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The Relationship Between FAST Mechanical Properties, Fabric Drape Coefficient and 3D Simulated Flared Skirt

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Abstract

The fabric digitization is the way to input a material to the 3D software as data. The priority of the virtual fashion design in the garment industry field makes the accuracy of the fabric characteristics composed the garment piece is the first, in the virtual environment. Garment assembling for samples purposes consumes times and materials. In this work, the teamwork suggest a way to conclude the fabric characteristics in a garment piece. The method is a trial to simulate the garment fabric draped in the human body.

Six fabrics were collected from the Egyptian market randomly, from different material and weights, they are categorized in 2 structures groups. The under study fabrics were tested by the FAST system, and their own fabric drape coefficient were measured traditionally. For the research procedures, the fabrics were digitized to CLO3D software through its standard procedures.

This study was established virtually using flared skirt as fabric samples. The flared skirt sample was assembled through angle flared skirt assembled method in two angles 180^0 and 90^0, with 54cm and 67 cm of length. In CLO3D software the virtual assembled flared skirts were captured and rendered in three different poses (front, side and bottom view). All the simulation properties and render values are unified to all the captured skirts. A virtual dummy was used as holder object for the fabric sample in form of the flared skirt.

Finally, the study concluded that the flared skirt can be used to a common method can be used to asses and to digitize the textile fabrics to 3d garment simulation software.

Keywords: Garment simulation, FAST tests, fabric drape coefficient, flared skirt silhouette analysis, *CLO3D* software, fabric digitization**.**

Introduction

About four decades ago, 3D virtual clothing simulation systems were introduced into different fields of computer graphic industries; Viz. games and animation1. Lately, the digital fashion industry considered as the promising business model2. At the start of the new century, there has been a regular ascent in the usage of the 3D virtual simulation software programs in planning of long-term strategies by different huge brands3.

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Different simulation software applications worked to get the highest reality of its simulation results. All the garment simulation software were suggested the way to digitize and simulate the textile fabric to its virtual environment (5, 6).

The improvement of fabric drapability always enhances the fabric combortablity[7]. The Cusick drape test is the most common one. The fabric drape coefficient can concluded the effect of the different fabric properties, also, which were affected by the applied additional treatment or finishing process. Recently, the Cusick drape results developed to digitally analyzed[8]. The mention drapability test method analyzed the sample fallen in a flat form, which is unlike the way of the fabric fallen on the human body, this finds lead the field scantest to find new fabric assessment method[9]. Whereas, Mei et. Al., affirmed that the fabric drape analyses are insufficient enough to similarly reflect the drape behaviour of fabric worn virtual situation[10].

Chen et al. compared between the square and circular specimen shape. 3 different way of the draped samples are captured 2D photo, 3D scanning and reconstructed virtually on 3D software. It is reported that, the mechanical properties have a strong relationship with the drape coefficient, in both situation real and virtual[11].

Miguel et al. assessed the fitting of a jacket by the assessment of a regular skirt made from two fabrics to assess the fitting, the skirts assembled using the same fabric, once is one layer and once is double layer[12]. The analysis of the drape defind that the difference between the two skirts fabrics were clear, as the simple made of the one layer fabric had a higher drapability than the double layer, which confirms the effect of fabric weight on the drape coefficient[12].

The assembling circular method of the flared skirt make it the best garment piece describes the drapability behavior of fabric, as it has a circular form as the fabric drape test sample form. Different studies attempted to use the flared skirt to develop the garment drapability definition. El Gholmy studied on a dole the flared skirts nodes number affected by different lengths and angles. It is concluded that, the 360º and the 270º flared skirts, the flares count are directly proportional to the skirt length. The flared skirt length can’t figure out the fabric drape index, but this method define visually the fabric drapability of garment[13].

The employment of simulation software proved the hypothesis which assumes the fabric drape coefficient could be described by the flared skirt in both situation physical or virtual, through the two factors the flares count and the flares dimension. Also, the fabric drape coefficient highly effected the garment appearance quality [14].

