Innovative design of Photonic Interior Textiles

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Abstract
Optical fibers have been widely utilized in communication and sensing technologies, but its ability to change colors also makes it a feasible material for interior textiles. In contrast to traditional textiles, the photonic fibres in the photonic textile can be connected to different Light Emmiting Diodes (LEDs) sources to transform the textile color to adapt to the user's preference. The technologies in fabricating photonic fabrics for interior textile are investigated in this study. The objective of this research is to examine the incorporation of optical fibers into fabric while maintaining positive tactility. For the purpose of this research paper, a piece of photonic fabric was created and the research rationale and process will be discussed. This research aims to integrate design and technology to create innovative interior textiles.

6. Introduction

Textiles form powerful interior components as they combine three strong design elements: the emotion of color, the impact of pattern and tactile qualities sensed through visual perception and physical touch. With the soft and comfortable tactility, textiles can offer physical advantages to interiors such as sound absorption, privacy, comfort, enhanced safety and aesthetics, and also can set a mood, establish a theme, and secure an ambience to create an enhanced interior environment.

Nowadays, as people are getting involved in more diverse activities within compact spaces, there is growing demand for interior environment to be flexible. Consumers demand for interior textiles which are multifunctional, reactive and interactive(Nielson, 2007). Interactive interior textiles enable individual users to interact with the interiors and flexibly customize their fixed interior surroundings for different purposes. Interactive interior textiles are especially relevant to densely populated cities.

With the emergence of photonic fibers, textiles engineered with the ability of being interactive with the user as well as other surrounding technology are now possible. Photonic textiles with interactive function through the changeable and tuneable color can present a pleasing visual effect and customized interior environment to the user, and therefore greatly enhancing the interior environment. Nowadays, as our lives become more diverse and personalized, interactive interior textiles appealing to lifestyle enhancement and entertainment have the potential to be utilized in value-added products which can enhance quality of life.

Some fashion, design and architecture products employing luminous fabrics have been commercially available in the market, such as textile switches, textile keypads(Tao, 2005). Optical fiber displays and textile illumination devices have also been reported (Harlin, Makinen, & Vuorivirta, 2003; Koncar, 2005), and the technology is mostly based on woven photonic fibers having cladding imperfections (mechanical, thermal, chemical damage) and therefore light emitting sites. In most cases, a multiplicity of polymer optical fibers are integrated into textile structures connected to a light source at the fiber ends. Various light sources can be used to feed the optical fiber matrix.

This article mainly introduces an innovative photonic textile for interior purpose. The objective of the design is to develop a photonic fabric, which can be used for design of interior furnishings, including cushions, wall hangings, etc. With the illuminative effect, the furnishings can create two different interior environments during day and night as illustrated (Figure 1).

