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Comparison of Body Measuring Techniques: Whole Body Scanner, Handheld Scanner, and Tape Measure

Sibei Xia
North Carolina State University, sxia2@ncsu.edu

Siming Guo
North Carolina State University, sguo10@ncsu.edu

Jiayin Li
North Carolina State University, jli54@ncsu.edu

Cynthia Istook
North Carolina State University, cistook@ncsu.edu

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Sibei Xia, Siming Guo, Jiayin Li, and Cynthia Istook,
North Carolina State University, USA

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Body measurement data is critical in the development of patterns for garments and the identification of sizes that enable the apparel industry to successfully meet the needs of their customers. Historically, body measurements have been collected manually using tape measures and calipers. The manual measuring process is quite time consuming, labor intensive, and susceptible to significant human error. Introduction of the three-dimensional (3D) whole body scanner in the 1990s automated the process of measuring the body. By implementing multiple optical distance measuring units, the 3D whole body scanner can produce digital 3D copies of subjects' body surface geometries (Daanen & van de Water, 1998). The digital copies allow the computer to extract any desired measurements, at any given time. Compared to the manual measuring process, the 3D whole body scanner shortens measuring time and provides data that has higher accuracy and consistency (Kim, LaBat, Bye, Sohn, & Ryan, 2015). Nowadays, 3D whole body scanners are being used by many apparel companies. However, because the whole body scanner is still relatively expensive, it has limited use in the marketplace. Researchers have been seeking ways to find alternatives that are less expensive by implementing other imaging techniques and reducing the number of optical units (Bragança, Carvalho, Xu, Arezes, & Ashdown, 2014).

A handheld 3D scanner, also known as a portable 3D scanner, captures 3D shapes from different viewpoints in sequence with a single optical distance measuring unit and stitches them together. Prices of low-end handheld scanners are several hundred dollars (https://www.sculpteo.com/blog/2016/04/18/guide-3d-scanners). The cost-effectiveness of the handheld scanner makes it a candidate for replacing whole body scanners. A popular example of the handheld scanner is the Kinect from Microsoft. Kinect technology has been used in much body measuring research, but results have not been satisfactory (Bragança et al., 2014). The Structure Sensor from Occipital is another handheld scanner. It is branded as the first 3D sensor for mobile devices such as the iPhone and iPad (http://occipital.com). Little research has been done using it to measure the human body. The purpose of this study was to compare the performance of a handheld, portable scanner with a whole body scanner and manual measuring methods.

Methodology

The Structure Sensor, a commercial 3D whole body scanner, and a tape measure were selected as the three tools used to measure a female mannequin in a straight posture. A mannequin was selected as a measurement subject, instead of a real human being, to minimize variance related to movement and breathing. Fifteen measurement locations were selected based on ASTM standards and the researchers' pattern making experience (ASTM International, 2015).

Three groups of measurements were collected. Group 1 contained 16 sets of measurements that were manually collected using the tape measure. Group 2 contained 27 sets of measurements that were collected using the commercial 3D whole body scanner. Group 3 contained 19 sets of measurements that were collected using the Structure Sensor. Unpaired t-tests were applied on the data to study the measurement difference between the different methods.

Results

The measurement results of the Structure Sensor were close to the results of the commercial whole body scanner at locations that could easily be identified using computer software. For example, the difference of the bust circumference was 0.3 inch which was less than the allowable error (0.35 inch) defined in ISO 20685 (International Organization for Standardization, 2010). However, neither the whole body scanner nor the Structure Sensor performed well at locations that were hard to locate. Both the structure sensor and the whole body scanner generated circumference measurements that were larger than the results of the manual method. The consistency of the Structure Sensor was the worst among the three methods. Because the Structure Sensor was not designed specifically to measure humans, no measurement extraction software has been developed, yet. It does appear, however, to have promise as a low cost measuring method, once appropriate measurement extraction software has been developed.

Discussion

This study reinforced the knowledge that measuring human bodies is not a trivial process. The decision to use a mannequin was made to reduce some of the human variables (breathing, movement, etc) that could impact the results. Significant effort was made to find a mannequin with a straight and even posture to support the expectations of the body scanning software and to provide clear sensor access to the whole body. Unfortunately, the slight bend in the leg and the slight forward location of an arm and hand impacted the success of clear image detection and successful measurement extraction on a consistent basis. Future research will benefit from the use of real people and the development of measurement extraction software for the portable device.

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