Interactive Acquisition of Apparel for Garment Modeling

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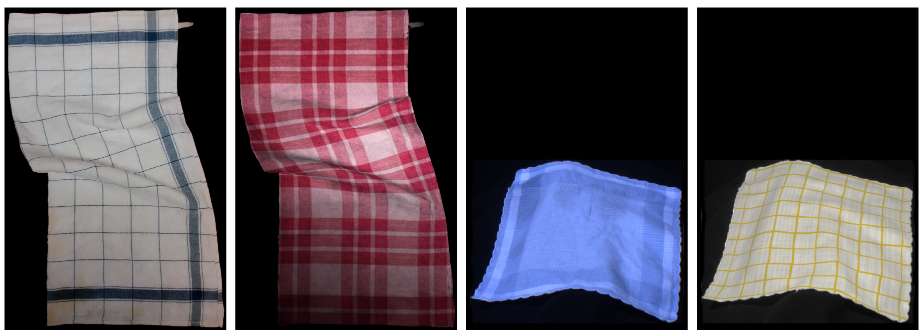


(a) (b) (c) (d)

Fig. 1. a) Picture of a real towel. b) Stylized version now depicting a folk-checkered cotton kitchen towel. c) Picture of a real handkerchief. d) Virtual handkerchief rendered using a gold linen fabric.

Abstract. In this paper we set out to find a new technical and commercial solution to easily acquire garment models. The idea is to allow the creation of new stylized versions of garments just by applying a new print design. To this end we introduce a technique for model acquisition of new apparel collection that makes use of a sparse set of guidelines in combination with an intuitive graphical user interface allowing the user to obtain and refine a 2D mesh representation of the garment. To achieve a 3D-ish look of the virtual garment we employ structured light scanning to automatically obtain a shadow map. We believe our system allows online clothes shops to bring new visual art into bespoke clothing to make apparel products more valuable compared to other garments on the market. Furthermore it helps artists and designers in virtual prototyping and visualizing garments with new print designs.

Keywords: fashion · garments · creative fashion · fabric rendering · artist

1 Introduction

Motivation. The creative industry, fashion industry, and clothing and textile branches in particular are undergoing meaningful changes as the clothing industry in the EU is in crisis — the production index is only 88.9% of its value from 2010. Revival of the sector should arise from research and innovative solutions. Besides clothes shops, designers are also affected by the crisis and have difficulties in supporting oneself from their artistic activity. One of the main reasons for this situation is the lack of means to exploit their work effectively on the market.

Our ambition is to support the clothing and textile industry and visual artists by providing a new technical and commercial solution which enables easy acquisition of garments allowing to create new stylized versions as is illustrated in the inset (Figure 1).

Contribution. In this paper we present a system to capture apparel products and create new stylized versions by applying a new print design to the acquired garment models.

Our method allows online clothes shops to bring new visual art into bespoke clothing to make apparel products more valuable compared to other garments on the market. Furthermore it helps artists and designers in virtual prototyping and visualizing garments with new print designs.

Approach. In Section 2 existing techniques for model acquisition of apparel will be analyzed. We will also look at common CAD & Design tools and their limitations. In Section 3 we propose our new acquisition approach. Regarding model acquisition of new apparel collection we will pursue the use of a sparse set of guidelines in combination with an intuitive graphical user interface allowing the user to obtain and refine a 2D mesh representation of the garment. To aid the user in achieving a 3D-ish look of our 2D virtual garment, structured light scanning is employed to automatically obtain a shadow map. In Section 4 we look at the results of our implementation. Finally, Section 5 is our concluding section in which we also set the context for future work.

2 Related Work

In this section we discuss different methods for creating or acquiring garment models.

CAD & Design Tools. During recent years CAD and Design tools have been widely adopted in the fashion creative industry. These can be broken down into two categories: B2B (Business-to-Business) and B2C (Business-to-Consumer) tools.

B2B tools, mainly provided through CAD-CAM solutions, offer an improvement into "offline" design activities like virtual prototyping, draping and rendering fabrics. Most known CAD suppliers are Browzwear, Optitex, Assyst, Lectra, Gerber technology, Grafis and Dassault System. These tools are only intended to support designers working for branded manufacturers in order to express and formalize their creativity during product conceptualization and formalization.

