Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

Report on activities of Result 3: Fabric and Garment Digitalization and Digital Fashion Platform

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Report on activities of PR3: Fabric and Garment Digitalization and Digital Fashion Platform

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1 INTRODUCTION

This interim report presents the general architecture, functionalities and implementation techniques of the DIGITAL FASHION Technology Platform, enabling fashion designers to quickly learn digital fashion design techniques from associated design resouces integrated into a relatively complete digital environment (databases, design knowledge bases, interfaces). This platform has been developed based on the results of FBD_BModel, a former European project realized in the frame of H2020 Program (2017-2021). Apart from the implemented platform structure and its associated design resources, the processes of fabric digitalization and 3D garment generation, playing a key role in digital fashion design, are also presented and integrated into this platform. These processes will enable to digitalize a real fabric by using the associated Lectra digital fabric database and intelligent computation of drape properties and weight, and generate a 3D garment and its fitting effect on a specific 3D human model. The current platform will constitute the foundation of the digital fashion design process, and more advanced functions, such as intelligent searching engine for design recommendation, will be further developed and integrated into this platform.

The report is composed of the following sections:

- General structure of the platform
- Process of fabric digitalization
- Process of garment digitzlization and garment fitting
- Technical implementation of the platform

2 General Structure of the Platform

In this section, we present the general structure of Digital Fashion platform, its interfaces and then go through details of each specific function.

2.1 General structure of the software

The home page is designed to encompass four main functions: garment design, fabric design, digital design learning, and garment e-shopping, as shown in Figure 2.1. In this phase, our focus is on development of the digital design learning function, which consists of three tasks: Knowledge Base, Virtual Try-On, and Digitalized Fabric Process.

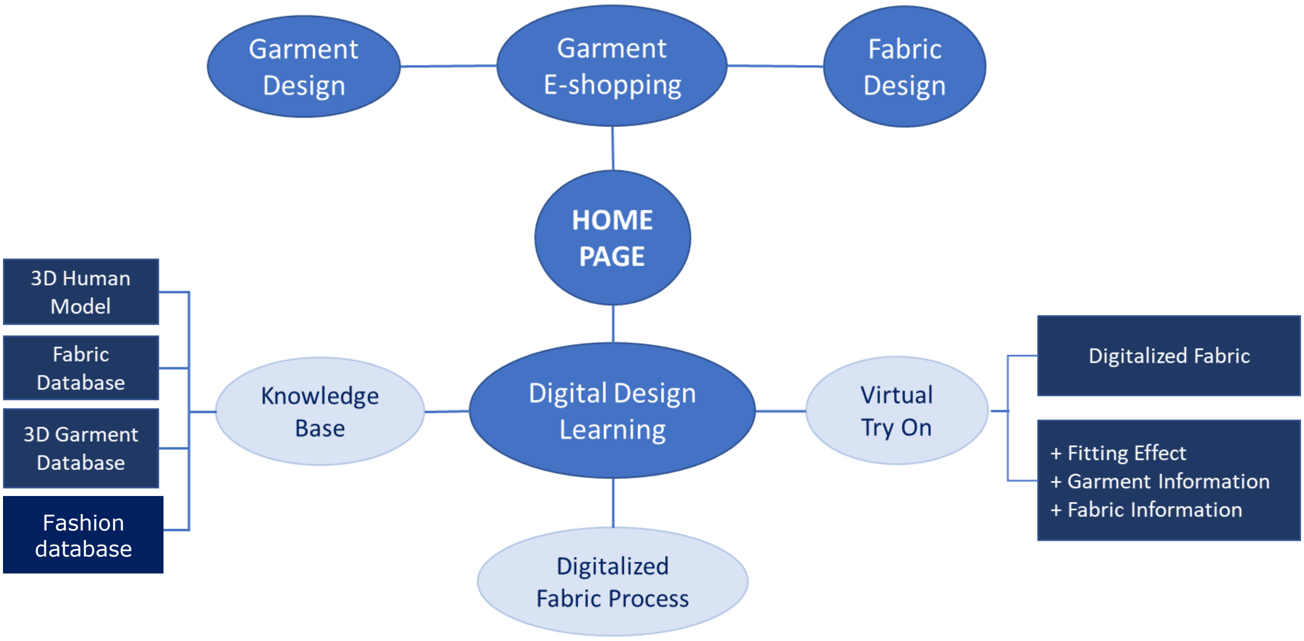


Figure 2.1: General structure of Digital Fashion Platform

At the current stage, the professional design knowledge base includes information about four databases: 3D human model database, fabric database, 3D garments database, and fashion database. A real fabric can be digitalized by using the digitalized fabric process, which relies on an existing digital fabric database implemented in the software of Modaris 3D Fit. A series of garment fitting experiments have been realized in the garment virtual try task, where fitting effects, garment and fabric information are combined together to generate a 3D garment under this software environment, enabling to show the designed garment style, fabric properties computed from real fabric drape effects and textures, as well as interactions between a specific human body and the designed 3D garment in terms of aesthetic appearance and ease allowance. The interface of the hompage is illustrated in Figure 2.2. The homepage is designed to integrate the modules of *garment design, digital design learning, garment e-shopping and fabric design*. However, the current report mainly focuses on *digital design learning*, even the other modules include some similar functions.

In Figure 2.2, a number of basic 3D garments are demonstrated in order to show to the students or design begginers the final effects of garment digitalization with different sizes. These basic garments include: women's skirts and blouses, men's trousers and shirts, jacket, legging, and sportwear. The user can select a specific fabric (e.g. F26, F27) and size (e.g. size 36, size 42) to adjust the garment parameters and obtain a desired fitting effect for a specific human body shape. The specific fabrics used in the platform have been provided by different partners of the project, enabling to show various physical properties and textures. According to the experience of designers, the fabric physical properties, including bending, shearing and tensile, can be visually taken into account by the drape effects of finished garments or original materials. In the same way, for different body sizes, the visual effects of garment fitting for both real and visual products are quite different, which are strongly related to the garment style, ease allowance, and fabric physical properties. The previous features are quite important, enabling to control technical design parameters of garments and fabrics according to their digital visual effects in order to obtained the satisfying digital and real garment products.