The apparel virtual software can make an objective improvement on the garment production[15]. The difference between real garment and virtual one worn on human body, is under study. The accuracy of garment appearance quality virtually is controlled by different factors, but mainly, the fabric drape coefficient is essential. The numerical value expressing of drapability will be useful for the simulation works[16]. Lee et al. analyzed the drapability of fabrics have different physical parameter by image analysis virtually. The flared skirt was used to declare the strong relationship between the fabric profile and the final form of the garment. The categorization of fabrics (stiff and drapery) can improved the explanatory process and it has been reported that the garment final form hasn’t an individual numerical value to explain the drapability of fabric[17].

In the virtual environment the simulation quality of fabric must be considered, as the particle distance composing the virtual fabric mesh is highly effective on the reality of the garment appearance [13].

FAST is a system developed by the CSIRO association, worked in a concept of fabric assurance by simple testing (FAST). FAST only can present the measured data on linear interpretation[21]. Power 2013, encouraged the idea of to reduce the complexity of fabric mechanical measurement system. The study investigated the different between the fabric digitization instruments Browzwear with the FAST system, and virtually, the effect of both systems on garment simulation were studied. Six knitted fabrics were measured compared and interpreted. A limitation of mechanical parameters such as (extensibility, shear rigidity and bending rigidity) were tested. As our study findings, It is observed that FAST mechanical properties investigated a good relation between and Brwozwear fabric digitization system even there are some difference in stretchability properties. As the FAST System aren't widely used in garment design field, but it is less expensive than Kawabata evaluation system. It is required to simplify the standard procedure for digitization textile properties into the required parameters for 3D virtual garment simulation. Also the 3d virtual system required to unify the fabric digitization method to facilitate the garment design method to the garment designer[21]. Bilgic 2019 studied the possibility of selecting fabrics with physical sample. And they use the 3D simulation instead of.

Sujoung 2014 studied the difference between 100 different fabrics in both situation real and virtual. And it is reported that the different fabrics properties in virtual environment, may have similar form of flared skirt[14].

In this study a new method of flared skirt analysis will explored to clearly express both, the FAST mechanical properties and the fabric drape coefficient.

Experimental

Materials

Six different fabrics were collected from the Egyptian domestic market, with two different structures are plain 1/1 and twill 3/1 and 2/1. Their properties are summarized in Table 1.

Table1: Profile of the used cotton, polyester and cotton/polyester blended fabrics

Fabric name	structure	material	Weight (g/m²)	Thickness (mm)	Yarn*cm (weft)	Yarn *cm (warp)
Carreau	Plain	100% Cotton	117	0.16	49	29
Fineblue		Cotton/polyester (50/50%)	121	0.34	30	20
Tricoline 3b		100% polyester	193	0.203	24	34
Twill blue	Twill	65% cotton 35% polyester	215	0.57	43	21
Twill beige		65% cotton 35% polyester	206	0.17	33	52
Jeans		50% cotton 50% polyester	227	0.1	25	34

Table2: the FAST mechanical properties and fabric drape coefficient

groups	Twill Group					
Fabric	Jeans	Twill beige	Twill blue	Tricoline 3b	Fine blue	Carreon
Dc%	43.7	50.8	48.6	28.4	35.0	36.0
wt	206	227	215	121	208	117
t20	0.54	0.47	0.57	0.46	0.6	0.4
t100	0.37	0.38	0.38	0.26	0.39	0.24
st	0.174	0.092	0.186	0.206	0.203	0.16
g	79	95.8	21.4	40.3	38	21
c1	16.8	24.5	15.2	16.4	15.3	18.8
c2	20.1	14.9	20.7	14	13.8	14.9
b1	9.6	32.7	7.4	5.2	7.3	7.7
b2	16.4	7.4	87	3.3	5.3	3.85
e5 1	0.2	0.2	0	0.5	0.2	0.3
e5 2	0.1	0.1	0.3	0.7	0.6	0.3
e20 1	0.1	0.1	0.3	0.7	0.6	0.3
e20 2	0.6	0.5	0.1	1	0.7	0.8
e100 1	0.4	0.6	1	1.4	1.9	1.4
e100 2	2.1	1.5	0.7	1.8	2	2.7
eb5	1.6	2.3	3.9	4.3	4.6	5.2
f1	1.6	1.1	1.4	3	3.3	5.7
f2	0.24	0.59	0.14	0.17	0.23	0.24

