UDK 687.15+004.94

DEVELOPMENT OF CLIMBING CLOTHES USING COMPUTERIZED 3D CLOTHING SIMULATION

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Men's rock-climbing pants patterns through the computerized 3D virtual clothing simulation program were developed in this study. The CLO program was utilized for 3D simulation method on the parametric avatar, in order to reduce time and costs needed to make the garments. Rock climbers need clothes that fit well, are comfortable and do not restrict the climbing body movements. Therefore, dynamic anthropometry is crucial for sportswear and personal protective cloth design. The fit of designed prototype in static and dynamic body posture through virtual fitting was analysed. A comparasion was performed regarding the clothing stress, strain, fit map and pressure points.

Key words: *climbing, pants pattern, virtual fitting, design, 3D simulation, prototype.*

INTRODUCTION

With pandemic restrictions, making difficult to work directly with models, virtual fashion show had become more proeminent worldwide. A number of 3D virtual programs software are available on the market, such as Clo 3D, Lectra, Optitex, V-stitcher, TUKA 3D, etc. The programs are showing virtual garments in static and dynamic on a 3D mannequin, with the posibility to chose fabric properties (texture, draping, elasticity, etc.) and sewing the patterns by fabric technical parameters.

Based on the growing of bouldering participants, in the present study was used a garment system to make clothes parttern and 3D virtual fitting experiment for this specific category. Rock climbing is unique from a physiological point of view because is a physical activity performed against gravity, a combination of body movements created with kinematic and kinetic parameters wich requires sustained muscle contractions for upward propulsion. Taking into consideration the latest advancements and the adaptation of clothing industry, we will present the theoretical background and review the literature regarding the applications of 3D virtual simulation. Information on anthropometric data is a precondition of garment patterns design [1]. In static anthropometry, people are measured in unmoving, defined postures. Functional anthropometry includes dynamic reaches and strength measurement with the body engaged in various postures. Dynamic anthropometry is a major research topic in clothing technology.

In 3D garment design, the mannequin is basicaly a personalized 3D human model from measurement of a body with anthropometric equipment, 3D body scanner or a measuring tape related to a specific client [2]. The researchers stated that the key to the functional design of clothes with special destination is simulation of its protective functions during its activity [3]. Lee compared in 3D virtual fitting two methods of pattern development to detemine curved design lines and their three dimensional construction, the offset and the split grading type. He analised the inguinal region and back crotch area in virtual fitting of two outdoor pants patterns. The difference between the 3D offset/projection and the split grading method was at the location where several curved lines merged [4]. Weiyi Liu measured the pressure of yoga suit under different wearing states through the virtual clothing pressure tool of CLO 3D platform [5]. For example, Jeong [6] measured and analyzed the pressure points in static state and cycling dynamic state with 3D human scan data. Then, based on the change rule of pressure, a clothing pattern optimization scheme was proposed and optimized the design of cycling jerseys pattern. Kaixuan Liu [7] built a pants fit evaluation system based on CLO 3D platform and came to the conclusion that, clothing pressure data from 3D virtual fitting software has predictive accuracy on the assessment of garment fitness.

PURPOSE

CLO3D is a design software with an intuitive interface and 3D simulation is a suitable method to get a good visualization of the products design. Therefore, the purpose of this study is to develop bouldering pants patterns and evaluate their static and dynamic wear comfort in 3D virtual try-on experiment (Figure 1).

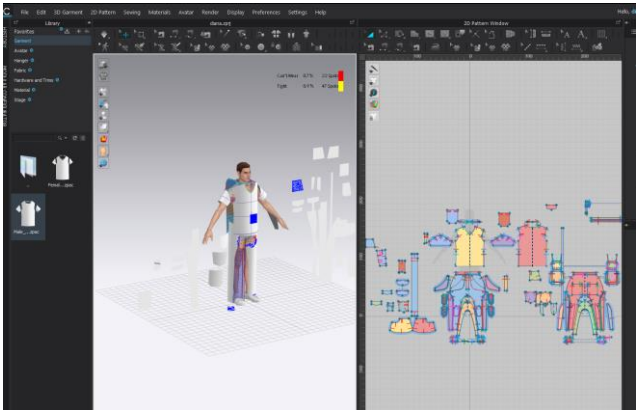

Fig. 1. Rock climber's jersey T-shirt and pants patterns

RESULTS AND DISCUSSION

CLO 3D system version 6.0 was used as experiment platform in order to identify the fit analysis capability promoted through virtual prototypes. First, the 2D-to-3D was applied to develop garment patterns of a rock climber's jersey T-shirt and

pants. The first step was characterized by the classical pattern design, after acquiring the information of anthropometric measurements [8] and garment styles. The patterns ere developed directly in the 3D software. The flat patterns can be visualised in the sewing/assembly stage of the prototype. Then, 3D animation technology was used in simulation.

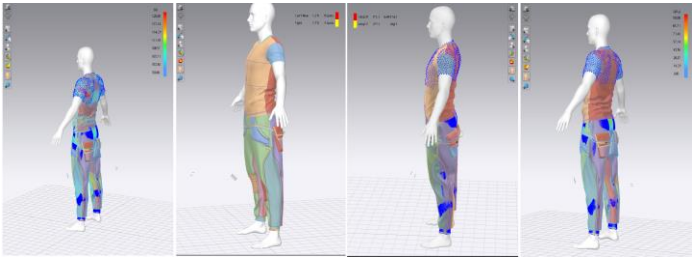

Fig. 2. Stress Map, Pressure Points, Strain Map and Fit Map

Figure 2 shows how we measured the pressure of rock climber's jersey T-shirt and pants under different wearing states through the virtual clothing pressure tool of CLO 3D platform.The Stress Map shows the external stress causing garment distortion per area of the fabric, and appears in the range of colour and numbers. Stress Map red colour indicates the strongest stress (100kPa) while the blue colour indicates zero distortion (0.00kPa). The Strain Map represents the rate of distortion of clothing due to external stress and is quantified in percentage form and is represented by a colour diagram. Red indicates 120% of the distortion rate while blue indicates 100% (no distortion). The Fit Map shows how tight clothes are on the user's body. The red colour indicates the impossibility of wearing and white colour indicates that the area is loose.

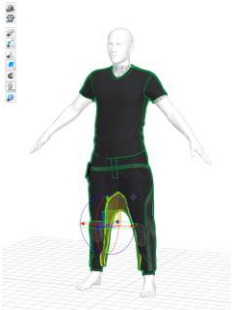

Fig. 3. Prototype adjustment

From the observation of the simulation patterns, it was possible to identify some aspects able to be improved: small adjustments, positioning of aesthetic details on pants, such as adjusting systems and pockets (Figure 3). The evaluation from the fit perspective was based on the observation of the images of tension

graphs with the test body in sport activity, in a static and dynamic positions. It was possible to observe the clothing's behaviour and the tension generated in a simulation of use. Based on the principle of minimum average pressure, the pattern of trousers was optimized to improve the pressure comfort.

CONCLUSIONS

The results showed that the first prototype can be optimized and the pressure comfort can be improved through the pressure points, stress, strain and fit map. Clo 3D software allows patternmakers by using their own experts know-how to parameterize anthropometric data and to get renderings from 2D patterns in a short time.

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