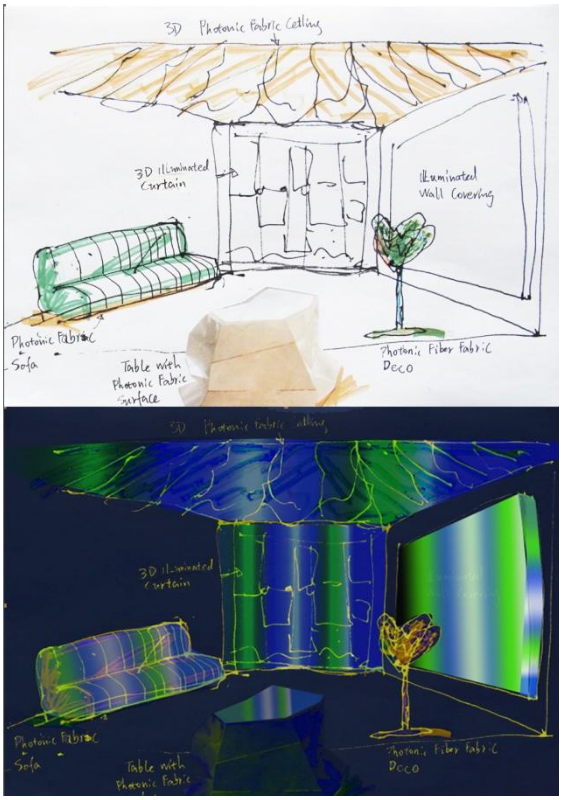

Figure 1. Design Sketch- Photonic interior textiles

7. Methodology

7.1. Weaving

As one of the oldest way to make fabrics, weaving still remains one of the most widely used methods to produce photonic fabrics. The photonic fabric created for this study was woven with the photonic fibers introduced as weft yarns, and cotton yarns on the warp. The interlacing of cotton and photonic yarns will contribute to a positive hand feel for the photonic fabrics. As the warp yarns were threaded under tension through the loom, it was more feasible to introduce the cotton yarns on the warp as the photonic yarns are brittle and fragile and will easily snap during the weaving process.

By varying the weave structure and incorporating the photonic luminescence generated by the integrated photonic fibers, different surface pattern, texture, color and lustre can be created. The following weaving loom was adopted for production of optical fiber fabric (Figure 2). Figure 3 shows a photonic fabric swatch using plain weave.

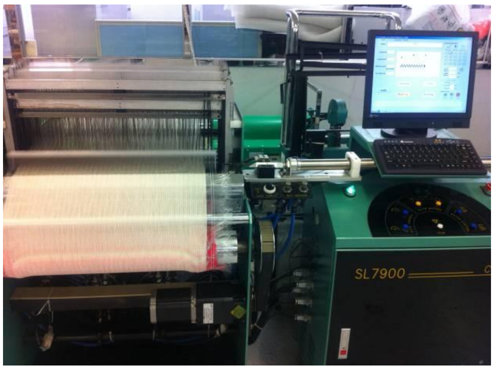

Figure 2. Optical fiber integrated fabric processing on a weaving machine

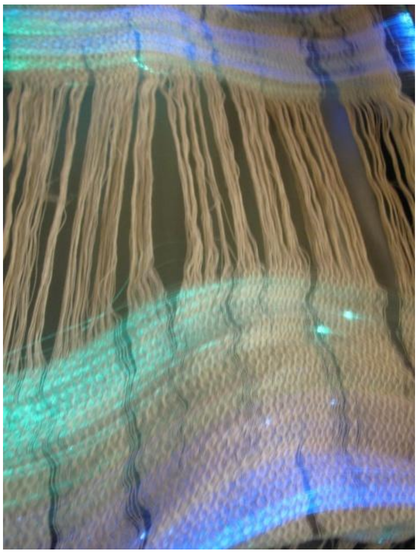

Figure 3. Photonic fabric swatch

7.2. Laser Engraving

In the application of optical fibers, polymeric optical fibers are always used due to the fact that they are more resistant to textile manufacturing processes and have a higher flexibility and low stiffness, compared to glass fibers (Kuzyk, 2006). Therefore, PMMA based polymeric photonic fibers were used for this study. The fiber has three layers. The light is mainly guided through the core layer following the law of total reflection at the boundary between the core and the first sheath. The second sheath has functions of anti-bending and color modulation achieved by different reflective index and optic gain materials. In order to let the light emit not only from the photonic fibers ends but also from the lateral surface of fiber to produce different luminescent effects and design patterns, the fibers were engraved by laser, to allow side illumination (Figure 4).

7.3. Integration of Electronics

LEDs with green, blue and white colors were used as the light source in order to produce mixed color. Groups of photonic fibers were bundled together and then coupled with LEDs with predetermined sequences.

Ultraviolet bonding technique was adopted in coupling LEDs, which can maximize the lighting efficiency and reduce the coupling loss. All controlling electronics of LEDs were docked in a motherboard (Figure 5).

