Evaluation of 3D Body Scans from Mobile App via Virtual & Physical Try-on Garments

Evridiki PAPACHRISTOU *1, Despoina KALAITZI 2, Nikolaos BILALIS 2
1 Creative Design & Clothing, International Hellenic University, Thessaloniki, Greece;
2 School of Production Engineering & Management, Technical University of Crete, Chania, Greece

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Abstract

This paper evaluates the accuracy of mobile 3D scanning technology in regards to exported anthropometric data and 3D body mesh, when comparing the virtual try-on of a bodice with the fit on the same physical body. Fashion students during their subjects of Virtual Prototype and 2D Pattern Design Systems, divided in groups, used Mobile Fit app by SizeStream to provide a 3D representation of a body of their choice. They used the extracted obj file into CLO3D as an avatar. With the extracted anthropometric measurements the students developed a basic bodice in Polypattern 8.4v2 22 Cad pattern design system. The exported dxf files of the basic bodices were imported in the 3d environment to virtual dress the scanned body/avatar. At the same time, the physical bodice was constructed by each team and dressed on the same scanned body. Evaluation of fit was conducted comparing the two methods. Authors state the pros and cons of the complete digital method.

Keywords: 3d body scanning, virtual try-on, Mobile Fit, fit evaluation, fashion education

1. Introduction

3D body scanning has gone, especially in recent years, under exciting development (technology-wise); from the CAESAR [1] project in the late 90s and its 16 cameras housed booth, to portable and handheld scanners and lately to mobile scanners. The acquisition of body data with new methods has drawn the attention of several researchers, especially now that smartphones are equipped with more progressive technologies for the measurement of 3D objects. [2] studied iPhone12 Pro with built-in LiDAR and TrueDepth non-contact 3D scanning sensor if it can be obtain an accurate 3D model of a human figure for measuring its dimensional characteristics. [3] also researched the smartphone use as a low-cost method for 3D body measurement based on photogrammetry. [4] earlier, tried to utilise LiDAR systems for the reconstruction of a dressed mannequin.

Since, however, the fashion industry cannot use this technology to create custom garment patterns [5], several researchers focus on different matters around it to advance and expand its use. [6] focused on measuring the compression of garments like a seamless knitted sports bra, whereas [7] studied how shapewear changes the body shape and attractiveness. Studies like [8], explore the relationship between 3D body technology and body pattern drafting enhanced by virtual prototyping. Others approach the use of 3D technologies as a mean to reduce the environmental footprint of the fashion supply chain processes. [9]&[10] proposed a new fully integrated product development model with 3D virtual simulation of design concepts on mannequins that represent the target market of the company with digital fit models based on accurate input size data.

Educational institutions and fashion or textile departments have implemented 3D body scanners into their courses' equipment for research experimentations and emerging technology deployment. [11] even studied the perception of students after interacting with their digital scanned avatar and virtual designed garments along with issues related to sustainable consumption. Recent development in 3D body scanning technology with improved level of accuracy, alongside with rapid developments in mobile and computing technologies and the "explosion" of online clothing purchases due to covid-19 outbreak, have led to mobile application launch by several companies. SizeStream [12] is the latest mobile application for body scanning. MobileFit app by SizeStream, is designed to allow employees and team members to determine their size requirements accurately, from the privacy of their own homes.

3D body scan apps, are very easy to use and free to download (to a certain extend), allowing the user to scan the clothed body in a matter of seconds, anywhere and anytime. These apps use advanced computer vision, deep learning, 3-D, and mesh processing technologies, to generate a body measurement chart [13] and a 360 view of the scan directly into any smart phone. Although these apps demonstrate the above mentioned game-changing opportunities for 3D body scan in large scale, are slowly being explored by researchers. To our knowledge, these apps are not included in the learning process of either 2D pattern development or customised virtual prototyping. However, similar test

implementations by actual users/students can help establish the usefulness of these scans, integrating even more technology tools into academic curriculums. They can open doors to new courses, bridging the gap of misunderstanding the scientific approach of engineers and the “sensible”, and at the same time vitally creative foundation of fashion designers [14].
The development of this technology in a way that overcomes the challenges and limitations (technological, human perception/attitude/trust and privacy), can help industry parties (creators, retailers and consumers) take body measurements quickly, accurately, affordably and comprehensively.

