3D Body Scanning: Towards Shared Protocols for Data Collection

Addressing the needs of the body scanning community for ensuring comparable data collection

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***Abstract*— Currently, there are no public, universal or easily applied protocols for capturing body scan data, which may result in discrepancies in the captured scan data; a series issue in a scientific field. This paper presents a step-by-step process that forms the basic procedure for capturing, storing, processing, and using body scan data based on that currently used at The University of Manchester. Here, the entire scan capturing protocol is explained from recruitment through to the scan process itself and final following up on the participant post-scanning. This process has allowed the Apparel Design Engineering cluster within the School of Materials to increase the repeatability, accuracy, and professionalism of their work in 3D Body Scan research, with the intention to disseminate this protocol throughout research and industry.**

***Keywords*— Anthropometrics; Body Scanning; Ergonomics; Methodology**

I. INTRODUCTION

Although 3D body scanning can be considered to a degree as a mature technology - being originally developed in the 70's [1] – the process of capturing body scans is still not standardized in protocol or practice. The importance of this is highlighted by previous research [2]–[4] that notes that differences in measurement definitions influences the obtained dimensions to statistically significant amounts. Consequently, a need exists to produce, disseminate, and create adoption of a universal protocol in 3D Body Scanning to bring unity and conformity to the process of capturing body scans. Current standards [5] do not provide sufficient detail for all aspects of the process..

This paper presents a step-by-step process that forms the basic procedure for capturing, storing, processing, and using body scan data based on that currently used at The University of Manchester. These scans are captured in a private cubicle with the participant minimally clothed, scans are captured using light sources and image capture devices and are only able to capture the body surface. Capture devices are similar to Kinect sensors [6] (used as a physical interactive data input device for PC and X-Box), and do not present any dangers to the participant.

II. A SHARED PROTOCOL FOR BODY SCANNING

A. Body Scanning and Ethical Procedures

During the scan capture process it is not possible to view images of the scanned subject and upon processing the scan appears as a point cloud for analysis (see Fig. 1). Data are captured by scanning personnel, who have received suitable training in capturing body scans and each scan session is the responsibility of a member of trained University staff.

All specific ethics approval documents refer directly to the process document and require separate approval for deviations from the standard methods. A copy of each project's specific ethics approval documentation is kept which allows for better management of all scanning activity and for project specific requirements to be catered for.

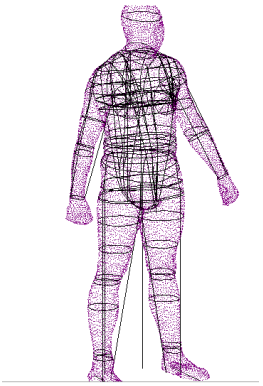

Fig. 1. Example of scan image as seen on screen at scan capture and during analysis

A copy of the scan procedure is made available to all participants before being scanned and is displayed in a prominent position in the location where body scans are being captured. Deviations from the scan procedure require the ethics committee to be notified for their consideration. The process document forms the backbone for all future projects allowing deviations to be noted, and are not required full approval again for standard practices.

B. Step by step procedure

1) Recruitment to body scanning

Recruitment of participants to be scanned is by one of the following methods:

- Individuals invited to participate in body scanning sessions whilst the scanner is situated offsite; e.g. during outreach activities.
- Open calls using social media, posters, and word of mouth, etc. This is primarily managed through the online booking system based on Eventbrite through the University webpages (http://www.materials.manchester.ac.uk/our-research/facilities/bodyscanning/bookabodyscan/)

2) Explanation of the body scanning process and details of consent

Each participant has the opportunity to have the scanning process explained to them and be referred to the systematic procedure detailing the process from start to finish.

The systematic guide and a copy of the consent form are provided for the participant to read before scanning. The consent form is retained, though a blank copy is available on the website for scrutiny by participants.

A general body scanning information sheet, and a sheet related to specific scan projects, is provided to each participant before scanning. The general information sheet indicates the type of underwear that should be worn during the scan process and the types of scan outputs that will be provided.

Scanning is only undertaken by trained personnel, whose names will be recorded on the consent form and all scanning is the responsibility of a member of university staff whose contact details is made available to participants.

3) Participants complete their record in the database

An encrypted and password protected database available on a single PC is used to record identifying and contextual data separate from any scanned image. This is then backed up to encrypted and password protected hard disks that are kept at separate secured locations.

