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Virtual Prototyping for Fashion 4.0

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ABSTRACT: Virtual prototyping shows enormous potential to make the fashion manufacturing industry greener and leaner. Yet the technology is not well embraced by the industry. No matter what the reason is, this is the only way towards e-manufacturing for fashion 4.0. This paper provides an overview of the technology and its features.

1 INTRODUCTION

Creative and technical designs are two integral parts of the fashion-product-development-process (FPDP) practised in the industry today (Glock & Kunz, 2000). The aspect of creative design covers the process of fashion design resulting from designers' imaginations coupled with market research information. On the other hand, the aspect of technical design includes pattern drafting based on the anthropometric information of the target market to facilitate geometric fabric cutting prior to clothing manufacture. Both manual and computer-aided techniques exit for both creative and technical fashion designs. However, the new generations of designers are naturally fond of computer-aided techniques following the millennial trend. A notable number of computer-aided design (CAD) systems is available today for use in the fashion industry. They offer efficiency and timesaving solutions to many complex and complicated tasks and facilitate smooth communication over the worldwide web platform between one place and almost any geographically remote corner of the world.

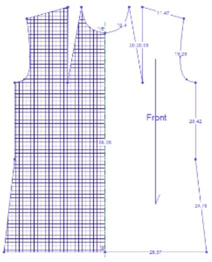

Figure 1. Front panel of a ladies' shirt drafted in a commercial 2D CAD system

2 2D CAD FOR FASHION INDUSTRY

General graphics design software packages such as Illustrator® from Adobe Systems Incorporated (USA) and CorelDRAW® from Corel Corporation (Canada); or more customised software systems for the fashion industry such as Kaledo® Style Lectra (France), Vision® fashion studio from Gerber Technology (USA), Tex-Design™ from Koppermann Computersysteme GmbH (Germany) are extensively used around the world for fashion drawing and illustration (Sayem et al. 2010). Specialised CAD software packages for drafting and grading flat patterns of garments were introduced into the industry in the 1980s (Burke, 2006) and they have become very popular within the fashion industry.

The commonly known 2D CAD software packages that offer options for drafting flat pattern pieces using the body measurements information of the target consumers are: cad.assyst from Assyst (Germany), Modaris from Lectra (France), Accumark PDS from Gerber Technology (USA), PAD Pattern Design from PAD System Technologies Inc. (Canada), TUKAcad from Tukatech (USA), GRAFIS from the company Dr. K. Friedrich (Germany) and Audaces Apparel Patterns from Audaces (Brazil) (Sayem et al. 2010). In addition to pattern drafting, they support importation of existing block patterns with the help of a "digitiser". Usually, they support automatic pattern grading with the help of pre-developed grade rule tables. Figure 1 illustrates a pattern piece of a shirt panel drafted in a commercial CAD system.

3 3D CAD FOR FASHION INDUSTRY

Several researchers have demonstrated effective techniques of draping digital pattern pieces on virtual mannequins and simulation of virtual clothing prototype (Fozzard & Rawling, 1991, 1992, Okabe et al. 1992, Volino et al. 1996, Kang & Kim, 2000b, 2000c, Chiricota, 2003, Fuhrmann et al. 2003, Thalmann & Valino, 2005, Luo & Yuen, 2005). This technology has already reached a stage of sufficient maturity to be implemented in the industry (Sayem et al. 2010, 2011). Commercial 3D CAD systems that include virtual avatars and support simulation of 2D pattern pieces on them started to appear on the market since 2001 (Goldstein, 2009). They include the software packages like Vstitcher from Browzwear (Singapore), Accumark 3D from Gerber (USA), Modaris 3D from Lectra (France), TukaCAD 3D from Tukatech (USA), PDS 3D from EFI OptiTex (Israel) and Vidya from Assyst (Germany).