B2C tools, mainly provided through e-commerce companies, offer consumers a made-to-order/made-to-measure configuration tool. Consumer needs are met by decomposing apparel items in style options (collar, cuff, etc), functional options (type of material, e.g. cotton, wool, breathable materials, etc) and size options, according to which the consumers can customize their garment. These proprietary tools, however, have specifically been developed for bespoke fashion. Examples of bespoke fashion companies are Tailorstore, Youtailor and Bivolino.

Model Acquisition of Apparel. Existing cloth modeling [1,2] involves a very expensive process in terms of computational cost due to the flexible nature of the cloth objects. One of the first attempts was made in the 1992 Disney feature animation movie Aladdin [3] for creating the Magic Carpet. Initially, a CGI model was about to be employed, however, as it looked too computerish [4] a hybrid (2D and 3D) approach was followed. That is, the magic carpet animation was entirely drawn on paper by a traditional animator after which a 3D model artist carefully laid out a geometric computer model over the drawn carpet.

A less labor-intensive approach is to make use of particle-based cloth simulation. Here, cloth is treated like a grid work of particles connected to each other by springs. Whereas for the geometric approach one has to take care manually for simulating the inherent stretch of a woven material, the particle-based technique inherently accounts for stretch (tension), stiffness, and weight by means of physical laws [5]. The resulting meshes, however, are very coarse making them less suitable for realistic texturing as self-shadowing effects and subtle wrinkles are often missing.

Specialized approaches (such as offered by Vidya [6] and Second Sight [7]) combine cloth simulation with 3D body scanning and CAD assistance in order to achieve a true 3D model. Others make (re)use of real photographs of humans and redress those digitally using painting tools (e.g., Lafayette recolors garments [8]) and post-production techniques (H&M draws or digitally pastes clothes on the models [9]). This demands a sophisticated setup and many (human) resources making it not feasible for SMEs or artists to implement.

Shape from texture is a computer vision technique where a 3D object is reconstructed from a 2D image [10]. Like human perception it is capable to realize patterns, estimate depth and recognize objects in an image by using texture as a cue [11].

Ebert et al. [12] use colour-coded cloth textures for retexturing virtual clothing. Together with range scans of the garment a parametrization of the mesh is obtained. The authors use a color code which has a limited size of codewords so that the pattern is repeated over the whole fabric. In this method the color code is only used for the parametrization of the surface.

Hilsmann et al. [13] employ optical-flow tracking to replace a textured region on a shirt by a virtual one. Their method uses a-priori knowledge of the color (i.e. green) of the shirt and the knowledge that there is a rectangular highly textured region an the shirt. A shading map is derived from the intensity of the uniform colored shirt after removal of the texture. These assumptions, however, make it impracticable for our case in which we deal with non-uniform colored and all-over textured garments.

The work by Guskov et al. [14] and Scholz et al. [15] is closest to our work. They use color-coded quad markers for the acquisition of non-rigid surfaces. Results for different surface types, including a T-shirt are presented.

3 Approach

In order to acquire new apparel collection coping with (subtle) wrinkles and shadows we want to employ a sparse set of guidelines giving the user intuitive control over obtaining and refining a mesh representation of how the piece of garment has been deformed. Users can identify these guidelines by means of an non-technical intuitive graphical user interface.

In a first step (as illustrated in Figure 2(b)), lines (already present or specifically printed) on the undeformed cloth need to be identified. This can be easily accomplished by the user by drawing straight guidelines on top of these lines. The guidelines are then sampled (according to a user-defined measure) by our tool in order to create a 2D base mesh corresponding to the undeformed cloth (Figure 2(c)). Using subdivision techniques a smoother mesh can be obtained (Figure 2(d)) without the need for extra guidelines.

