Needle User Interface: A Sewing Interface Using Layered Conductive Fabrics

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ABSTRACT

Embroidery is a creative manual activity practiced by many people for a living. Such a craft demands skill and knowledge, and as it is sometimes complicated and delicate, it can be difficult for beginners to learn. We propose a system, named the Needle User Interface, which enables sewers to record and share their needlework, and receive feedback. In particular, this system can detect the position and orientation of a needle being inserted into and removed from a textile. Moreover, this system can give visual, auditory, and haptic feedback to users in real time for directing their actions appropriately. In this paper, we describe the system design, the input system, and the feedback delivery mechanism.

ACM Classification: H.5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General terms: Algorithms, Measurement, Design

Keywords: Sewing Interface, Embroidery Supporting System, Conductive Fabrics.

INTRODUCTION

Embroidery is a manual craft that can support our daily lives in various ways. Sewing requires knowledge and fine-motor skills, and as such can be difficult for beginners to learn. In an attempt to solve this issue, we propose an interface for recording and sharing the process of sewing with other users using digital media technologies.

As a basic study for this purpose, we propose a sensor and feedback system, called the Needle User Interface, for enhancing the needlework learning. Our system can detect the position and the orientation of a needle being inserted into and removed from a textile surface in real time by using the characteristics of conductive materials. In addition, this system can provide several kinds of feedback according to the actions of the users, allowing for guidance or appropriate information to be given in a natural way.

Alternatives to our proposed system include those that use conductive materials to detect touching or pinching actions on textiles [1][2]. Some systems use power supplies on a surface composed of two layers of conductive fabrics so that sensor modules containing a needle can be used at any place on the surface [3][4]. In contrast, in our research, we developed a novel interface that uses three layers of conductive fabrics to detect the position and orientation of the needle.

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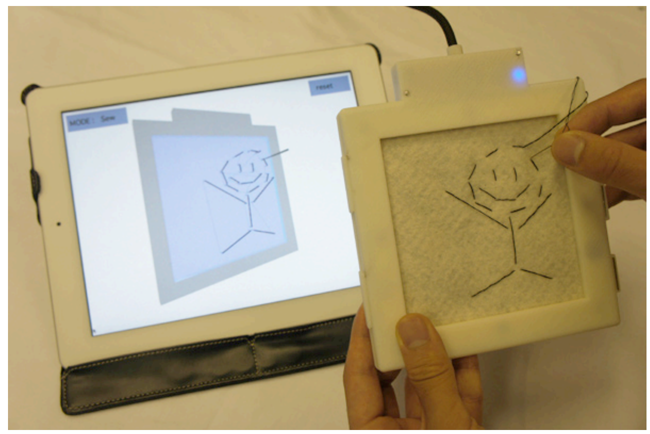

Figure 1: By detecting the orientation of a needle being inserted into the interface, the proposed system can show the drawn line of the string in real time.

NEEDLE USER INTERFACE

System Overview

We propose a "sharing and archiving" system that uses the Needle User Interface. This application is divided into three main phases. First, when users carry out needlework, their procedures can be recorded and checked on the display. Second, the recorded processes can be shared and archived. By sharing the processes, which can then be replayed, people can learn how others sew by watching the ordering or the rhythms of the stitch-work. Third, organizing the archived data of the sewing processes as charts can help people navigate to particular sewing patterns. Users are guided by several feedback mechanisms according to their actions so that even beginners will be able to sew complicated patterns. Moreover, during the navigation, users can make corrections to the previous sewing data. Since this procedure is also recordable, we believe that a cycle of manual creation would occur.

The following is a description of a basic system to realize the above stated functions.

Input System

The input system of our interface can detect the following states of a needle in real time: whether a needle is inserted, which way the needle is inserted (orientation), and where the needle is inserted (position).

The textile-input system consists of three layers of conductive fabrics with two different types of resistance. Layers of conductive fabric are placed between layers of ordinary fabric, which function as insulators.. In this system, high-resistance fabrics are used for layers A and C and a low-resistance fabric is used for layer B in the center as shown in Figure 2.

Stacking three layers of conductive fabrics can form two pairs of switches: layers A and B form one pair, and layers B and C form the other. With this structure, when the needle is inserted from above, layers A and B are electrified first. By detecting such input, we can identify the orientation of the needle as it is inserted. The orientation of the needle as it is withdrawn can also be detected by using the same method.

To detect the position where the needle penetrates, we implement the following input system. Considering the top and bottom layers to be the X and Y axes, we wire the electrodes in the breadth-wise direction on layer A, and the length-wise direction on layer C. The ground is connected to layer B. Then, when the needle is inserted, an electric current is generated by the electrodes at both ends of each axis in rotation. Thus, the voltages between each electrode and the needle are detected. Because these voltages are proportional to the distance between the electrodes and the needle, the position of the needle can subsequently be estimated.

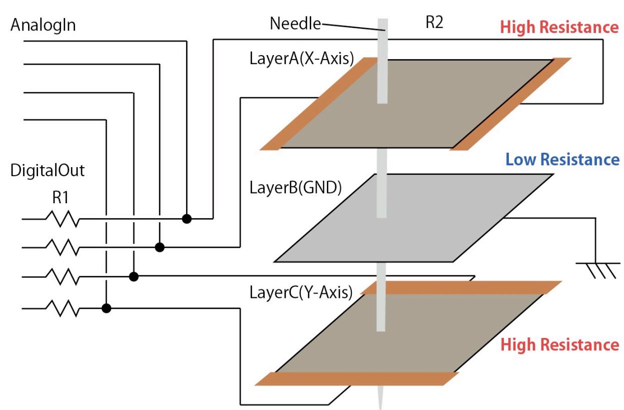

Figure 2: The system is composed of three layers and two types of conductive fabrics for sensing the needle.

Feedback System

Next, we describe the feedback system. This system is composed of an embroidery-frame-based device, a display, a speaker, a PC, and a micro-controller. The embroidery-frame-based device consists of a 10 cm × 10 cm input interface, an acceleration sensor, a tilt sensor, red and blue light-emitting diodes (LEDs), and a vibration motor.

Using the needle-detecting input system described previously, we can draw the line of a string by connecting each point of the string in the order of penetration. This can be visualized on the display (See Figure 1). Moreover, when a needle is inserted, the position and orientation of the needle can be visualized. The acceleration and tilt sensors can recognize the inclination of the device. We developed the system in such a way that the surface of the display is synchronized with the device's motion. Therefore, the lines of the string are visualized on both surfaces of the device on the display, and the users can intuitively recognize the visualized strings. Moreover, the proposed system provides visual, auditory, and haptic feedback with a display, a speaker, and a vibration motor. By making use of such sensations, users' actions can be directed appropriately. For example, by giving different sound effects depending on the positions of the needle, users can learn where to stab or sew.

FUTURE WORKS

In the future, we will enhance the system to be able to archive and share users' embroideries on the Web. Users all over the world who have their own devices will be able to upload their needlework data. They will also be able to download any data from the Web and create their own stitch-work by referring to the downloaded data. Thus, this system will connect sewers throughout the world, and enable them to share their embroidery skills and knowledge.

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