Figure 2. An example of a virtual fashion prototype produced in a commercial 3D CAD system

3.1 *Virtual Human Models*

3D clothing CAD systems usually come with a library of built-in virtual avatars, which can be customised with the variation of different anthropometric and demographic information such as age, gender, measurements, body posture, skin tone, hair style and colour, and even the pregnancy stages (Sayem et al. 2010) They work as a platform for 3D clothing generation. The systems allow to position 2D digital pattern pieces on the avatars and to stich them virtually to facilitate virtual simulation of drape. With the help of 3D bodyscanning technology, it is now possible to capture a full human body very quickly as a 3D scan and to extract measurements out of it. This helps to morph virtual avatar with required size and shape to produce a virtual twin of a human model. Figure 3 illustrates the morphed avatars in the different available 3D CAD systems. However, the commercial systems differ in the number of parameters they utilise to morph virtual avatars (see Fig. 4 presents the number of morphing parameters utilised in a few available 3D CAD systems.

Figure 3. Morphed male avatars in different CAD systems

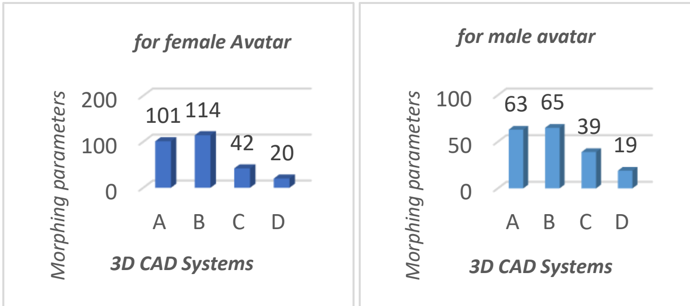

Figure 4. Number of morphing parameters utilised in commonly available CAD systems.

3.2 *Fabric Library and Virtual Drape Simulation*

The 3D fashion CAD systems include a built-in library of fabrics and other related materials together with their physical and mechanical characteristics Once digital pattern pieces are positioned on avatars, drape simulation can be performed applying relevant material properties (Fig 5). This can be done by selecting appropriate fabric from built-in fabric library or by adjusting the properties a close one. In a few cases, it is also possible to input new fabric properties taken from an objective fabric measurement system such as KES-f and FAST to view differential drape. Very recently few software companies have brought their own fabric testing instruments on the market for use in acquisition of materials parameters of drape modelling and do not include the KES-f and FAST data converters anymore. However, these newly introduced fabric testing systems need go through the processes of standardisation (Power, 2013), approval, and accreditation from the international standardisation bodies for use in the industry.

Figure 5. Steps in virtual simulation of clothing

3.3 *Virtual Fit Analysis*

Available 3D CAD systems allow their users to check garment fit in various fabrics and sizes and facilitate the virtual review of prototype garments. Colours, motifs and trims etc. can be easily and quickly changed on virtual garments to help decision making, as presented in the Figure 6.

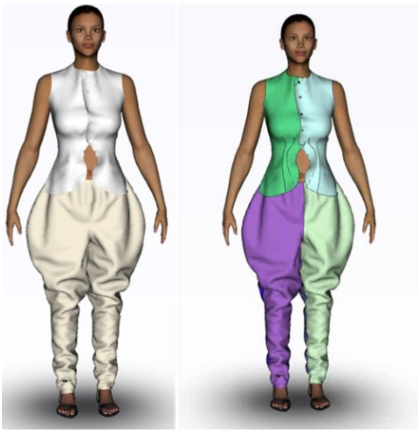

Figure 6. Examples of same virtual garment in different colours

However, it is apparent from the works of Kim (2009) and Kim & LaBat (2013) that only a visual check of virtual prototype does not provide any conclusive clue for decision making on the state of virtual fit. They simulated a pair of woven trousers based on fabric properties and found that the appearance of virtual fit significantly differed from that of real fit of garments. Particularly wrinkles that existed on physical prototypes they made were not accurately reproduced on virtual prototypes. The work by Lim (2009) include a virtual comparison of a women's wear simulated two different systems utilising identical material properties. He found that the visual appearances of the simulated garments looked different in two systems he used. Power et al. (2011) also highlighted similar limitation of visual assessment of virtual fit. They virtually simulated two different fabrics having vastly different characteristics and found a very similar appearance of the virtual simulations resulted from those two fabrics. This supports the findings of Kim (2009), Lim (2009) and Kim & LaBat (2013). This indicated the existing subjective evaluation is not sufficient to evaluated virtual fit of clothing and asks for an objective approach in addition to this.