The database can only be accessed by members of the scanning team with a password, and will store personal details of each participant; as well as manual measurements not recorded by the scanner.

Completion of each participant database record generates a unique code that is used to name the scan file and retain anonymity of the scan participant whilst linking the scan file to the database entry.

4) Print and sign the consent form (Participant and scanning personnel)

A copy of the consent form is then printed from the database and once read is initialed and signed by the participant and the names of both scanning personnel are recorded. The signed copy of the consent form has details of the manual measurements recorded on it and after completion of the scan is stored in a secure location. A blank copy of the consent form is available for each participant online.

5) Manual measurements taken prior to the scanning process

To enable full analysis of the scan data a number of manual measurements are taken:

- [D2] Height – the shoes are removed for this measurement
- [D3] Head Circumference – taken to help understand garment opening requirements
- [D4] Min Max hand – taken to help understand garment opening requirements
- [D5] Hand length – taken as a reference for garment opening requirements

Measurements are taken manually in accordance with detailed methods that are available for the participants to view before giving consent and during the process.

6) Using a private changing cubicle, change into underwear and record weight

Participants are directed to a private changing cubicle adjoining the body scanner and requested to change down to their underwear. Should the scanner be located where this is not possible then, participants are provided with a gown for privacy to wear when travelling between the changing cubicle and scanner.

Participants are instructed to step onto the weighing scales in the private changing area and the scanning personnel from a remote screen record weight. Participants are asked if they would like to know their weight and have it recorded on the output.

Due to the nature of the scanner, it is explained that underwear must be close fitting as detailed on the information sheet. Appropriate underwear is made available to wear over or in place of the participants own, should they not have close fitting underwear. At no point should the participant be undressed whilst in view of the scanning personnel or other participants.

7) Enter the scanner booth and adopt the scan posture

Before entering the scanning booth, the scan position of the body is explained to the participant and a definition provided for their reference. The participant is then instructed to enter the scanning booth and adopt the required scan posture.

Whilst the participant is in the scan booth (and before the scanner is activated) the scanning personnel inputs the unique code from the consent form to name the scan file. This retains the anonymity of the participant but allows the scan to be matched with the details in the participant record during analysis.

The participant stands in the scan position and has their scan captured, remaining in the scan booth until the scan is complete and a usable image is collected; approximately one minute. Once the scan has been captured, it is checked on screen and if a rescan is necessary; communicated to the participant verbally. Once a suitable scan is captured then the participant returns to the changing area/ cubicle to get dressed.

8) Leave scanner booth and get dressed in the private changing area

On completion of the scan, the participant re-enters the changing area (directly connected to the scanning booth) and dresses in their original clothing in full privacy. On leaving the

changing area the participant is offered a copy of their scan data printed out showing a front, back, and side view and displaying their measurements.

9) Following scan capture and debrief

Each participant is offered a print out of their scan data on completion of the process and the opportunity to take a copy of their scan files. Participants are offered the opportunity to have their weight and height recorded on the printed sheets. Electronic copies of their scan data can be requested by personal email and will be sent where practical. Participants may also be sent summary data by email should they request this following from their scan.

10) Notes on the procedure

A minimum of two scanning personnel must be present at all times one of which must be an experienced and approved staff member. The participant is free to withdraw from the activity at anytime even though the consent form has been signed. If a participant withdraws from the activity during the data collection period, all data is destroyed immediately.

11) Data usage and storage

Any anonymized scan data taken from the scanner location is kept on encrypted computers, or within encrypted folders on storage devices. All scan data is backed up on encrypted external hard drives and kept in a secure locked location with controlled access. This is a separate hard drive to the one used to back up the participant database.

Measurements taken from scans and scan images themselves may be used within publications (academic and non-academic). In instances of scan images being used, the faces on scan avatars/ point clouds/ etc. are obscured to ensure anonymity. Examples of scan outputs used in publications are provided to participants when necessary.

C. Protocol for data management (storage and backing up)

All body scanning activity within The University of Manchester is conducted on the understanding that all data collected contributes to the general data pool. Any embargos on data use or participant contact are detailed in the specific project ethics approval documentation of which a copy is kept with the scanning technology and a reference is made, by note and ethics approval code, in the Project Categories field within the participant database. All data collected through body scanning is stored on the PC used for data collection for both the body scans and participant records.