- **DC: drape coefficient**
- **Wt: weight (g/m2)**
- **T20: thickness at 2 (gf/cm2)**
- **T100: thickness at 100 (gf/cm2)**
- **ST: surface thickness (mm)**
- **G: shear**
- **C1:warp bending length (mm)**
- **C2:weft bending length (mm)**
- **B1: warp bending rigidity (μN.m)**
- **B2: weft bending rigidity (μN.m)**
- **E51: warp extension at 5g**
- **E52: weft extension at 5 (gf/cm)**
- **E201: warp extension at 20 (gf/cm)**
- **E202:weft extension at 20gf/cm**
- **E1001: warp extension at 100(gf/cm)**
- **E1002:weft extension at 100(gf/cm)**
- **F1:warp formability (mm2)**
- **F2: weft formability (mm2)**

Table 2: represented the FAST mechanical properties and fabric drape coefficient the fabric categorized in two group according to their structures

Methods:

The said fabrics were simulated in CLO3D software the fabrics mechanical properties according to CLO3D standard method, to be digitized to CLO3D software

Position Simulation

Fig. 1: (A) the front view(B) the side view

Figure 1 has the virtual dummy was used to be a holder for the fabric sample (flared skirts) and it is used to simulate the skirts, on the bottom view the dummy was hidden in the rendering step, to have a clear view of the hem outline shape.

Flared Skirt assembling method

The Flared skirt was assembled in the virtual environment by CLO3D simulation software. Four angles of Flared skirts were assembled using circular geometric method (900, 1800,)18 a cleared on Figure2. The Skirts were applied in two different suggested lengths according to knee height. (54 cm and 68 cm). The skirt is virtually assembled using two sides seam lines.

Simulation process

The assembled elements of skirts were limited, only a flat band to fix and fit the skirts on the virtual dummy; and the sewing property was unified throughout the skirt19 (Figures 3). Simulation and rendering properties were common for both, the flat samples and the flared skirt, each separately, in order to unify the dimensions ratio of each. All skirts were captured from the 3 different positions (front, side and bottom view) to analyse the outline shape areas of the skirts on the virtual dummy.

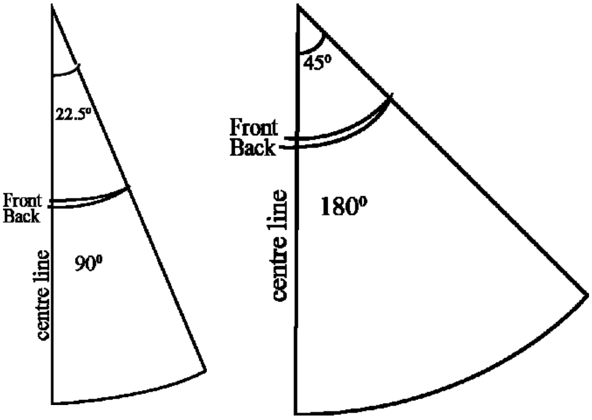

Fig. 2: Circular flared skirt method based on angel for the angles 90 &180[14, 19]

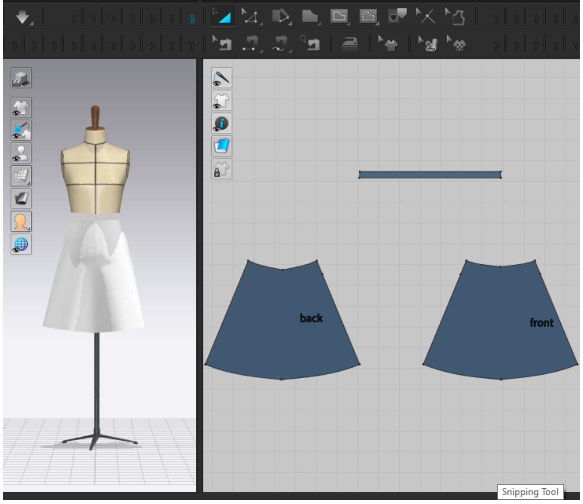

Fig. 3: The 2D pattern window flared skirt (left) and skirts worn on *CLO3D* virtual dummy (right)