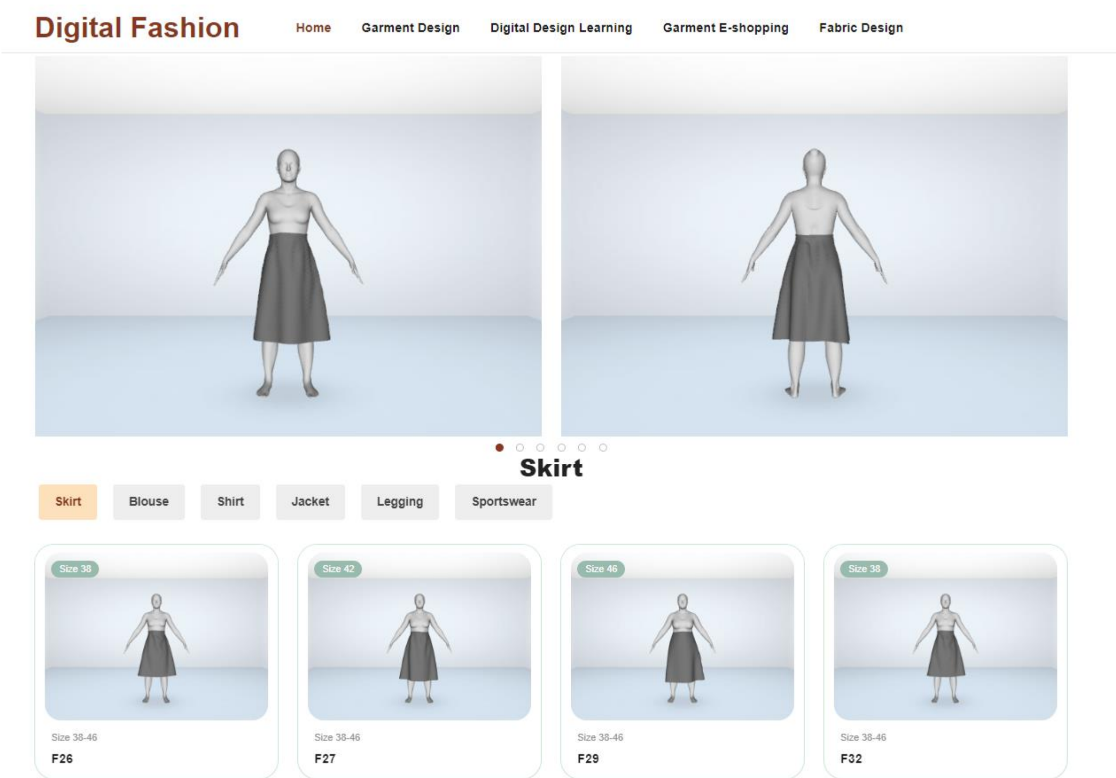


Figure 2.2: Home page of the Digital Fashion Platform

2.2 **Digital Design Learning Functions**

When clicking on *Digital Design Learning* from the homepage, we will open the page of Figure 2.3, which is composed of 3 main functions: Knowledge base, Virtual try-on, and Digitalized Fabric process. It will systematically show how a digital 3D garment can be relized through the previous 6 basic garment styles. On this page, clicking on DDL Home will enable the user to return to homepage.

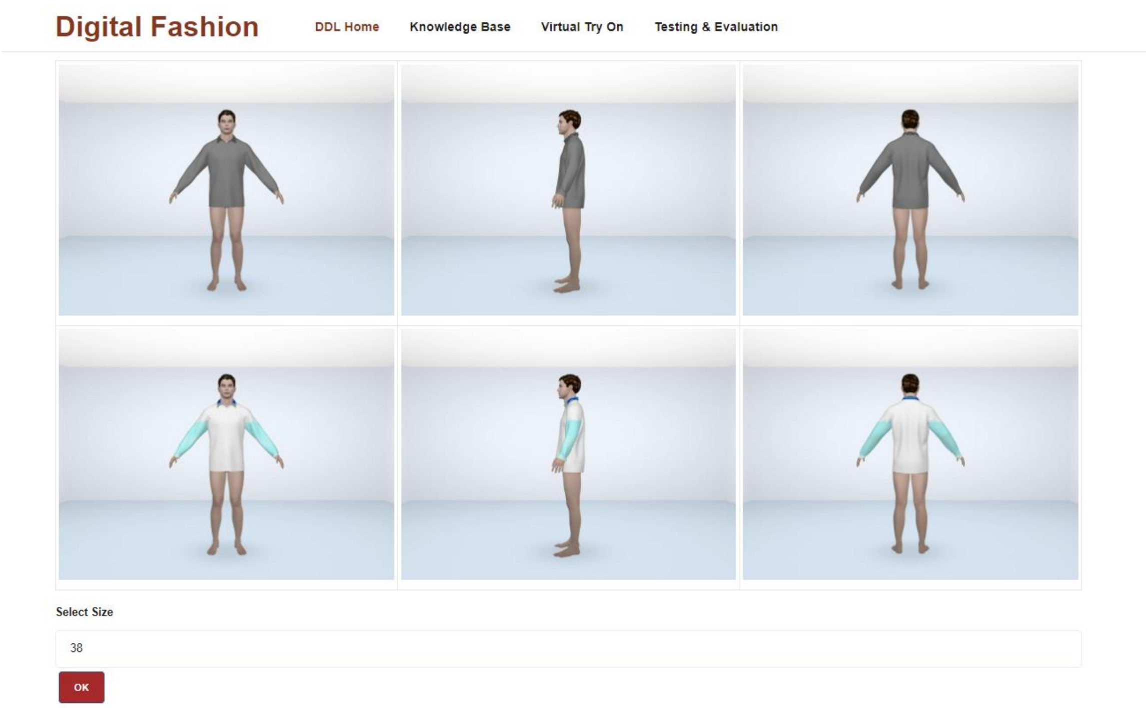


Figure 2.3: Digital Learning Page

2.3 **Knowledge base**

The professional design **knowledge base** is the core component of the whole platform and digital garment design process. This knowledge currently includes information about the previously mentioned four databases, namely the 3D human model database, fabric database, 3D garments database, and fashion database. Several examples are shown in Figure 2.4. The other information in the knowledge base, such as garment adjustment rules and operations or combinations of fashion elements, will be completed in the second stage of the Project. The intelligent engine for garment pattern selection and adjustment for specific fashion requirements will also be developed in the second stage by exploiting these databases. The current four databases have been designed to be connected to the processes of digital human modelling based on 3D body scanning, fabric digitalization, 3D garment generation and fitting, and fashion design element online interview. More detailed descriptions are given in the following sections.