Each is backed up in duplicate to encrypted Hard Drives or USB's kept separately and in a secured location. Where possible these drives are password protected.

1) Participant Records

Copies of the database are kept in the *FileMaker Pro* database format. For the purpose of each study data will be extracted from the database into excel sheets, this does not include the participants name but instead uses the scan code to allow these details to be matched to measurement data taken from the body scans.

D. Use of body scan data

Any use of body scanning data adheres to the following conditions unless consent has been granted by the participant, and this has been signed off by the ethics committee of The University of Manchester.

Data is blinded (named with a code) on receipt, stored as blinded and double-blinded (named with secondary code) before use in publication.

Double blinded scan data issued in publications and lists of anonymous double blinded scan measurements may be used in teaching and in the development of research.

Any screen shots of the scan image captured from the scan files have identifiable data such as face profile removed before any publication.

1) Prior to being scanned

Before participants are scanned they are provided with details explaining the process, those booking online go through the website to book an appointment. Here a video is provided detailing the process as well as copies of the consent form; scan information sheet and samples of the data output from the body scanner:

Participants who have not booked through the website are provided with hard copies of these details and the opportunity to access the video guiding on the process prior to being body scanned.

2) Post being scanned

Participants are provided with a printed copy of their body scan, including an extensive list of body measurements. All participants are offered the opportunity to take away a copy of their electronic scan data, copies in *.obj* format (which can be quickly produced) and can be opened using a number of existing computer programs.

E. Outline of Database and rationale for data collected

Participant's details are recorded in a database that also creates the unique scan ID.

The eight character participant code is created as the database record is being completed. The code consists of a four digit unique identifier, a code for gender (M or F); a letter code for ethnicity and two digits for age. Having this data in the code helps with managing the scans, and later matching of specific scans with specific participants data the during analysis. A record is also kept of the person responsible for capturing each scan.

The notes section in the records allows for the capture of specific project details or for other important data that may be relevant to future data analysis. This may include whether the participant is employed as a fit model or if they participate to a high level within a sport.

F. Scanning personnel and training

The capturing of body scan data at each session will be the responsibility of an experienced member of University Staff; it will also be supported by trained scanning personnel. These scanning personnel may be other University staff, PG or UG students who will have been provided with in-house training on

how to capture scans and dealing with scan participants. Names of the scanning personnel and staff member will be recorded on the consent form and contact details for the staff member responsible for the scan capture session will be made available to participants.

III. Conclusion

The protocol outlined within this paper has been developed by the Apparel Design Engineering cluster within the School of Materials, University of Manchester through a co-design methodology, utilizing design thinking to research, specify, develop, and deliver the final solution. The result has been to create a uniform and useful user experience that ensures that ethical requirements are met at all stages, experiments and measures are repeatable, and the body scanning experience can be controlled, improved, and applied equally to all those who participate in our research; an important aspect of Service Design. This has created a better research environment within our research cluster with a greater level of professionalism relating to each point highlighted within the above protocol.

Further collecting data against these protocols, ensures that it can analyzed in the knowledge that participants are dressed and stood in a similar manner. Adoption of these protocols will ensure that all users of body scanning systems collect full and accurate data about their participants, especially details not captured by the scanner, but required for future data analysis.

Acknowledgment

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References

[1] E. J. Lovesey, "The development of a 3-dimensional anthropometric measuring technique," Appl. Ergon., vol. 5, no. 1, pp. 36–41, 1974.

[2] S. Gill, C. J. Parker, S. Hayes, P. Wren, and A. Panchenko, "The True Height of the Waist: Explorations of automated body scanner waist definitions of the TC2 scanner," in 5th International Conference and Exhibition on 3D Body Scanning Technologies, 2014, pp. 55–65.

[3] D.-E. Kim, K. LaBat, E. Bye, M. Sohn, and K. Ryan, "A study of scan garment accuracy and reliability," J. Text. Inst., vol. 106, no. 8, pp. 853–861, 2015.

[4] L. Mckinnon and C. L. Istook, "Body scanning: The effects of subject respiration and foot positioning on the data integrity of scanned measurements," J. Fash. Mark. Manag., vol. 6, no. 2, pp. 103–121, 2002.

[5] BSI, "BS EN ISO 20685:2010: 3-D scanning methodologies for internationally compatible anthropometric databases," British Standards Institute, London, UK, 2010.

[6] G. M. Ryan, "Visual Target Tracking," 8,682,028, 2014.