Development of 3D Printed Shoe Designs Using Traditional Muntin Patterns

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Abstract: This study proposes 3D printed shoe designs with patterns made by reinterpreting traditional Korean muntin patterns as customized designs that are unique to individual consumers and different from existing products. In the fashion industry, shoes with diverse designs grafted with 3D printing technology have been introduced. Artistic 3D printed shoes showcase the unique designs of designers. Functional and practical 3D printed shoes that can be worn during daily activities and during exercise have been actively developed. Traditional Korean pattern designs are also being recreated into designs reflecting the aesthetic sense of modern times with our own identity. The uniqueness of the traditional muntin patterns in geometric shapes, such as intersections of lines, rectangles, and octagons, are expressed in shoe designs with modern aesthetic senses by utilizing the traditional patterns that conform well to the modern geometric beauty of forms. This study was intended to develop 3D shoe designs that reinterpreted the motif of muntin patterns from among traditional Korean geometric patterns with a modern aesthetic sense. The octagonal patterns that express the scenery of spring can be seen through the muntins in traditional Korean-style houses were designed on the heels of shoes. Utilizing the Rhino CAD program and ProJet 660 Pro 3D printer, shoes were designed and printed. The processes for making shoes using 3D printing technology proposed in this study are significant because they represent the creation of designs in a new area. The results of this study might help in the development of 3D printed fashion products.

Key words: 3D printed shoes, traditional pattern, design process, 3D CAD design

1. Introduction

The increasing importance of cultural diversity and the unique traditional cultures of various countries have led to efforts to develop cultural products reflecting the traditional Korean beauty and aesthetic sense. Since modern consumers are more likely to prefer products that possess a unique individuality, differentiated apparel products made modern by reconstructing traditional Korean designs should be developed (Jung et al., 2014). That is, designs should be developed that not only reflect traditional culture but also grafted with modern aesthetic senses and technologies in response to customer needs.

Muntin patterns are one of the traditional patterns widely utilized to emphasize Korean emotions, and the designs show the beautiful formative aesthetic that reflects the daily life of our ancestors and their artistry (Hong & Kim, 2011; Kim, 2016).

Muntin patterns form numerous geometric shapes with vertical, horizontal, and diagonal lines intersecting each other. The characteristics of muntin patterns include the harmony between the lines of muntins and the faces in window paper, and the geometric shapes such as triangles, rectangles, hexagons, and octagons composed of many lines. In addition, the subdued light that passes through the window paper and the shadows of the muntins express more diverse geometric shapes (Kang & Kim, 2008).

Therefore, the uniqueness of the traditional patterns in geometric shapes, such as intersections of lines, rectangles, and octagons, are expressed in shoe designs with modern aesthetic senses by utilizing the traditional patterns that conform well to the modern geometric beauty of forms.

As the personal preferences of modern consumers diversify, the demand for personalized products that are unique for each individual customer has been increasing. Thanks to the recent development of information and communications technology, production systems that can manufacture customized products are changing. Shoe manufacturers such as Nike and Adidas have recognized these changes and now offer customized shoe services. In addition, they are focusing on the development of high-performance sneakers utilizing 3D printing technology.

Recently, 3D printing technology that enables the creation of products with complex shapes and innovative designs by stacking many layers of raw materials one by one has been applied in diverse industrial fields, while creating new paradigms of manufacturing technologies (Byun, 2016; Lee & Lee, 2016). In the field...
of fashion, designers are creating innovative and formative fashion designs under the concept termed as the convergence of fashion and 3D printing technology (Kim et al., 2015). As such, 3D printing technology enables small batch production. Therefore, customized shoes with designs unique to individual consumers can be efficiently fabricated.

This study proposes 3D printed shoe designs with patterns made by reinterpreting traditional Korean muntin patterns as customized designs that are unique to individual consumers and different from existing products. This study is relevant in that it develops creative designs in a new field by presenting 3D printed shoe design processes that reflect the convergence of digital technologies and traditional fashion design.

2. Theoretical Background

2.1. Traditional pattern design

Patterns are defined as the configuration of points, lines, and/or colors into figures to stimulate aesthetic senses. Traditional Korean patterns are patterns and forms that reflect our ancestors’ excellent creativity, knowledge, artistry, and life based on our unique historical background (“Korean Culture Portal”, 2016). Traditional Korean pattern designs are also being recreated into designs reflecting the aesthetic sense of modern times with our own identity. Traditional Korean patterns can be divided into human patterns, animal patterns, plant patterns, artifact patterns, natural scenery patterns, character patterns, geometric patterns, and complex patterns, according to their shapes and materials (“Korean Culture Portal”, 2016; Ye et al., 2013). Geometric patterns are the most frequently used among the traditional patterns used to express Korean emotions. These geometric patterns include letters, dancheong, muntin, rice cake patterns, roof-end tiles, and taegeuk (Hong & Kim, 2011).

Among the many traditional patterns, muntin patterns form shapes that have the conciseness of geometric structures and reflect the traditional formative aesthetic through the composition of faces created by intersections of lines. According to compositions of intersections of muntin lines, traditional muntin patterns can be divided into those composed of vertical lines, vertical and horizontal lines, diagonal lines, diagonal and vertical lines; diagonal, vertical, and horizontal lines; patterns made by simplifying the shapes of letters or animals, and those made by shaping flower patterns (Kang & Kim, 2008; Kim, 2016).

Examples of products that utilize traditional Korean patterns include the “An-Chae” line of kitchen furniture (Fig. 1) released by Enex in 2007. The furniture expressed Korean beauty such as handles inspired by the muntin of traditional Korean houses and the doorknobs of traditional doors with paper windows. “休 & Funny” featured the convergence of kitchen furniture that emphasized traditional beauty (“Enex released kitchen furniture”, 2007). In 2009, the denim brand Jambangee released T-shirts that featured traditional Korean patterns such as the traditional door with paper windows and muntin patterns as motifs (Hong, 2009).

Fig. 1. Ennex ‘An-Chae’. http://www.edaily.co.kr

Fig. 2. Jambangee traditional patterned T-shirt. http://news.inews24.com

2.2. Current state of 3D printed fashion product development

Shoes are traditionally made using lasts, which are models of feet made by fabricating frames of molds and then pouring plastic substances into the frames. The leather or fabric is then cut according to the design, followed by gluing and sewing processes. In contrast, when utilizing 3D printing technology, shoes can be produced instantaneously without fabricating the frames of molds, thus reducing the steps in the production process and allowing the implementation of complex and characterful designs.

3D printing techniques can be classified into three types: fused deposition modeling, which melts and creates stacks of solid filaments; stereo lithography apparatus, which cures liquids by shooting laser beams; and selective laser sintering, which melts powder-based materials with high-intensity laser beams to create sculptures (Song & Kim, 2015). In the fashion industry, shoes with diverse