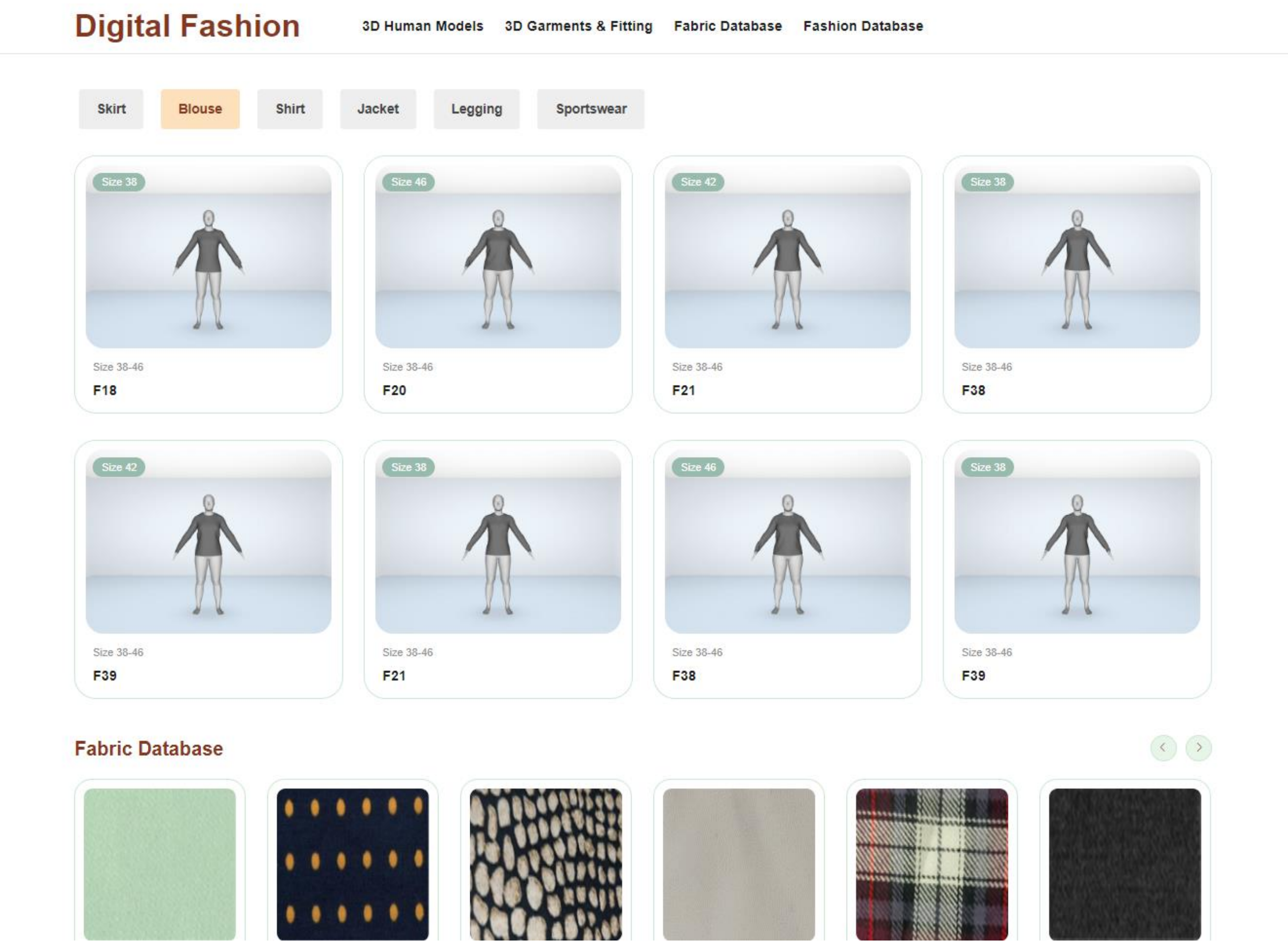


Figure 2.4: Digital Learning Page

2.3.1 **3D Human Models**

The 3D avatars information is provided by University of HOGENT, including 3D and 2D avatar images of young ladies aged from 18 to 25 years-old with different sizes 38, 42 and 46, and avatar's measurement details. As shown in Figure 2.6, the platform shows the 2D images of the 3D human body from three views (i.e. front, side, and back) and QR code allowing the user to scan by his/her mobile phone to access the most relevant 3D human avatar (constructed by using the Echo3D platform), as shown in Figure 2.5. Then, the user can visualize the detailed body measurements of the corresponding human model for a given size by clicking on 'Garments for full Body details' button (See Figure 2.7).

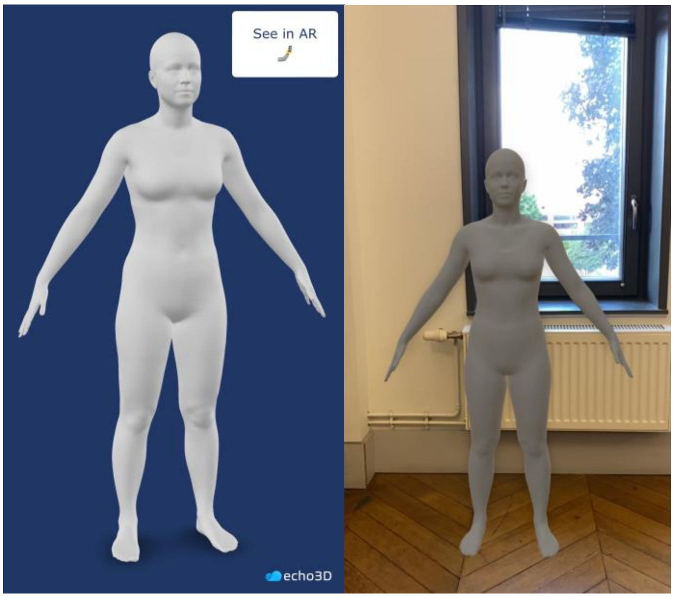


Figure 2.5: 3D Avatar by scaning QR code

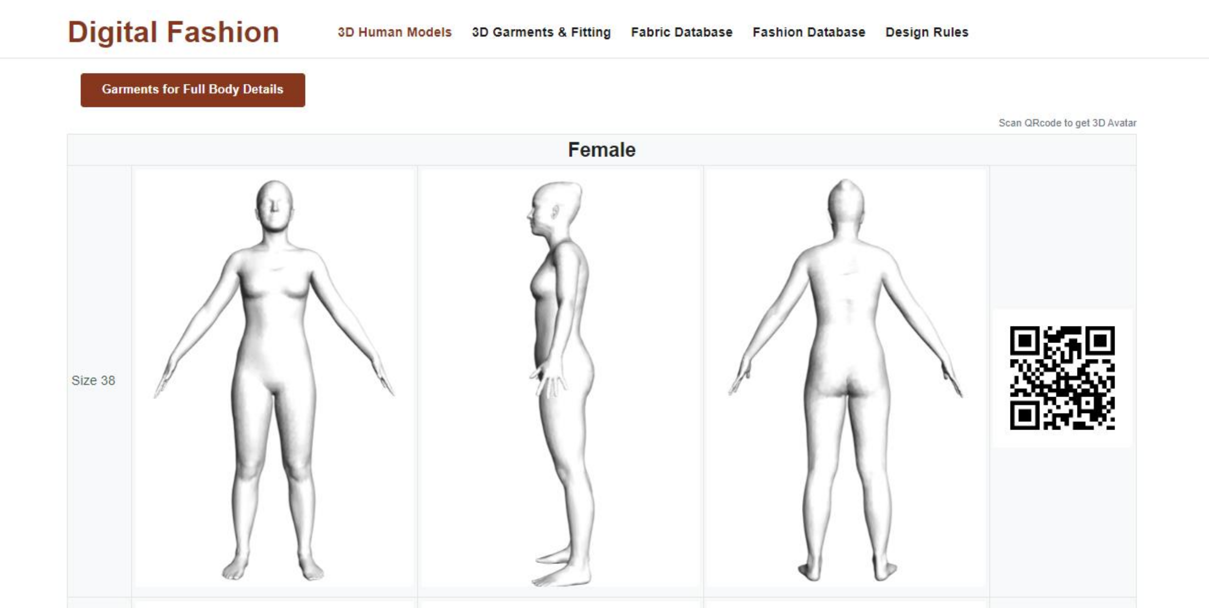


Figure 2.6: 3D human models

Female – Garments for Full Body

Size	38	42	46
Bust girth	88	96	104
Range bust girth	86 - 90	94 - 98	102 - 107
Body height	166	166	166
Body height	88	96	104
Waist girth	70	77	87
High hip girth	76.5	84.5	97.5
Hip girth	95.5	101	107

Figure 2.7: Measurement details of human bodies for different sizes

2.3.2 **3D Garment Database**

The garment database that we are using in the project includes two categories of garments, namely woman skirt and woman blouse (note that, Legging, Jacket, Shirt, and Sportswear taken from FBDModel will not be futher taken into account). The information about the visual effect of the 3D garment and its associated pattern and material is given in platform. The 3D garment digitalization process is presented in Section 4.