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Analyses

Analysis of the skirts silhouette outline and hemline form area

To analyze the three captured area of the worn flared skirt, as shown below in figure4, the three capture photo was illustrated, the areas formed of the outline shapes of the front, side and bottom view were measured. These measured areas of the three skirts poses were described using pixel count ratio on Adobe Photoshop software. The concept of shadow is excluded from this study, specially, for the bottom view whereas, the area of the shape formed by the skirt hemline. This due to the common render option used to capture all the skirts on all view. In figure 5 the areas of the bottom view and the average of the three poses outline shape area were represented

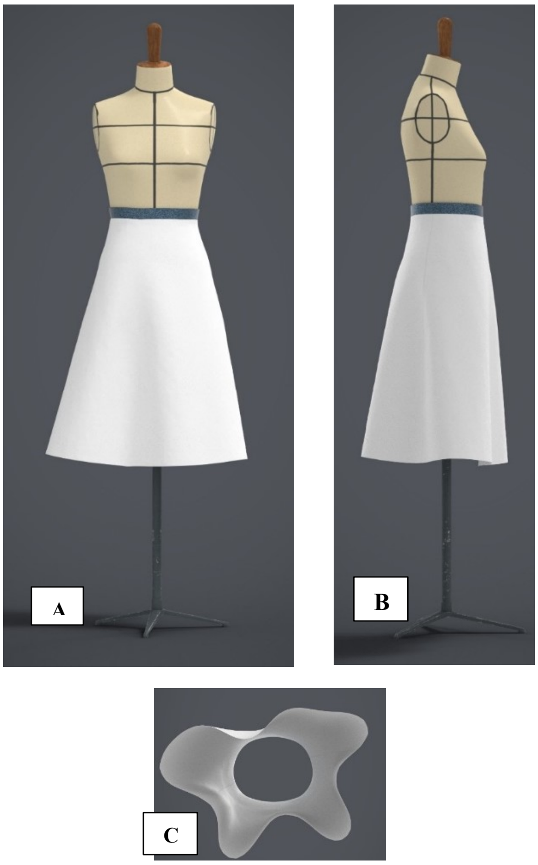

Fig.4: the skirts simulated on the virtual dummy, A the front view, B the side view and C the view of the hemline

Statistical analysis

A T-test was done to the mean of the obtained results, for both the fabric structure groups. Also, the relationship between the skirts analyzed areas, the FAST mechanical properties and the drape coefficient for the two fabric grouped was statistically analyzed. The significance of this relationship was investigated using regression analysis.

Results and Discussion

The difference between the fabric structure groups

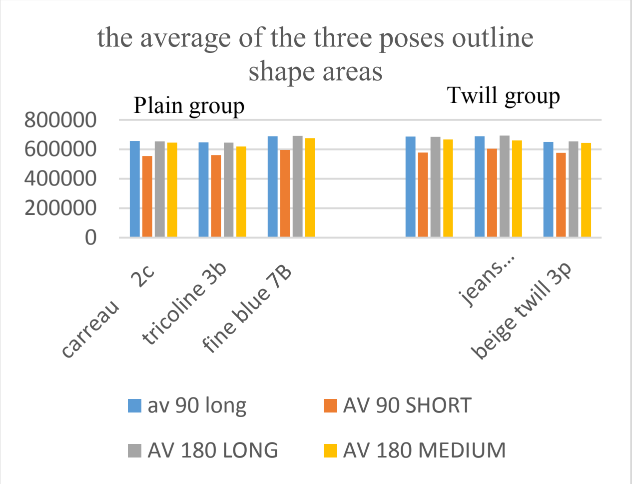

Fig. 5: The graph represents the averages of outline shape area by pixels count of different skirt worn on the virtual dummy.