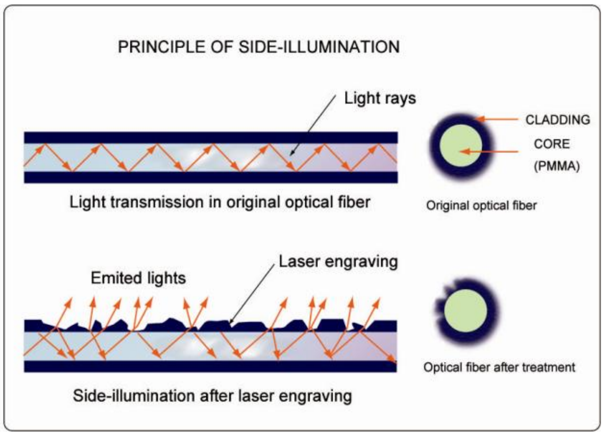

Figure 4. Principle of side-illumination by laser-engraving

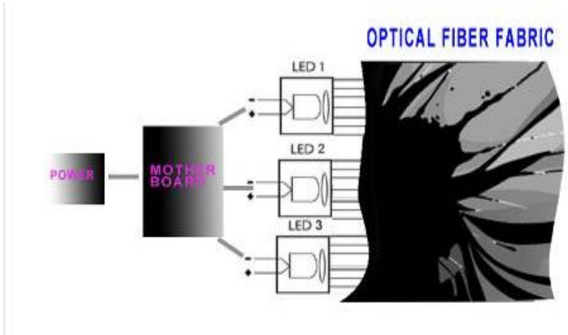

Figure 5. Schematic diagram of the POFF system

8. Result

A piece of photonic fabric named "Rhythm" was created (Figure 6). The normal cotton yarns and optical fiber were integrated into a fabric. More than 40 LEDs with blue, green and white color were used as light sources. The dimension of the fabric is 150centimeters by 70 centimeters. With illumination, the fabric presented a dynamic and dramatic appearance. In contrast to the unchangeable nature of traditional interior textiles, the innovative photonic textiles can be adapted to suit different preferences and light conditions to create an enhanced ambience.

Figure 6. "Rhythm"

9. Discussions and conclusion

This research explores the development of innovative interior textiles with consideration of both aesthetics and technology. The researchers were successful in weaving the photonic fibers with cotton yarns to create positive hand feel and good flexibility as demonstrated by the draped shape of the artwork. The researchers were also successful in using laser engraving technology to cut the fiber surface to allow emission of light at the engraved areas along the length of the fiber. Traditional weaving technique has successfully enhanced the surface texture and design aesthetic without compromising on the technological functionality of the photonic textiles.

The engineered prototypes can be used in interior design, and can enhance the interior environment. The prototypes have the potential to be utilized in value-added products which can enhance the quality of life.

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Authors

Dr. Jeanne Tan is currently an Assistant Professor at the Hong Kong Polytechnic University. She received her PhD from the prestigious Glasgow School of Art (University of Glasgow). Her research interests are in interactive textiles, fashion design and surface embellishments. Dr Tan has active roles as both researcher and practitioner. She is member of the editorial board for the International Journal of Costume and Fashion by the Korean Society of Costume and Praxes Journal by Shih Chien University, Taiwan. Her creative work had been exhibited in many internationally recognized venues like The Lighthouse, U.K. (Scotland's Centre for Architecture, Design and the City), Museum of Siam, Thailand, Chengdu Art Museum, China and Innocentre, H.K. Dr. Tan's creative fiber art work *Linear*, had recently received an Excellence Award at the 1st Contemporary Chinese Fiber Art Exhibition organized by the China National Arts & Crafts Society.

Bai Ziqian is currently a PhD student under Dr Jeanne Tan's supervision. Her research topic is *Innovative photonic textiles: The investigation and development of polymeric photonic fiber integrated textiles for interior furnishings.*