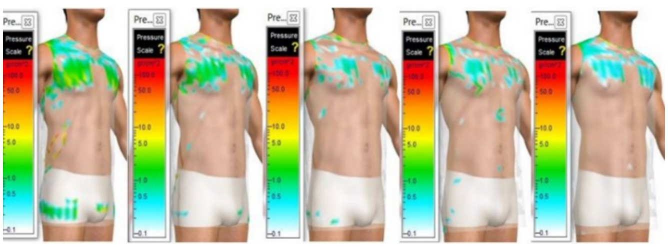

Figure 7. Examples of Tension maps of virtual garments

3D CAD systems offer several technical tools for virtual fit analysis such as tension, pressure, stretch and ease mapping tools, as can be seen in the Figure 7. These tools offer the opportunities of both subjective and objective fit evaluations in addition of visual check of the simulated drape and fit on virtual avatars (Sayem et al. 2010, 2012, Lim & Istook, 2011). This provides an opportunity to review and forecast the clothing fit at the pre-manufacture stage and to take decision on the correctness of drafted pattern pieces (Sayem, 2017, Sayem et al. 2017).

4 PRESENT BUSINESS SCENARIO AND VIRTUAL PROTOTYPING

In these days of globalisation, offshore sourcing has become a key business strategy for many fashion retailers (Christerson & Appelbaum, 1995, Firoz & Ammaturo, 2002; Gereffi & Memedovic, 2003). To take the advantages of labour market differentials in many lower labour cost countries, most of the world's clothing production today takes place in the far eastern counties. However, most of the activities of fashion design and product development are done and still controlled from the retailers' head offices in Europe and America. The geographical distance between manufacturers and retailers causes a considerable long period of time for making prototypes at manufactures' factories according to designers' specifications and transporting those prototypes to the retailers. Often this process needs a repetition in order to rectify any problems related to assembly or fit or to incorporate any change in design. Together with the distance involved, it inevitably increases the development lead-time and cost even further. Therefore, there is always pressure from the retailers' side to curtail the development lead-time and to minimise the cost involvement in physical prototyping in order to cope with rapid fashion changes and business competition. Virtual prototyping offers a solution to this problem. It is now possible to drape 2D digital pattern pieces on a virtual avatar to simulate the 3D appearance of clothing close to an acceptable reality. This gives the opportunity of identifying flaws in 2D patterns through a process of virtual fit checking to rectify initial problems with 2D pattern pieces without any need for a physical prototype with real materials. As the process of virtual fit assessment can also be communicated over the worldwide web platform between suppliers and retailers from any corner of the world, the product-development lead-time can be significantly shortened and the dependency on physical prototypes can be reduced (Ernst, 2009, Sayem & Bednall, 2017).

5. CONCLUSION

The suppliers claim several advantages of using these 3D systems such as improved communication of design data throughout the supply chain and product life cycle and lowering of product development time and costs (Ernst 2009, Sayem et al. 2012, 2014). However, the fashion designers and industry are yet to get any true benefit from the prevailing virtual fashion technology, despite such software systems being available on the market for more than a decade now (Sayem, 2017, Sayem et al. 2014). Little information is available on how and at what extent such technology is being used in the industry around the world and what practical benefits of using them are being experienced. No academic literature reports the reasons behind the slow and sluggish adoption of virtual simulation technology within the fashion industry (Poterfield & Lamar, 2017). It is important to strengthen the research and development (R&D) from industry and academia to address these current issues.

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