2. Method

A total of 34 third year students in 3D prototype class of a Clothing Design course, created 2-3 persons groups to download Mobile-Fit app and scan a female person of their choice. When all 12 Groups completed the scan, SizeStream gave access to the full measurements chart table (198 measurements), an obj file of the scanned body and two png images (front and side view) of the scan. See Fig.1.
The student groups selected only eleven (11) of the measurements (Fig.2) and collaborated together to draft a custom basic bodice in 2D CAD pattern system. Basic bodice was drafted according to [15]. The basic bodice (Fig.3) was composed with front and back waist darts, bust darts, shoulder darts and no sleeves. A center back zipper opening was optional.
All students used the same cupro fabric to cut and sew the test bodices.

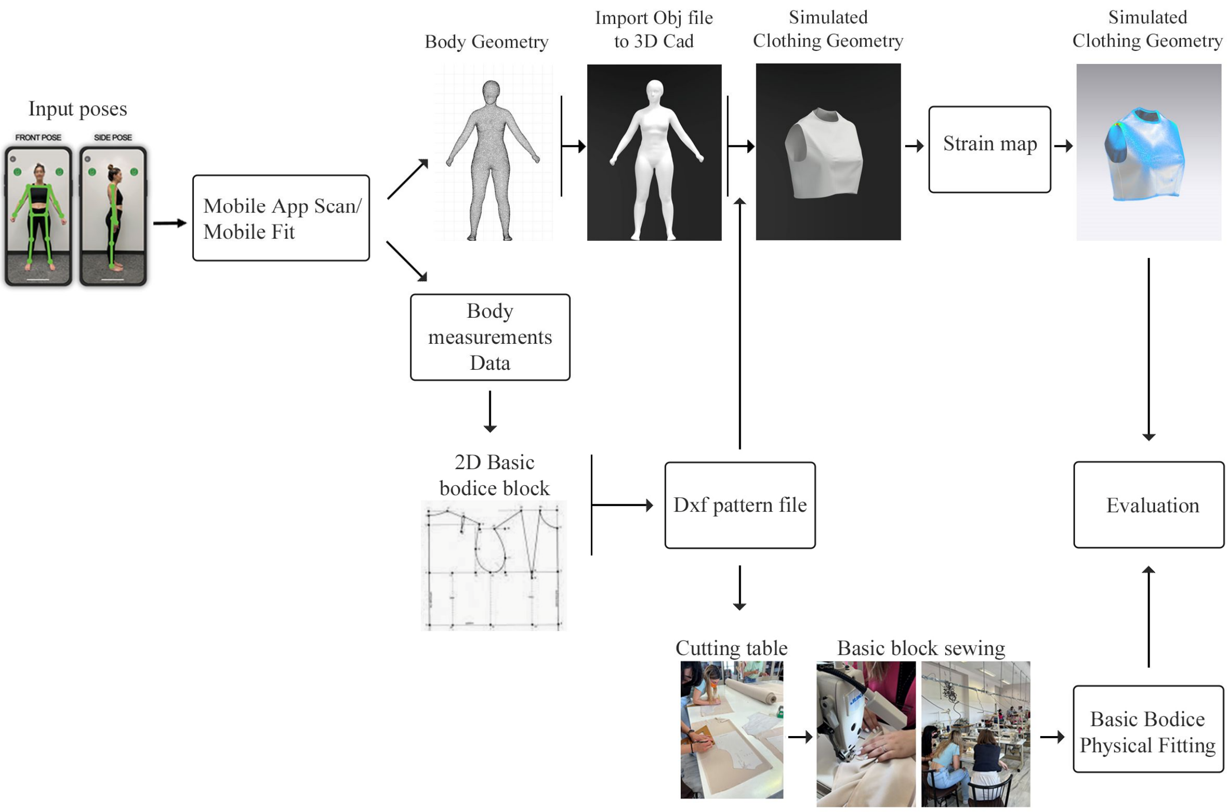

Fig.1. The process of the research

NeckCircumference
ShoulderLengthLeft
ShoulderLengthRight
ChestCircumference
BustToBustLength
SideNecktoBustlengthLeft
SideNecktoBustlengthRight
ArmCircumferenceLeft
ArmCircumferenceRight
WaistCircumference
WaistHeight