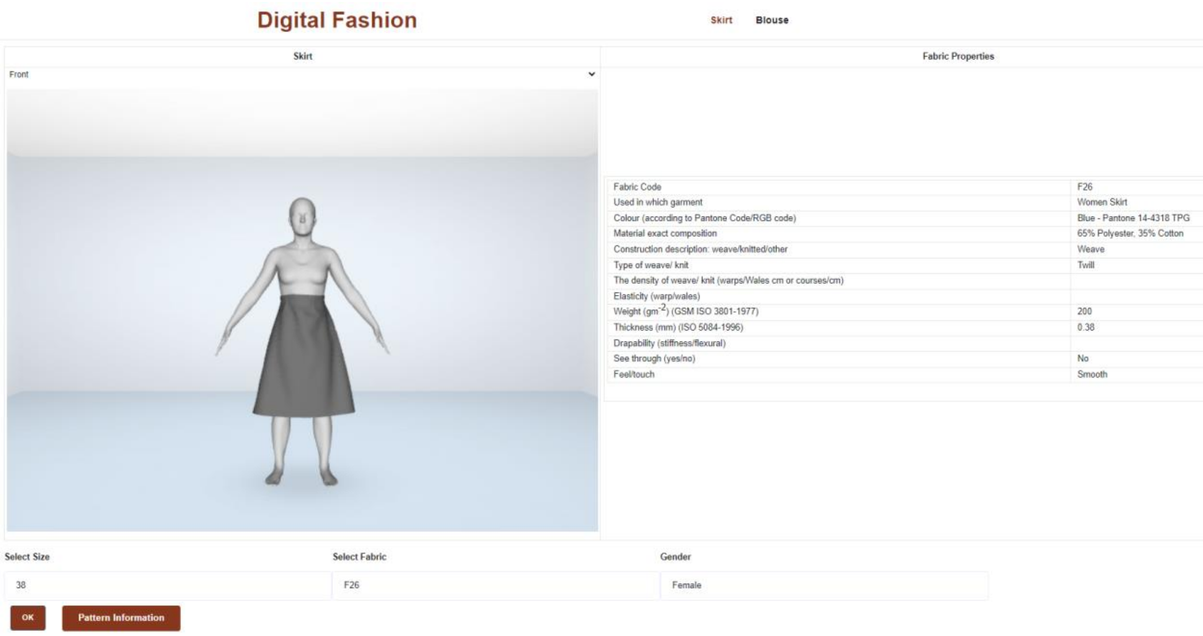


Figure 2.8: 3D Garment Database

2.3.3 **Fabric Database**

The fabric database consists of a total of 49 different types of fabrics named according to their numbers given by the project (F1-F49). The additional parameters include the fabric image, color according to Pantone or RGB code, precise material composition, type of weave/knit, yarn density in the weave/knit, fabric weight, thickness, see-through (yes or no), and the touch feeling (rough or smooth). As an example, the details of the F1 fabric are displayed in Figure 2.9.

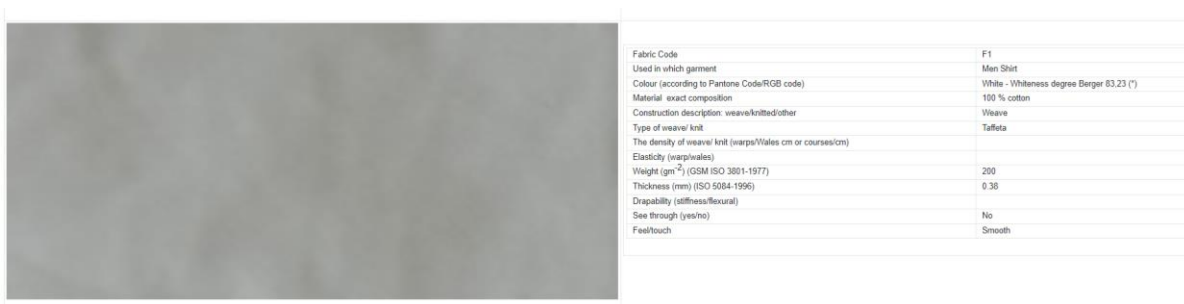


Figure 2.9: F1 Fabric Sample

2.3.4 **Fashion Database**

Fashion Database includes information about style description of garments (woman skirt and woman blouse), as display in Figure 2.10. The current fashion information on garment style will be further refined by introducing frequently used concrete and abstract design elements and associated fashion images. The relationship between fashion data and previous technical design parameters will be further exploited in order to generate a complete digital design value chain from fashion thinking to finished digital and real garment products.

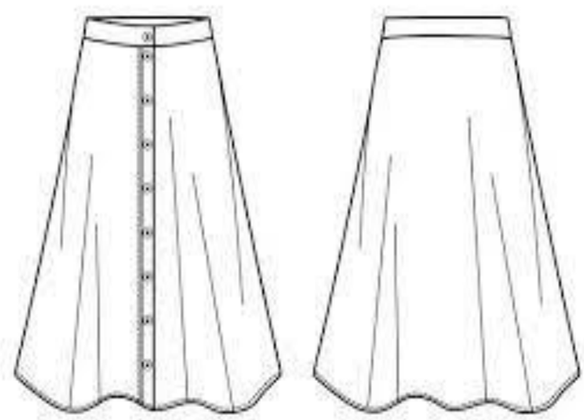
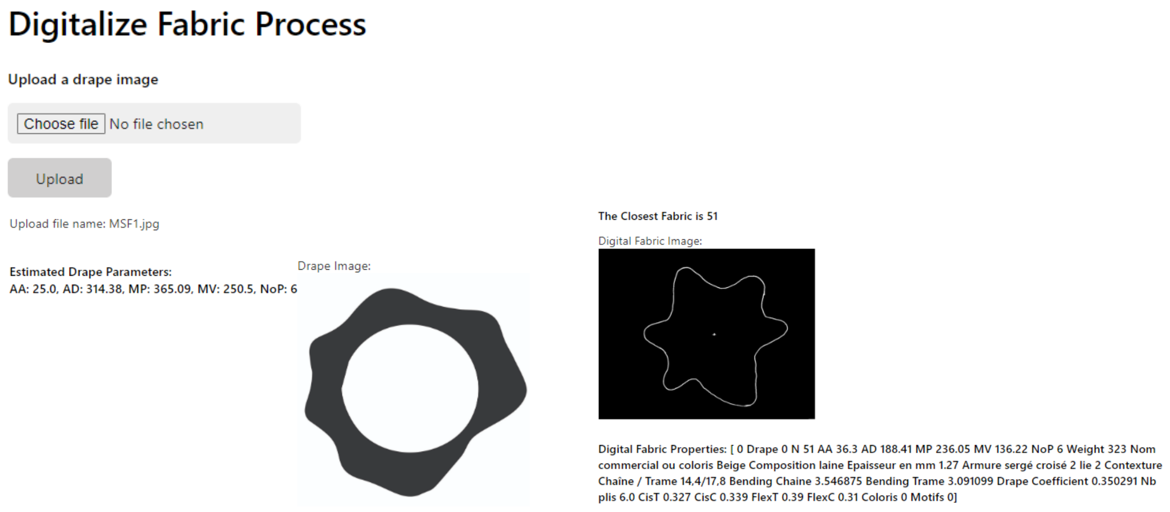
Item	Description
Garment	Skirt
Style	A-line
Technical Drawing	

Figure 2.10: Garment Style Description

2.3.5 **Digitalizing Fabrics and Virtual Garment Try-on**

Digitalizing fabric technique is based on Image processing and machine learning algorithm. The technical deteails are presented in Section 3. In the point of view of user, the prediction process for fabric technical parameters is realized by inputting drape image of real fabric and exploiting a comprehensive digital fabric database implemented in the Lectra Modaris 3D Fit Software. This exploitation will be carried out by using data mining and image analysis, in order to identify the most relevant digital fabric and its associated technical properties existing in the Lectra database. One example is given in Figure 2.11.