In a second step (as illustrated in Figures 2(e–h), a deformed version of the base mesh is created in a similar way. As the initially parallel lines now are deformed, the user has to identify them by means of curved guidelines (in our case subdivision curves) instead of straight lines. The identification of the guidelines itself needs to happen in the same order as in the first step in order to end up with a one-to-one correspondence between the deformed and undeformed guidelines. When overlapping areas of fabric are involved such as permanent and stubborn creases users can also indicate extra features. For instance, a user explicitly could mark the start and end of a crease (for the undeformed as well as the deformed garment) indicating that the absolute distance between the marks needs to be preserved. This would prevent the final texture (in a later step) from unwanted stretching/squeezing behavior.

As in both steps the number of guidelines, order of identification and number of samples are the same, the base and deformed mesh will have the same topology. Consequently texture coordinates calculated for the base mesh can be transferred to the deformed mesh resulting in a visually realistic simulation of the deformed garment when applying a texture pattern on the virtual model (Figure 2(i)).

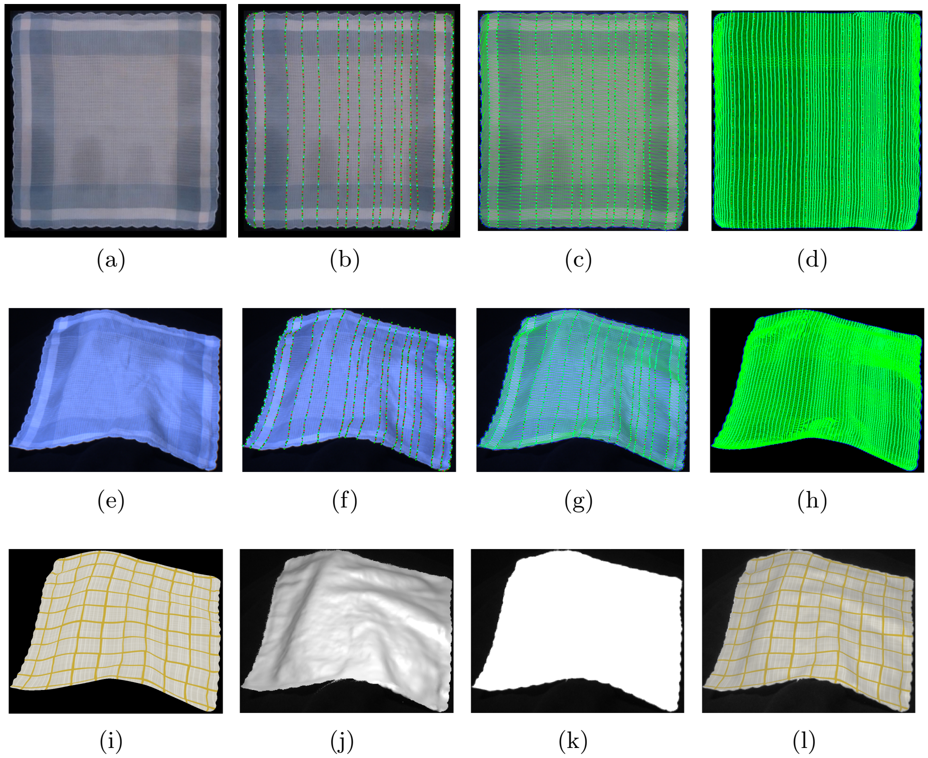


Fig. 2. Overview of our approach. a–b) Original (ironed) handkerchief without/with user imposed guidelines. c) 2D base mesh. d) Base mesh after two subdivision steps. e–f) Target wrinkled handkerchief without/with user imposed guidelines. g) Target handkerchief with initial base mesh. h) Target mesh after two subdivision steps. i) Rendering of virtual handkerchief using a cotton-like fabric. j–k) Shadow map and mask automatically derived using structured light scanning. l) Final rendering of virtual handkerchief.

Finally, to achieve a 3D-ish look of our 2D virtual garment, a shadow map and mask are applied yielding a realistic result (Figures 2(j–l)).

3.1 Guideline Creation

Concerning the identification of the deformed guidelines we employ subdivision curves (see Figure 3) in combination with an intuitive graphical user interface. The idea is that you start by placing a simple polyline (by means of control points) on top of the deformed line which will act as a control curve (Figure 3(a)). Then, by repeatedly refining (i.e. subdividing) this control curve a new and more smooth curve is created (see Figures 3(b–d)). To this end, we employ the Chaikin scheme [16] in which each old vertex gives rise to two new vertices. When this process is repeated several times a very good approximation of the uniform quadratic B-spline curve defined by the original set of vertices is obtained.