Fig.2. Selected measurements for bodice pattern drafting

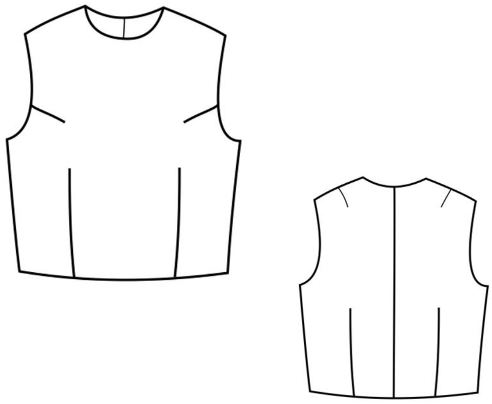

Fig.3. Bodice Flat Drawing

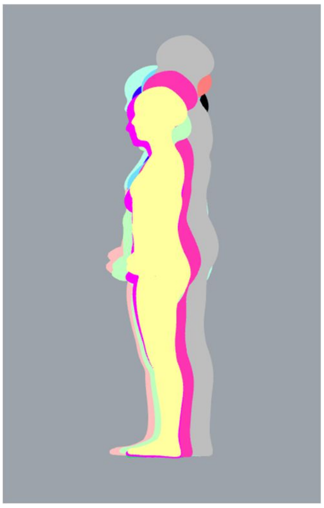

Fig. 4. 2d side view bottom-aligned images of scanned bodies placed in Rhinoceros

3. Test/Data

3.1. 3D Virtual

Using a 3D model directly from a body scan along with a virtual try-on system, allowing the user to decide whether he/she likes the fit of the garment is not new. Peng [16], proposed this as motivation to encourage a user to engage with Body Scanning System. More recently, [17] & [18] researched the pressure points as an index for fit evaluation by color.

In this study, students imported the obj file of the scan body into Clo3D (Load Type-Open), replacing the default avatar of the system. Dxf pattern files were imported from a 2D CAD system into Clo3D, they were arranged in 2D & 3D window, were virtually sewn and simulated on the avatar. [19] used a 3D virtual prototyping system with integrated 2D computer pattern making system, however in this study seamless integration was achieved without such restrictions. Strain Map function was activated in order to check the stretch of the 3D garment due to external pressure (See Fig.5 3rd & 4th column). The part with no stretch appears in green, but with greater stretch the part of the bodice turns closer to red (Fig.5 line L).