Figure 2.11: Digitalized fabric result



The virtual try-on includes the following steps as shown in Figure 2.12. The whole process consists of 5 steps. Step 1 – digitalize fabric (optional) could be skipped if the user does not need to digitize real fabric but instead chooses from existing fabrics in the database. The virtual try-on process can be completed by selecting a digital fabric, an avatar, and a garment type. The achieved fitting result returns a virtual fitting image with the ease allowance effect (color map), pattern information, and material properties, as illustrated in Figure 2.13.

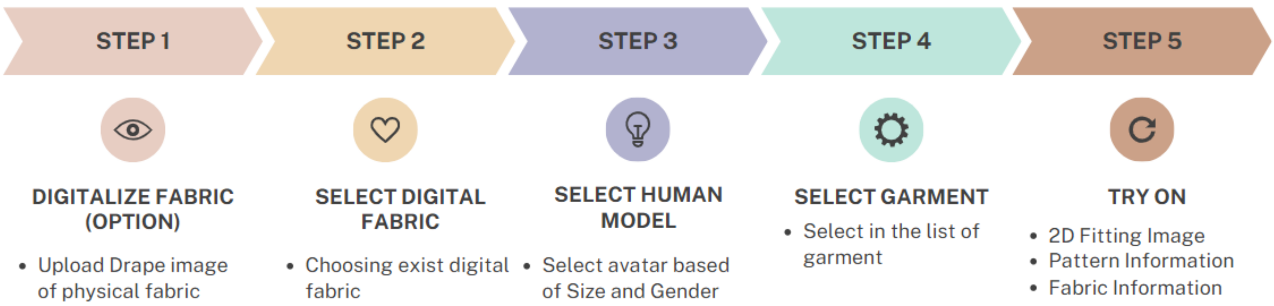


Figure 2.12: Vitual try-on Instruction

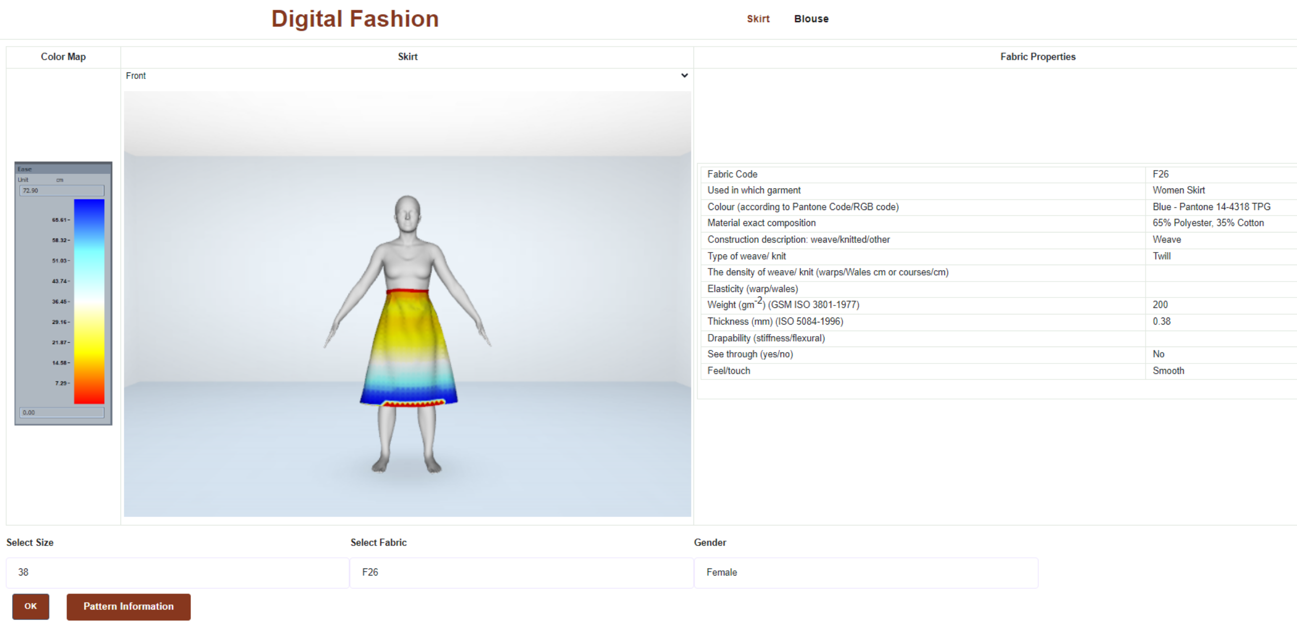


Figure 2.13: Vitual try-on template

3 FABRIC DIGITALIZATION PROCESS

This section presents the concepts, general topology and the database, including digital online Lectra database and DigitalFashion database, composed of the fabric data collected from the partners.

3.1 Lectra database

The Lectra database is a large dataset of fabric properties [1], including the contour of fabric drape and associated drape features. The Lectra database includes 111 pictures of drape as illustrated in Figure 3.1.

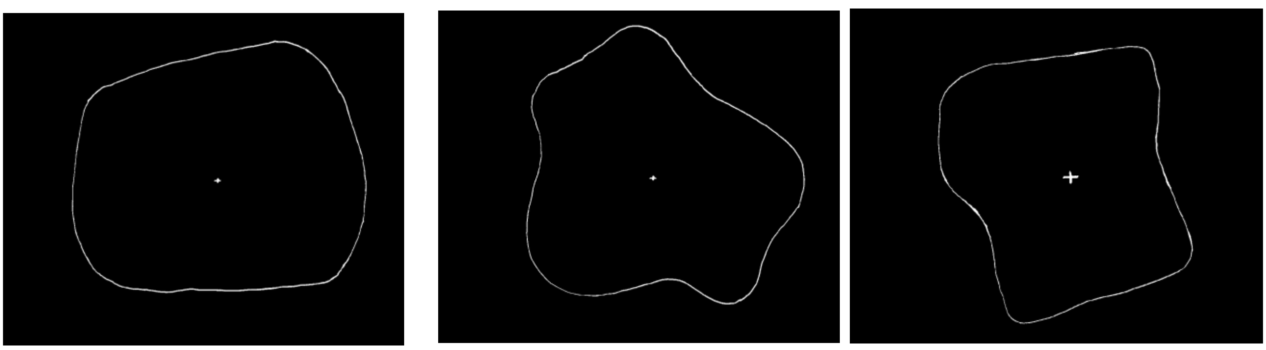


Figure 3.1 Drape images with contours in the Letra digital fabric database

All images have the same dimension of 1296x1025 pixels. For each digital fabric of the Lectra database, 23 properties (23 columns) are provided, including: Drape shape, Number of fabric, Average amplitude of drape, Average distance of drape, Maximum peak dimension, Minimum valley dimension, Number of peaks, Weight, Commercial name or color, Composition, Thickness, Armor, Warp/Weft Contexture, Weft Bending, Warp Bending, Drape coefficient, Nb folds, CisT, CisC, FlexT, FlexC, Color, and Patterns. Several examples of digital fabrics are showed in Figure 3.2. These properties will enable to create 3D digital garments and virtual fitting effects using the Modaris 3D Fit Software.