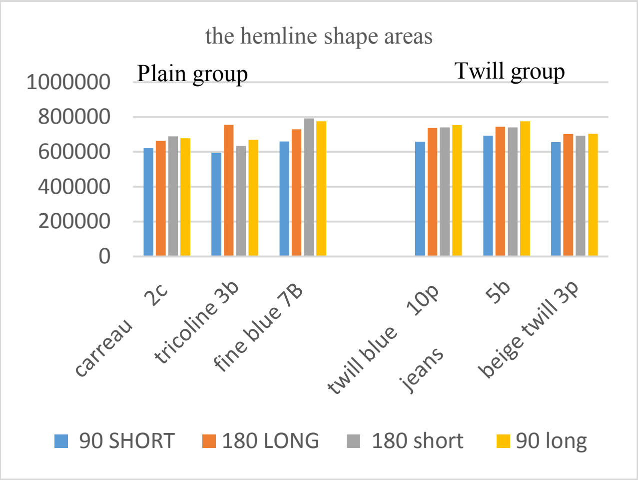

Fig. 6: the graph represented the area of the hemline by pixel count of the skirts worn on the virtual dummy

Figure 5: shows the sample areas measured by pixel. Figure6 shows the area of the hemline shape. The differences between the two fabric groups were tested, but in two steps, the first one between the 2 groups for the FAST mechanical properties and fabric drape coefficient, and the second one is the between the measured area of the skirts grouped according to the fabric structures without considering the skirts lengths. And it is obtained that the difference between the fabric 2 groups is clearly appeared on the comparison between the flared skirts area, more than on the fabric FAST mechanical properties and drape coefficient. As the difference

between the two groups has a P-value less than 0.005 which means that there is a significant difference between the two groups.

The correlation between FAST mechanical properties, DC%, the areas of hemline and the averages of the measured three poses areas

The correlation coefficient between the FAST mechanical properties, DC% and the areas measured for the skirt outline shape formed was investigated regardless the structure categorization. The relation between the areas and the fabric drape coefficient is almost investigated between all the skirts lengths in the two angles (90^O&180^o). But for the FAST mechanical properties the relationship appeared on the bending rigidity properties, extensibility in the warp direction for both 5gm and 20 gm and fabric formability on both directions only. as shown in table 3 the correlation coefficient between the factors and each other are very high in the majority of the averages of the skirt shape outline, whereas it is less between the hemline shape areas. This correlations recorded significance according to the level of confidence of P-value 0.005 only on the fabric formability on both directions, on contrary the fabric drape coefficient didn't achieved the P-value which means that this strong correlation is not significant statically. This relation appeared clearly in the areas of the hemline formed of the short skirt in 90^o and all the skirts averages of the three poses measured area.

Table3: The correlation coefficient drape coefficient between real and virtual:

plain	*dc*	*b1*	*b2*	*e5 1*	*e20 1*	*f1*	*f2*
0 90 SHORT	-0.90	-0.89	-0.95	1.00	1.00	-0.90*	-0.98*
0 90 long	-0.98	-0.98	-0.82	0.98	0.98	-0.98	-0.89
0 180 LONG	-0.40	-0.42	0.36	0.03	0.03	-0.40	0.24
0 180 short	-0.92	-0.91	-0.93	1.00	1.00	-0.92	-0.97
AV 90 long	-0.96	-0.96	-0.88	1.00	1.00	-0.96*	-0.93*
AV 90 SHORT	-1.00	-1.00	-0.69	0.92	0.92	-1.00*	-0.78*
AV 180 LONG	-0.97	-0.97	-0.86	0.99	0.99	-0.97*	-0.92*
AV 180 short	-0.86	-0.86	-0.97	0.99	0.99	-0.86*	-0.99*

twill	*dc*	*b1*	*b2*	*e5 1*	*e20 1*	*f1*	*f2*
0 90 SHORT	0.78	0.99	-0.53	0.44	0.26	0.96*	-0.97*
0 90 long	1.00	0.68	0.12	-0.22	-0.40	0.57	-0.59
0 180 LONG	0.99	0.56	0.27	-0.37	-0.54	0.44	-0.46
0 180 short	0.96	0.44	0.40	-0.50	-0.65	0.31	-0.33
AV 90 long	-0.96	-0.96	-0.88	1.00	1.00	-0.96*	-0.93*
AV 90 SHORT	-1.00	-1.00	-0.69	0.92	0.92	-1.00*	-0.78*
AV 180 LONG	-0.97	-0.97	-0.86	0.99	0.99	-0.97*	-0.9*
AV 180 short	-0.86	-0.86	-0.97	0.99	0.99	-0.86*	-0.99*

* the significant level (*p-value* less than 0.05)

The relationship between between different FAST mechanical properties and DC%

The correlation coefficient between the fabric formability and the DC% was investigated for each group individually. The coefficient recorded for the twill group R^2 not less than 0.8. which is mean there are a strong relationshiop betweeen fabric formability and DC%. And the confidence level of this relationship was highly sinificant to the level of the P-value, which recorded a P-value less than 0.005.This could lead as to defind the relation between the fabric drapability and the form composed of the flared skirt.