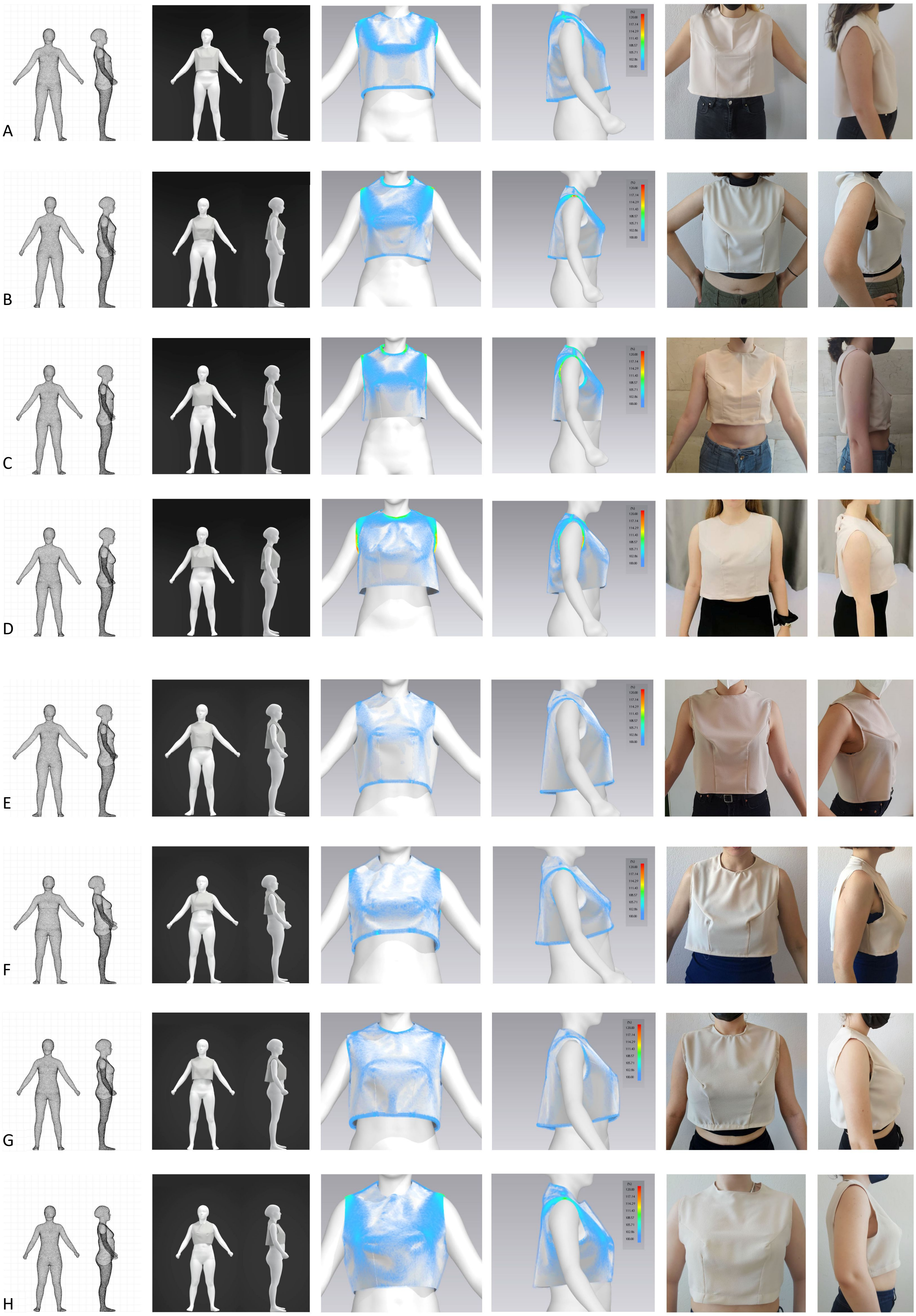
A
B
C
D
E
F
G
H

Fig. 5 2D body mesh (front-side), extracted obj in CLO, strain map on bodice, physical dressed bodice. (From left to right)

3.2. Fit Analysis

Although garment fit as a concept is not defined completely, mainly it includes two aspects: aesthetic fit and comfort fit [20]. However in this study we will follow McKinney's model [21], in which fit evaluation is done with objective measurements (measuring the volume space between the body and the garment) and subjective measure. Subjective measure involved the observer's (judge) perception of bodice fit and the wearer's perception of how the bodice fits. As mentioned previously, the aim of this study is to compare the bodice fit using virtual try-on software by dressing a mobile scanned customised body avatar, to bodice fit on a live model with the physical bodice constructed by the measurements provided by the mobile 3D scan app.

For the live fit analysis, each student group modelled their garment on the same body that was scanned with the mobile app and took two photographs, while one judge evaluated the fit. For the 3D virtual garment, each dressed avatar (zprj file) was saved and two screenshots of front and side view were taken with strain map view on. Fig. 5 shows the comparison between scanned 3D virtual dressed avatars and dressed models with physical bodices. Columns 3-4 show the virtual fit, while 5-6 show the physical fit (both front and side view).