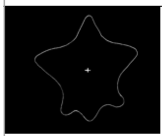
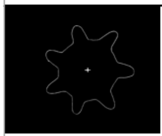
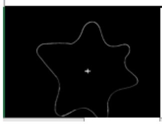
Drape	N	AA average amplitude	AD average distance	MP maximum peak	MV minimum valley	No.P number of peaks	Weight in g/m²	Nom commercial ou coloris	Composition	Epaisseur en mm	Armure	Contexture Chaîne / Trame	Bending Chaine	Bending Trame	Drape Coefficient	Nb plis	CisT	CisC	FlexT	FlexC	Coloris	Motifs
	1	33.18	181.32	229.23	134.45	6	68	Budget 70707 Réf 70		0.13	toile	44/22	0.860	0.504	31%	6	0.311	0.239	0.035	7%	Glaïeul 322	
	2	32.8	158.3	196.74	123.14	7	163	M WEIL Q: 12429	100% laine peignée	0.41	armuré	50/35	0.648	0.372	16%	7	0.311	0.204	0.034	6%	Bordeaux	7182
	3	35.29	177.73	234.58	130.88	6	105	Aurora 67707 Réf 67		0.18	Satin de 5	84/26	0.790	1.178	33%	5	0.186	0.126	0.148	8%	Cèdre	526

Figure 3.2 Several examples of the Lectra digital fabric database

3.2 DigitalFashion fabric database

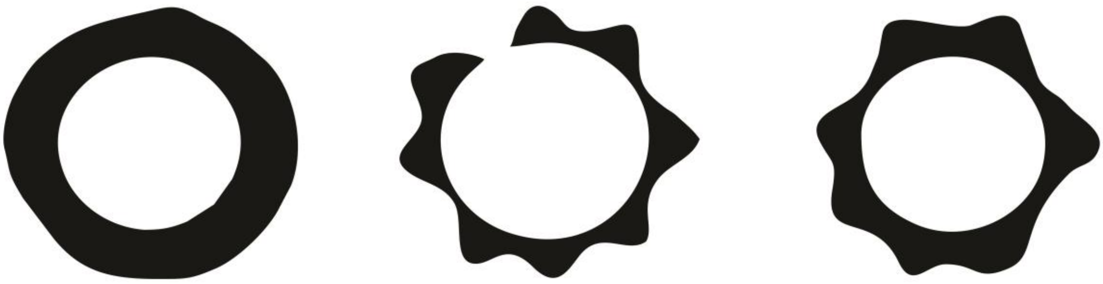


Figure 3.3 Real fabric drape images obtained from the physical experiments (drapemeter)

In the frame of the DigitalFashion Project, new representative physical samples of fabrics and garments have been collected from the project partners in order to construct a digital fabrics database (named DigitalFashion Database) and then demonstrate the complete digitalization process (including fabris and garments) to fashion designers. From the parners, we have collected 49 fabric samples for designing 8 garments (two men shirts, two men trousers, two women blouses, and two women skirts). From these samples and their parameters, we obtained their drape images (Figure 3.3) and extracted 14 key attributes (UNI MB, Orthogonal projections of the draped fabrics, Fabric No, Lectra, Fabric ID_Lectra, Drape ratio, Node number, Weave amplitude (cm), Weave length (deg), Minimum amplitude (cm), Maximum amplitude (cm), Average amplitude (cm), Variance (cm), Fourier transform/ Original, Dominant / Original) (Figure 3.4). There also exist other fabric parameters (e.g. density, fibre composition) in the database but we only consider drape image-related parameters here.

Men shirt													
Fabric code UNI MB	*Orthogonal projections of the draped fabrics*	Fabric No, Lectra	Fabric ID_Lectra	Drape ratio	Node number	Weave amplitude (cm)	Weave length (deg)	Minimum amplitude (cm)	Maximum amplitude (cm)	Average amplitude (cm)	Variance (cm)	Fourier transform, / Original	Dominant / Original
MSF1		**F1**	CITEVE_F04	0.691	7	14.03	51.43	10.48	15.21	13.39	1.22	100.189	99.037
MSF2		**F2**	CITEVE_F03	0.679	7	14.10	51.43	11.73	14.79	13.34	0.73	103.041	102.411
MSF3		**F3**	MARIBOR_F03	0.460	8	13.65	45.00	9.22	14.70	12.04	2.37	100.792	98.883

Figure 3.4 An example of drape-related parameters in the Digital Fashion database

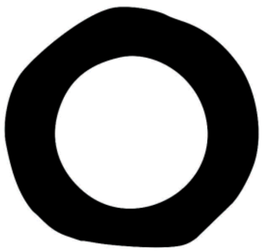
3.3 The process of Digitalizing a Real Fabric

Creating a 3D digital garment requires inputs of the corresponding digital fabric properties. These properties can be directly measured using physical instruments, such as Kawabata Evaluation System (KES) and Fabric Assurance by Simple Testing (FAST). However, these measurements are rather complex and require interventions of well-trained technicians. In this situation, to facilitate the creation of a 3D garment, it is imperative to select a suitable digital fabric already existing in an extensive fabric database linked to the 3D software (for example Lectra, Toray-Acs, Gerber, Investronica, Optitex, etc...), in which the technical parameters (drape parameters, optical parameters, and mechanical parameters) of the representative fabrics are complete.

In this report, we focus on a simplified and automated technique for digitizing a real fabric, i.e. finding the most relevant digital fabric in the database of a 3D software by using image processing and machine learning techniques to **drape images** and associated parameters. This process is illustrated in Figure 3.5 to show how a real fabric is digitalized from its ***drape image***. Its inputs include a drape image taken from a simple drapemeter and the weight of this fabric for a fixed surface. The output of the process is the identified digital fabric and its associated technical parameters.

<u>Input:</u>

- Weight sample: 335.45 g/m2



Output:

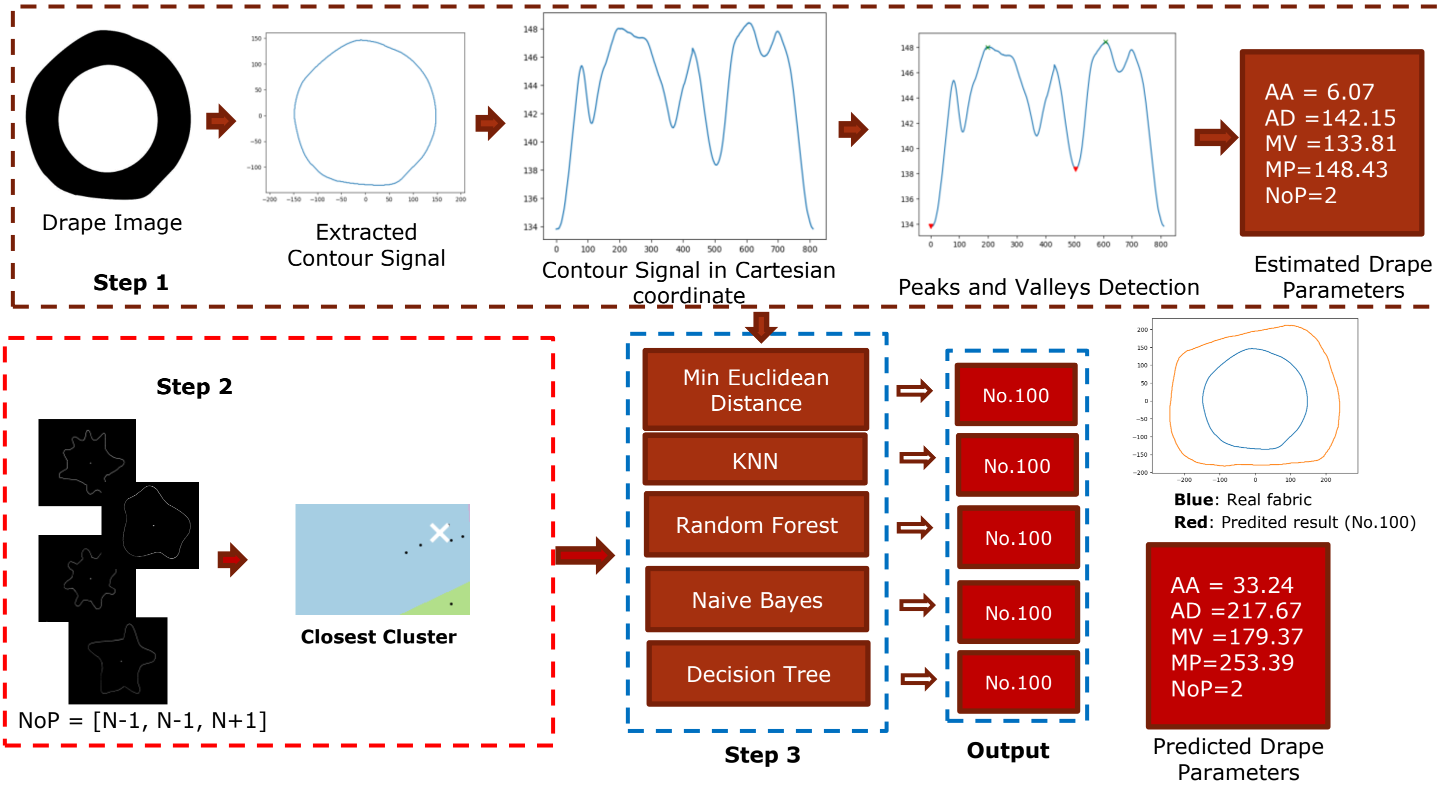


Figure 3.5 Testing in a real fabric (Drape example)

The details of this process are illustrated in Figure 3.5. Six machine learning models are applied to predict the results. It should be noted that the achieved results (predicted numbers of digital fabrics) may differ in some cases. In such cases, we can provide all the results and the users can decide by themselves which one is the most relevant according to their preference or experience. If the user's experience is not available, the majority rule can also be used to select the most relevant digital fabric. For example, if five learning models delivers the fabric n°90 and another n°95, we will naturally take n°90 as the most relevant fabric.

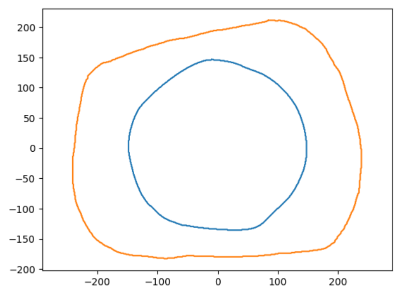


Figure 3.6 Visualize the contour curves of the real fabric and its digitalized prediction

The achieved results may be affected by differences in the distance between the camera and fabric, as well as variations in the size of the image captured. These factors can influence the accuracy and consistency of the obtained results, and should be taken into consideration when analyzing the data. In Figure 3.6, the drape parameters of the digital and real fabrics are different but their contour shapes are almost the same. We consider that they are very similar fabric samples. Our objective is to find the most similar fabric in the Digital Lectra database, and we can enhance our performance by extending the size of the database sample.

The process of digitizing fabric can be accomplished manually, although it is important to acknowledge that this approach is inherently subjective and reliant upon the opponent of user/designer. With the objective of establishing a more precise and consistent approach, we initially developed an objective method to digitalize the digital fabric that most closely resembles the real fabric from the Lectra database. Our objective is to identify the most accurate digital match for a given fabric within the Lectra database. Our effort is try to find the best possible digital match for a given fabric within the Lectra database. This process can be refined further to attain even greater accuracy. Further expansion of the digital fabric collection in the Lectra database could potentially enhance the accuracy of this method.

4 GARMENT DIGITALIZATION PROCESS

Modaris 3D Fit is a garment CAD software developed by LECTRA Company for digitalizing the process of garment design and related 3D garment products based on 2D garment patterns and 3D parametric human models. In this environment, the personalized garment virtual fitting effects can be created for a specific human body shape by a designer through his/her interactions with the software. The process of garment digitalization with Modaris 3D Fit follows the following steps:

1) Body size and garment style determination
2) Initial garment pattern making
3) 3D garment fitting simulation
4) Design solution evaluation and adjustment
5) Modification of details related to consumer personalized requirements
6) Determination of final garment parametric patterns

In this section, we will focus on garment pattern making, 3D garment fitting as well as design solution evaluation and adjustment. Body size and garment style are processed in human database and fashion database, respectively.

4.1 **Initial Garment Pattern Making**

Pattern making methods are mainly divided into draping cutting and flat cutting. Draping cutting is mainly used for designing complex garment styles at 3D level, such wedding dress with many folds and waves. In fact, for complex style, it is difficult to use flat cutting methods because their one-time molding is higher and cannot be adjusted repeatedly. Flat cutting is mainly suitable for designing daily simple garments, in which garment patterns can be made once we obtain the related body sizes. In the context of garment design using body measurements obtained from a 3D scanner, it is more appropriate to use flat cutting. Moreover, flat cutting can be divided into prototype method and proportional method. The prototype method is mainly used for the mass production of garment factories while the proportional method is more relevant to realize customized garment patterns of different styles for small series. In the frame of the

Digital Fashion project, we use the proportional method for generating initial garment patterns and then further improve them in the following steps.

4.2 **3D Garment Fitting Simulation**

By using the software of Modaris 3D Fit, we can easily simulate the garment fitting effects for a specific body morphology after selecting an appropriate garment style. Taking an example of customized jacket design, we obtain its initial 3D fitting effect in Figure 4.1.

Figure 4.1: Initial 3D garment fitting effect of a customized jacket

The initial 3D garment fitting effect is usually different from its effect of the real garment or designer's expectations. For the case of customized jacket design shown in Figure 4.1, by comparing with the designer's expectations, we find that the virtual garment size and related should width are too large, the hat pattern is quite different from the real one, the sleeve is too long, the front chest is too large the back chest size is too small. In this situation, we need to quantitatively evaluate their differences at all body positions and make necessary adjustment.

4.3 **Design Solution Evaluation and Adjustment**

The evaluation of garment fitting effects and garment comfort performed by the designer or consumer is extremely important for validating the proposed design solution. This step enables interactions between the virtual product and the consumer in order to optimize the final design solution. Once the garment style and fabric are selected, both garment fitting and comfort can be determined by its ease allowance. In the environment of Modaris 3D Fit, the user can visualize the appearance of the virtual garment to evaluate the fitting effects and use Colorization of ease map and Clothing transparency map to visualize and evaluate both the fitting and comfort effects. In a Coloration map, a positive ease allowance value (blue colour) represents that there exists a distance between the fabric surface and human body surface while a negative ease allowance value (yellow and red colour) means that fabric is stuck to the skin with a pressure. For the previous customized jacket design, we obtain its Colorization of ease map for the Fabric n°124 of the Modaris 3D fabric database (Figure 4.2).