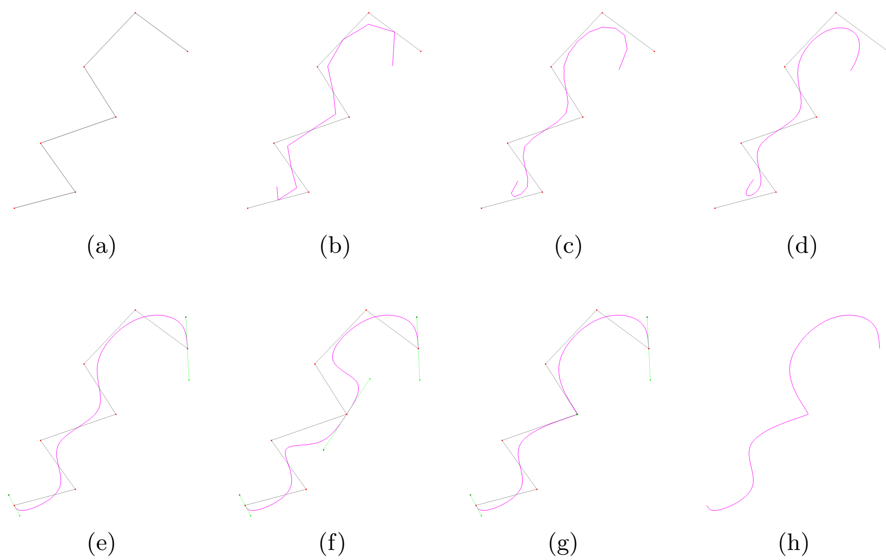


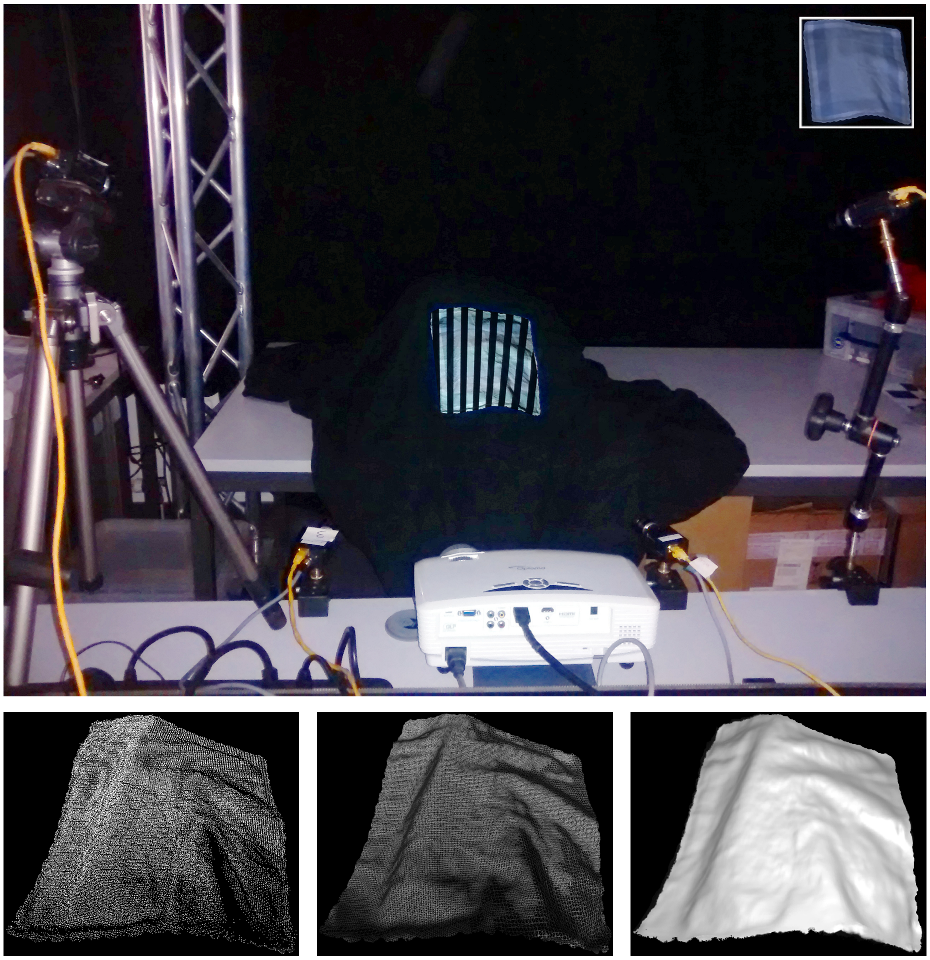
Fig. 3. Subdivision curve used as guideline. a) Control curve. b–d) Subdivided (consecutive subdivision steps). e) Interpolating vs approximating. f) Tension control (flatten). g) Tension control (sharpen). h) Resulting curve.