According to [13], wrong pose and body posture can affect the final result in pattern design, sizing, and fitting due to landmarks' shift. Chosen positioning of the subject can affect the consistency of new mobile scanning tools [22]. From Fig.4. we can see that during the groups' 3D mobile body scan, the body posture was not similar to all. This could have been one of the reasons that result to several fit issues of the physical bodice. One other reason is that students even though trained to use 2D CAD pattern systems, still use 1-D measures extracted from the measurements' table (MobileFit App). 3D shape data, as similarly noted in [13], cannot be integrated into the pattern making process. Moreover, although students followed the same instructions for basic bodice drafting, the results in the basic measurement of bodice length are different. For example, bodice F is very short in length (just below under-bust), while bodice J is very long (below waist line). Bodice L could not be fitted due to miscalculations from body measurements to 2D pattern drafting. The finished garment could not be fitted- was too small for the fit model, as can be seen from the virtual fit in column 3-4 (red stain map in chest, bust, shoulders, neck, armhole, hip). Also, some underarm curves are deeper than others; examples of B, E, F compared to A, C, D & G. However, the same depth in these armholes can be seen in virtual bodice. Neckline curves are similar when comparing virtual to physical showing a consistency between the two methods. Bust and waist darts help to create a better fit when the garment is steam-pressed (Bodice D, E, H, I - last two columns). On the contrary, bodices B, F, J,K can not be evaluated for their fit compared to their virtual ones due to wrinkles and shrinkage of the cloth material in a few seams.

4. Results

4.1. Pros

Learning to use 3D mobile apps along with 3D prototyping tools to evaluate the fit of a customised garment, can result to well-fitted garments which in return enhance future sales of creative ideas.
The creative process of clothing without the nuisance of repetitive iterations in 2D pattern in order to achieve better fit, can focus more on experimenting with materials and new techniques than with the fitting performance of ideas.
Learning to evaluate fit via dressing 3D mobile body scans, enhance the technical skills of a designer or a pattern maker and bridges the gap between the fashion creators with an aesthetic approach and fashion engineers with a scientific approach.
A good fit leads to a satisfied customer and therefore ensures customer loyalty in the long run and ultimately enhances business performance of the employer [23].

4.2. Challenges

ISO 20685-1 [24] recommends that the subject being measured wears garments that expose landmarks. Students were advised to do the 3D mobile scan at home and wear as closely fitted clothes as possible that expose the landmarks. However, not all students followed this advice and several outputs of the scans were deformed which resulted in mobile scan repeat in class with typical worn clothes. Less worn clothes by the wearer subject increases accuracy. However, students showed hesitance in wearing the appropriate clothing in class in fear of someone seeing them, which increased probability of errors in their measurements. Another factor that was not considered as important by the students at the beginning of the process, was body sway during the scan; also mentioned in [25] [26].
Cupro material which was chosen for the construction of the physical bodice, does not belong to the simulations' software library. Instead a viscose polyester was chosen as the closest match. As [27] state, this difficulty and limited possibility to use customised fabrics limits the quality of simulation.
Accuracy of data derived from 3D body mobile scan apps does not necessarily mean perfect fit of 2D or 3D garments. Pattern making skills especially during learning process in an educational environment, is a factor to be considered.

5. Future Research

Students participating in groups, although they followed the project brief's instructions and drafted a 2D digital pattern bodice block for the selected scanned body using MobileFit app by SizeStream and later constructed a physical prototype of this bodice and did a model fitting, did not evaluate either the challenges of the process itself nor the fit analysis. Future work could include an investigation into the students' consideration of 2D digital computer pattern making and 3D virtual prototyping, using body scanned measurements to promote objectivity. Moreover, more accurate prediction of fit can be achieved when measuring the fabric's physical textile properties instead of replacing it with a random one from the 3D library.

6. Conclusions

During the development phase of both the virtual and the physical dressed bodice, students demonstrated joy and excitement as the driving factor for following the project brief's instructions, unparalleled to their inadequate skills caused by their limited experience in such experimental learning model. However, many studies including [13] state that the designer ultimately has to make the transition from real fit evaluation to the virtual environment. Fashion design students are the designers of tomorrow. Learning to evaluate fit with virtual technology tools that integrate mobile apps, can facilitate the needed transformation of skills which is prerequisite for the future proof of clothing design, development, production, testing/evaluation and promotion/selling. At the same time, having such experience during their academic projects can affect (in the long-run) their behaviour as consumers who want to engage with fit online as [28] describes. In a better scenario, getting used to 3D mobile body scans and their integration in the fitting process, can create mature fashion experts who can choose to leverage these tools in their future working environments, combining them with other technology tools like 3D virtual prototyping, virtual dressing rooms, sizing personalisation systems and size recommendation solutions. This evolution and maturity of fashion experts will eventually impact a multi-disciplinary collaboration between sales and creation teams, traditional fashion mindsets and tech-savvy forward thinkers.

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