The relationship between between different FAST mechanical properties and DC%

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Conclusion:

The study and the previous studies confirmed that still we have a problem on the fidelity of the virtual simulation results and the physical garment, the fabric drape coefficient is a good property that can describe the fabric behavior on the body. Based on the obtained results the fabric drape coefficient investigates a strong relationship between the fabric drapability and the flared skirt shapes area.

In consistently with the earlier works, the flared skirts could be a simple tool that can clearly describe the fabric drapability, not only but also the FAST mechanical properties. Worth to mention, the fabric formability is a combination of the different mechanical properties[4]. Despite of there are no correlation between different properties of FAST, the strong relationship between the fabric formability in both directions (warp & weft directions) and the 90^o

flared skirt in the short length and all the skirts angles and all lengths averages area of outline shapes.

The study was made virtually to verify its validity before physical trial, to reduce waste of time and material.

The difference between the fabrics groups were clearly declared by the flared skirt outline analysis than the difference between the FAST properties and Fabric drape coefficient. Finally, this study can be applied in a wider range of fabric, and using other evaluation system. Also, applying this trial using different simulation software can leads for a common method that can be used for all simulation system, and simple to be used by unspecialized users.

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العلاقة بين الخواص الميكانيكية FAST و أنسدالية الأقمشة و الجونلة الكلوش ثلاثية الأبعاد

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الملخص

رقمنة الأقمشة هي الطريقة المستخدمة لأدخال خواص الأقمشة للبرامج المحاكاه ثلاثية الأبعاد. تعتبردقة نتائج برامج المحاكاة ثلاثية الأبعاد من الأوليات الأولى في مجال الملابس الجاهزة. عمل العينات الحقيقة بهدف التجارب تعد أستنفاذ للوقت و الموارذ في هذا العمل، قام الفريق البحثي بأقتراح طريقة تلخص خلواص الخامة المستخدمة في القطعة الملبسيةز الطريقة هي محاولة لمحاكاة أقمشة الملابس و طريقة انسداله على الجسم الأدامي. تم تجميع 6 خامات من السوق المصرية عشوائيا، من خامات و تراكيب و أوزان مختلفة. تم تقسيم العينات إلى مجموعتين بناءا على تركيبهم النسجي. تم قياس الالخواص الميكانيكية بنظام ال FAST ، كما تم قيا أنسداليتهم بالطرق التقليدية. لأجراء خطوات البحث، تم رقمنة الخامات لبرنامج ال clo3D بأستخدام الخطوات المقترح من قبل البرنامج.

تم أنجاز العمل أفتراضيا بأستخدام الجونلة الكلوش كشكل للعينة. الجونلة الكلوش تم رسمها بناءا على طريقة الزوايا للدائرة بزاويتي °90 و °180 و في طولين مختلفين هما 54 سم و 67 سم. في برنامج clo3D تم التقاط صور للجونلة من ثلالث زوايا مختلفة هم (الأمام والجانب و أسفل الجونلة) مع الأخذ في الأعتبار بتوحيد خواص المحاكاه و خواص التقديم. كما أستخدم مانيكان أفتراضي لعرض و محاكات العينات علية.

من خلال أختبار ال T-Test تم ملاحظة الفرق ببين مجموعتي الخامات، و أخيرا، توصلت الدراسة إلى أن يمكن أستخدام طريقة الجونلة الكلوش كطريقة موحدة تستخدم لتقييم و رقمنة الأقمشة المنسوجة لبرامج المحاكاة ثلاثية الأبعاد

الكلمات الدالة: محاكاة الملابس، الخواص الميكانيكية **FAST**، معامل أنسدالية الأقمشة، تحليل الظل للجونلة الكلوش، برنامج **CLO3D**، رقمنة الاقمشة