Furthermore, in order to allow the user to further refine the curved guideline we extended the subdivision curves with an additional support of normal interpolation and local tension control around control points (see Figures 3(e–g)). This allows us to use only a limited number of control points to fully control a subject with an irregular outline.

3.2 Shadow Map Generation

To achieve a 3D-ish look of our 2D virtual garment, a shadow map texture needs to be created which can be rendered on top of the current result. The idea is to generate this shadow map using a structured light scanning approach which involves projecting a known pattern of light onto a scene, and recovering scene geometry by analyzing distortions of the pattern [17].

Our setup consists of one projector and four cameras as shown in Figure 4(top row). Starting from our target garment shape, reconstruction is accomplished by projecting structured light patterns which in turn are captured by our camera system. These patterns allow each projector pixel to be identified and triangulated resulting in a large point cloud (Figure 4(a)). Next, a mesh of



(a) (b) (c)

Fig. 4. Shadow map generation of a handkerchief (original is shown in the inset). Top row: Structured light scanning in action. Bottom row: a) Identified 3D point cloud. b) Reconstructed mesh of the visual surface. c) Captured depth/shadow map as rendered from the light's perspective.

the object's surface is reconstructed using standard meshing techniques (Figure 4(b)). Note that the reconstructed mesh approximates only the visual surface of the object rather than the whole object meaning it cannot be textured directly as missing depth information (e.g., wrinkles) will stretch/squeeze the texture nor can it be viewed from multiple angles. Since we are only interested in generating a shadow map, this poses no problem as the mesh still can be rendered from a light's perspective. The resulting depth buffer is then captured in a texture which will be used as a shadow map (Figure 4(c)).

4 Results

In this section we look at some of the virtual garments created using our technique.

Figure 5 illustrates the acquisition process of a kitchen towel (being used in our institute's kitchen). Figures 5(a–b) depict the towel with user imposed guidelines respectively put flat on a table and naturally folded. Only 9 guidelines have been used and the existing striped pattern has been used as a visual guidance for laying out these guidelines. Figure 5(c)) shows the employed shadow map and mask combined into one image. By employing assorted textures various kinds of towels can be created: (d) a folk-checkered cotton kitchen towel, (e) a kids' bath towel, and (f) an AMDO beach towel.

Figure 6 illustrates the acquisition process of a handkerchief. Figures 6(a–b) respectively depict an ironed handkerchief as well as a wrinkled version together with user imposed guidelines. In this case 18 guidelines have been laid out on the existing striped fabric. Figure 6(c) shows the automatically derived shadow map and mask. New stylized handkerchiefs are depicted using different sorts of fabrics illustrating the robustness of our method: (d) cotton, (e) French silk, (f) gold linen, and (g) crochet yarn.

5 Conclusion and Future Work

In this paper we presented a system to capture apparel products in order to apply a new print design to the acquired garment models. Regarding model acquisition of new apparel collection we made use of a sparse set of guidelines in combination with an intuitive graphical user interface allowing the user to obtain and refine a 2D mesh representation of the garment. To achieve a 3D-ish look of the 2D virtual garment, we proposed the use of structured light scanning to automatically obtain a shadow map. Our method allows online clothes shops to bring new visual art into bespoke clothing to make apparel products more valuable compared to other garments on the market. Furthermore it helps artists and designers in virtual prototyping and visualizing garments with new print designs.