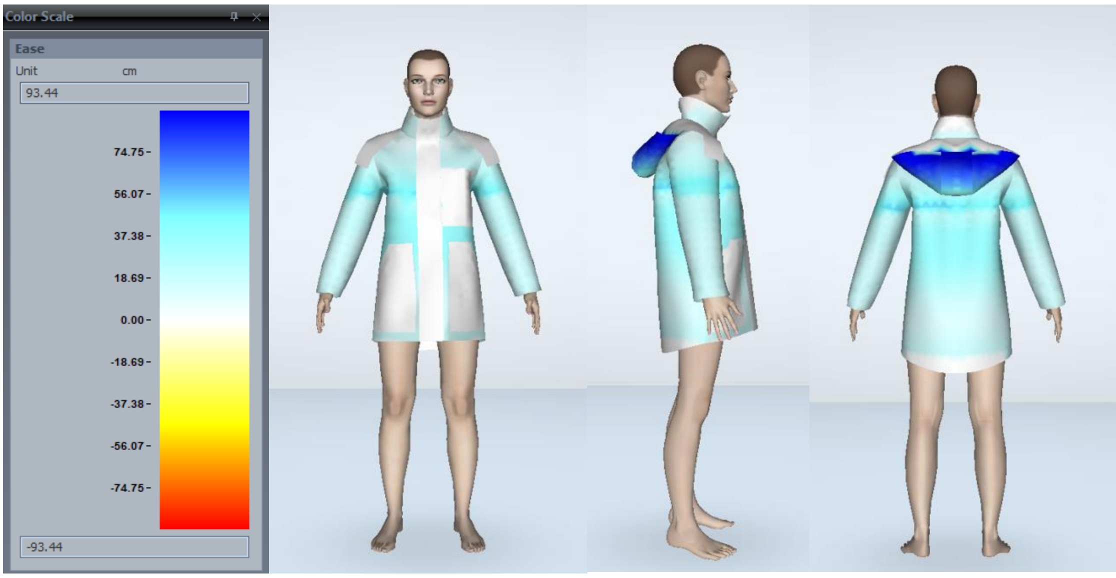


Figure 4.2: Coloration map of the jacket design with the Fabric n°124

From Figure 4.2, we can obtain a rough view on the fitting and comfort level. We can further adjust ease allowance values at different body positions in obtain a desired effect.

Another way to evaluate and adjust the fitting and comfort effects is with a Transparency Map. The transparency map of the jacket fitting is shown in Figure 4.3. From this figure, the garment pattern maker can clearly visualize the empty space between the garment and human body surface then make an adjustment of the initial garment patterns according to the space at different body positions.

Apart from human evaluation given by the user, for a specific body position (shoulder, waist, hip, etc.), the distance between the garment surface and human body surface can also be quantitatively calculated by the software and shown to the user. According to this distance, the designer can make new adjustment for patterns.

Figure 4.3: Transparency map of the jacket design with the Fabric n°124

After a series of adjustments of garment patterns according to the distances between the garment surface and human body surface, we obtain the final sizes of the designed customized jacket for different key body positions (Table 1). The corresponding garment is shown in Figure 4.4.

Figure 4.4: The final jacket fitting effect with the Fabric n°124

Style	Front length	Back length	Bust girth	Sleeve length	Sleeve opening
Designed jacket	78cm	83cm	108cm	55cm	30cm

Table 1: The final garment size specifications chart

Once the pattern making and adjustment is realized, we can show the virtual garment with different fabrics to study their impacts on garment fitting effects and ease allowance. In the design of customized jacket, we take 5 various fabrics from the database of the software, whose technical properties and draping effects are given in Table 2 and Table 3 respectively.

	Fabric type/Fabric prooerties			29 Lectra	30 Lectra	34 Lectra	90 Lectra	124 Lectra
JACKET FABRIC	Generic Name			Gabardine	Unknow	Unknow	Denim	Denim
	Composition			100% Cotton	100% Cotton	65% Polyester 35%Cotton	100% Cotton	100% Cotton
	Category			Woven	Woven	Woven	Woven	Woven
	Structure			Twill 1x2	Plain Weave	Twill 1x2	Twill 1x2	Twill 1x2
	Weight			234 g/m^2	304 g/m^2	223 g/m^2	342 g/m^2	3401 g/m^2
	Thickness(cm)			0.06	0.07	0.04	0.07	0.08
	Bending Resistance	B(1e-6N.m)	Warp	18.394	45.371	24.035	34.642	571.433
			Weft	9.565	94.421	16.187	21.459	139.793
	Tensile Resistance	EMT (%)	Warp	6.793	4.307	4.199	9.233	7.6
			Weft	8.336	1.709	3.429	5.182	2.4
		LT	Warp	0.58	0.613	0.705	0.691	1.02
			Weft	0.595	0.632	0.694	0.66	0.93
		WT (N/M)	Warp	9.663	6.475	7.259	15.647	19.8
			Weft	12.164	2.649	5.837	8.388	5.8
	Shearing Resistance	(N. m−1/°	Warp	1.766	4.17	3.863	3.372	11.023
			Weft	1.732	3.556	4.108	3.005	11.278
		T (N. m−1)	Warp	15	49	49	49	196
			Weft	15	49	49	49	196
	Friction		Warp	0.1485	0.136	0.145	0.179833	0.165
			Weft	0.1385	0.150667	0.153833	0.187833	0.178

Table 2: Five fabrics with different properties for jacket design

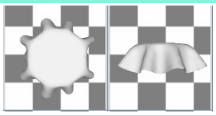
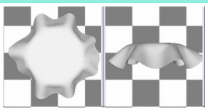
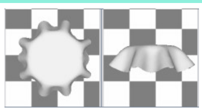
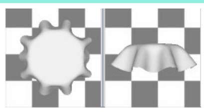
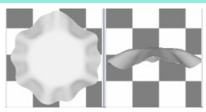
FABRIC	29 Lectra	30 Lectra	34 Lectra	90 Lectra	124 Lectra
DRAP					

Table 3: The draping effects correspond to the five previous fabrics

Apart from the Fabric n°124 given in Figure 4.4, the digital garment with another fabric (n°29) is shown in Figure 4.5.

Figure 4.5: The final jacket fitting effect with the Fabric n°29

The previous digital customized jackets with various fabrics have been realized by a designer following the process of *design – fitting effects visualization – evaluation – adjustment* for a number of times. For different fabrics, we can find that their draping effects on the same body morphology are quite different, leading to different garment fitting effects and different ease allowance values.

5. Conclusion

This interim report presents the current results of the PR3 of DigitalFashion, including the digital fashion design technology platform design and implementation, as well as its associated digitalization processes for fabrics and garments. The results of PR3 are strongly correlated with those of PR2 through integration of the appropriate databases into the digital design platform. The databases have been established with the help of all involved project partners. The structure and interfaces of the platform have been initially implemented. The fabric and 3D garment fitting databases are almost completed, but the searching engine for recommendation of relevant garments meeting consumers' personalized fashion requirements, adjustment of garment and fabric parameters with professional design rules for producing customized design, and new data-driven fashion design process will be further developed. More AI techniques will be introduced for making designers easy access to the design databases and knowledge base and intelligently support their decisions at different levels (fabric selection, garment evaluation, etc.). Moreover, the current user interfaces will be further improved in order to make the proposed design process and resources easy to undertand and more attractive.

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