Exploring Methods to Make 3-D Images of Historic Clothing Using Photogrammetry

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Introduction; Photogrammetry is a method to make a digital three-dimensional (3-D) image of an object by combining photographs. This process also results in a digital image that enables measuring capabilities. The technological tool is used in various fields; such as geographic mapping and preservation of heritage and archeological objects. Measuring capabilities of the tool enables assessing the scale of an object and tracking the size of a deformity (e.g. Remondino, 2011). The method has been used in the apparel and textile industry to understand fit by capturing photographs of dress forms or individuals wearing bodysuits (Percoco, 2011).

Significance/usefulness: Photogrammetry has potential for a plethora of uses in the apparel field, such as analysis and preservation of historic garments and garment fit. However, further exploration is needed to understand the method. The purpose of this abstract is to research how photogrammetry can be successfully applied to documenting historic clothing. To achieve this purpose, a series of experiments were conducted to identify the procedures that resulted in the highest quality and most accurate measurements of historic clothing.

Method: Two contrasting garments from a historic costume collection were selected for this research. The first garment was a man's tailored World War II military jacket made from wool, while the second garment was a patterned cotton day dress of the same era. The garments were documented using photogrammetry within guidelines by the Cultural Heritage Imaging (personal communication, 2016) by taking three sets of photographs at the top, middle, and bottom of the garments with a prescribed camera setting. Guidelines allowed for varying physical and digital settings given the subject. These possibilities included: 1) background; 2) direction of the camera; 3) distance from subject; 4) focus; 5) garment; 6) type of lens; 7) lighting; and 8) scale bar position. The process was documented given these variations. After the digital 3-D image was made, the actual garments were measured at points in each direction of the garment (e.g. top of a pocket; center front; around hems, waist, etc.). These measurements were compared to measurements from the image made using the computer software.

Results: A DSLR camera with settings ISO 100, F-Stop 3.5 and shutter speed 40 was used.

Table 1. Sample measurements of actual garment versus photogrammetry image (cm)

	Actual.	Photog. Image	Actual	Photog. Image
CF length	17.5	16.8	28.8	28.8
Pocket width	15.0	15.0	14.8	14.8
Around sleeve hem	39.5	39.2	30	30.6

Table 2. Result of taking photographs varying the set-up to build photogrammetry images.

Trial	Back-ground	Direc-tion	Distance	Focus	Garment	Lens	Lighting	Result	Scale bars
1	BCG	W	55"	M	PD	ST	S	PNR	ASU
2	B	W	55"	M	MJ	ST	S	PNR	ASU
3	B	W	55"	M	MJ	ST	R;S	D	ASU
4	C	A 15	55"	M	MJ	WI	R	CD; H	ASU
5	C	A 15	75"	M	MJ	WI	R;S	SI	ASU
6	C	A 20	55	M	MJ	WO	R; S	S; B	ASU
7	C	A 20	55	M	MJ	ST	R;S	SU	ASU
8	C	A 20	55"	A	MJ	ST	R; S	B	ASU
9	C	A 20	55"	M	PD	ST	R;S	SU	ASU

Codes: Background (B=Black only, BCG=Black backdrop with contrasting white edges, C=Classroom, G=Grey only); Direction (A=photographs taken around the figure, W=Camera facing subject against a wall, 15=15 images, 20 = 20 images); Focus (A=Auto, M=Manual); Garment (MJ=military jacket, PD=pink dress); Lens (ST=Standard, WI=Wide); Lighting (L = Studio Lights, R = Room Lights); Results (B=Blank spaces – under arm or shoulders, CD=cannot detect scale bars, D=Too dark for photograph to be taken, PNR=Photographs not shown around figure in software SI=Scattered image, SU=Successful); Scale bars (A=Above, B=Back, F=Front, S=Side, U=Underneath)

Discussion/Conclusions: The results provide a guide on the process to document historic clothing using photogrammetry. The method that achieved the best results included: 1) 20 photographs taken around the garment; 2) camera 55" from the garment; 3) photographs taken closer together at the side of the garment; 4) additional photographs taken at the side, under, and top of the arm; 5) illumination of the garment with studio lights; 6) photographs taken using a standard lens. By doing this, the measurements of the photogrammetry images were close to the actual garment, particularly vertical and horizontal lines.

Photogrammetry is a tool that has been used to document some types of material culture artifacts (e.g. statues). Results demonstrate this tool has potential for assisting with preserving and providing further understanding of historic costume. Measurements could be used to track deterioration of artifacts (e.g. the size of a tear) and to conduct research on garments, such as tracking changes in waist sizes overtime. Further research could examine how to achieve the best results given different fabrics (e.g. grey, shiny) and accurate measurements in fabric folds.

Percoco, G. (2011). Digital close range photogrammetry for 3D body scanning for custom made garments. *Photogrammetric Record*, *26*(133), 73-90.

Remondino, F. (2011). Heritage recording and 3D modeling with photogrammetry and 3Dscanning, *Remote Sensing*, 3, 1104-113.