Discussion and Future Work. One of the main difficulties of the tool is the manual identification of guidelines when heavy distortions are involved. For instance, a scarf with a knot in which case large parts of the guidelines will be obscured. Therefor, instead of acquiring the garment model at once, the garment could be captured in several phases each corresponding to a piece of garment that is more convenient to handle. For the scarf case, it would narrow down to capturing three pieces (the knot and the two loose ends) and merging these together.

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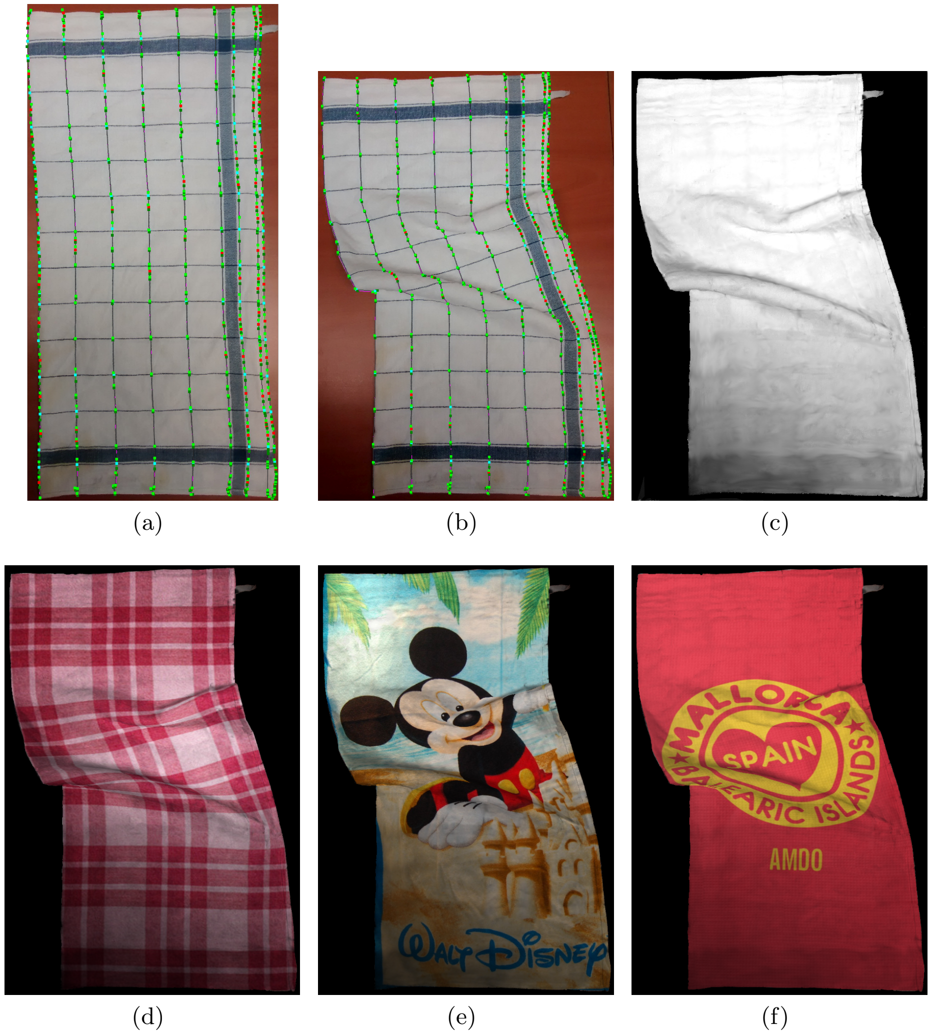

Fig. 5. Towel. a) Original kitchen towel with user imposed guidelines. b) Target folded towel with user adjusted guidelines. c) Shadow map and mask (combined into one image) derived using standard image-processing algorithms. d–f) Renderings using different textures: (d) folk-checkered cotton kitchen towel, (e) kids' bath towel ©Disney Enterprises, (f) AMDO beach towel.

