated into an area of clothing that they specify. To create their rough prototype, participants will combine the various materials introduced to them earlier using safety pins that will be provided. Once the 35-minute time limit is up or if the participant states they're finished with their design early, they will then move on to the final 10-minute concluding interview phase. During this time, participants will be given an opportunity to describe their design, its features, and their reasoning behind it.

4 KNITTED STIMMING FABRIC AND DEVICE PROBES

In this section, I will discuss the different device and fabric probes I designed and created, using the advanced automated knitting machines and KnitScript, that will be later used in the study.

4.1 Textured Fabric

I created many different textured fabrics that will be used in the study as a standalone object, as well as integrated into certain aspects of everyday clothing. Some of these textured fabrics include a brick stitch fabric, a alternating ridge fabric, bobble stitch fabric, fabric with 1x1 cables, and fabric with 2x2 ribbing.

The brick stitch swatch is created by a combination of knits and purls that results in rows of a textured, bumpy pattern. 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 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 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 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.

4.2 Knitted Maze

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 opening of the maze, where the user will then guide the marble through the mazes path to the ending of the maze.

4.3 Knitted Bubble Pop Toy

The bubble swatch stim toy is created by using the short rowing technique. Short rowing consists of knitting more courses for certain needles than others, causing the fabric to bend in a specific way. 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 user can pop the bubbles inwards and outwards, as each bubble is reversible.

4.4 Knitted Fidget Bracelet

By using two separate spiral shaped fabrics that were then interlaced together, I created a spinning fidget bracelet that allows the user to pull one of the spiral fabrics around the other. The spiral shaped fabrics were created by a series of garter stitches, followed by increasing into each stitch twice, with then another series of garter stitches to finish it off.

4.5 Knitted Fidget Noodle

I created a fidget noodle through the use of a 3D knitting method that I designed. This method works by knitting the noodle in layers, where each layer is an identical knitted circle. Then each circle is connected by the last knitted edge where the next layer begins. After knitting, the layers are stacked on top of each other and a separate thread is ran through the layers vertically to hold the stacked layers together. This knitted fidget noodle allows the user to bend and squish the noodle, providing a stimulating effect.

4.6 Knitted Braiding Toy

The knitted braiding toy is made by knitting an i-cord array swatch. This is done by starting with knitting a tube and then transferring the needles between each cord diagonally. Then each i-cord is created by knitting in the round for a width of three each with a different carrier to eliminate floats between the i-cords. The user is able to fidget with the different i-cords by twirling them individually or braiding them together, similar to fidgeting with hair.

5 FUTURE WORKS

Future works for this project include integrating some of the knitted fabrics and devices I mentioned into everyday clothing, such as gloves, socks, and pockets, to then use in the future user study. Once this is complete, we hope to conduct the user study as described above and possibly use the probes in another future study in collaboration with an children autism center in Georgia, USA.

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