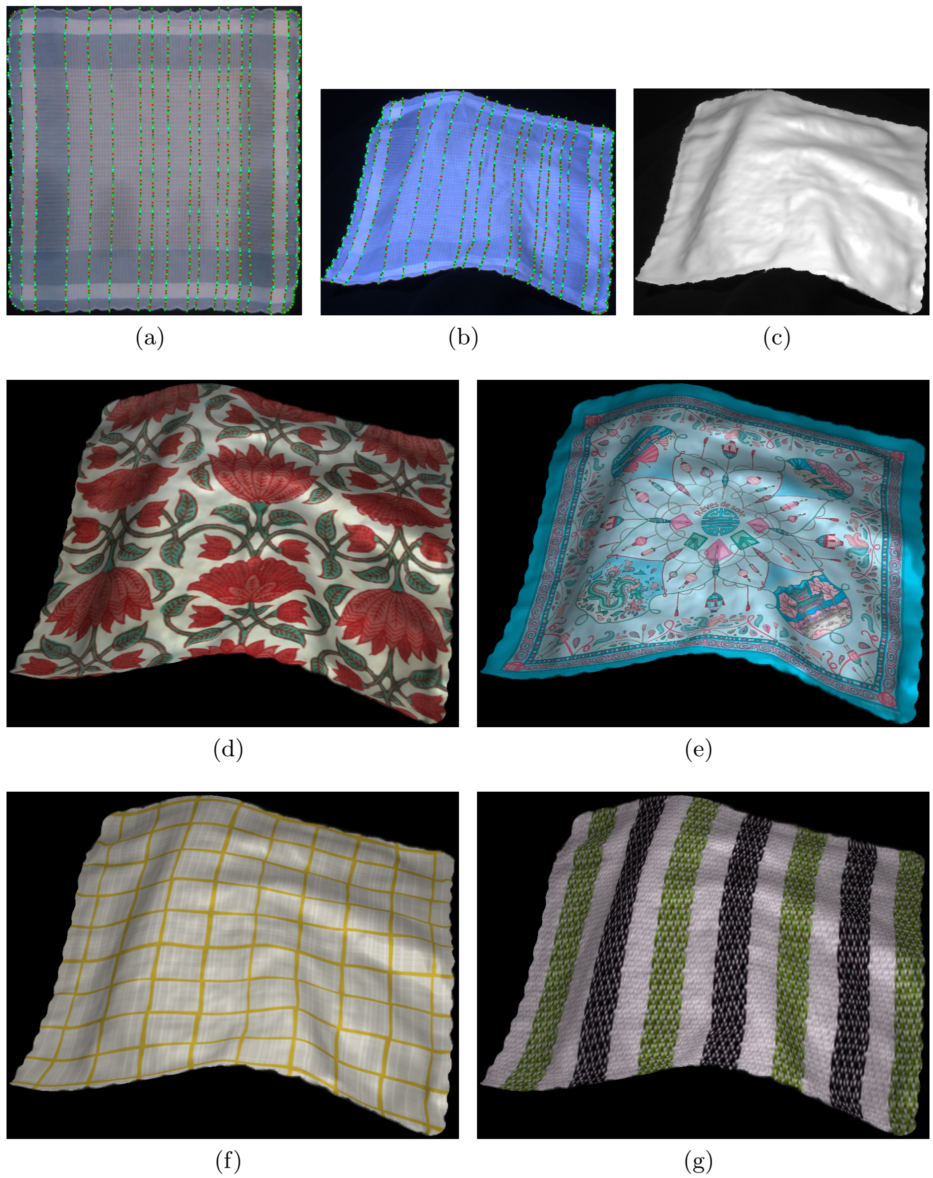

Fig. 6. Handkerchief. a) Original ironed handkerchief with user imposed guidelines. b) Target wrinkled handkerchief with user adjusted guidelines. c) Shadow map and mask (combined into one image) automatically derived using our structured light scanner. d–g) Renderings using different fabrics: (d) cotton, (e) French silk, (f) gold linen, (g) crochet yarn.