# Reliability of KinectV2 based 3-dimensional human-body scanner for kinanthropometry survey of calf girth and waist girth

Applied Measurements in Sports Engineering (66-707420)
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**Introduction:**

Cameras that capture depth and colour have been used to perform 3 dimensional (3D) human body reconstruction and used in healthcare applications (Treleaven & & Wells, 2007), the apparel industry (Istook & Hwang, 2001) and for anthropometric surveys (Jones, 1997) . In all these applications 3D scanning helps attain rich human body measurements with minimal contact. Manual kinanthropometry measures allow for 1% technical error in measurement (Marfell-Jones, Stewart, & De Ridder, 2012) and the same needs to be followed by measurements from 3D models (de Onis, 2004). This study aims to report the reliability of getting calf girth (CG) and waist girth (WG) measures from reconstructed 3D human-body scans using cost friendly Microsoft Kinect V2 sensor and the adapted Kinect Fusion technique of proven validity (Chiu, et al., 2019).

**Methodology:**

Eight university students (6 males, 2 females) were recruited from Sheffield Hallam University following the ethics approval. The participants wore close fitting clothes and stood on the centre of the rig for three scanning trials. The Kinect V2 is moved in a circular path around the participant and using an adapted Kinect fusion technique a 3D human body scan is reconstructed.



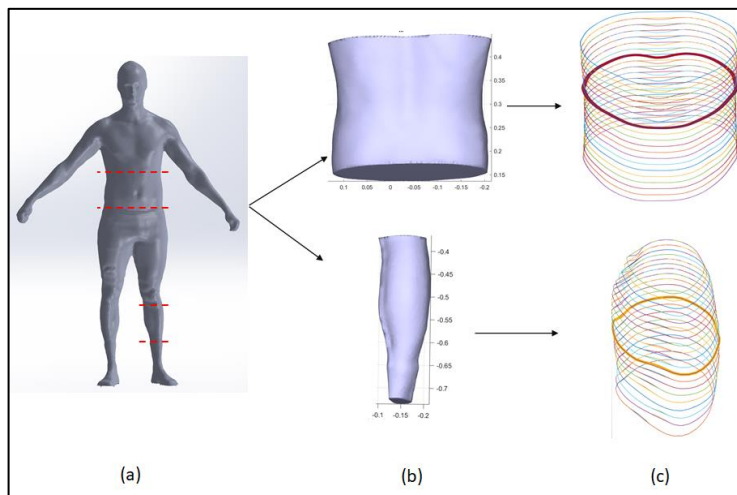Figure 1: Rig used for the experiment



Figure 2: (a) reconstructed human body scan (b) trunk and calf section (c) Contours calf and trunk.

After cropping regions of interest using MeshMixer, a MATLAB script is developed to extract the CG and WG. CG is measured as the greatest girth of the calf muscle and WG is the smallest circumference between the last rib and the iliac crest. The reliability for kinanthropometry assessment by the 3D scanner is presented by looking at intra class correlation (ICC), Bland Altman (BA) plots. TEM is also calculated.

## Results:

The intra-class correlation coefficient for both CG (0.987) and WG (0.998) obtained from the 3D models were above 0.9 which shows excellent correlation.

**Intraclass Correlation Coefficient**

| | Intraclass Correlation[b] | 95% Confidence Interval | | F Test with True Value 0 | | | |
|---|---|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | Value | df1 | df2 | Sig |
| Single Measures | .963[a] | .878 | .993 | 79.494 | 6 | 12 | .000 |
| Average Measures | .987 | .956 | .998 | 79.494 | 6 | 12 | .000 |

*Table 1: Intra-class correlation SPSS output for WG*

**Intraclass Correlation Coefficient**

| | Intraclass Correlation[b] | 95% Confidence Interval | | F Test with True Value 0 | | | |
|---|---|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | Value | df1 | df2 | Sig |
| Single Measures | .995[a] | .981 | .999 | 645.242 | 6 | 12 | .000 |
| Average Measures | .998 | .994 | 1.000 | 645.242 | 6 | 12 | .000 |

*Table 1: Intra-class correlation SPSS output for CG*

For both CG and WG the all the data lies within the 99% confidence intervals of a BA plot showing high test-retest reliability.
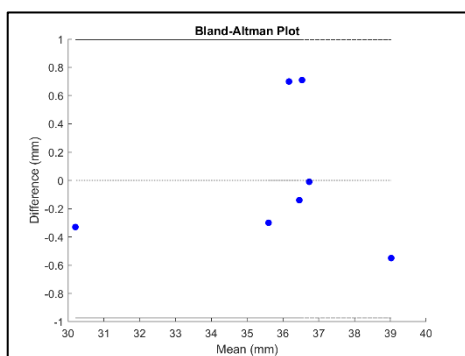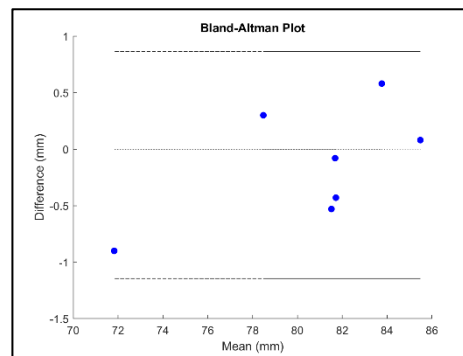


*Figure 3: BA plot for CG*



*Figure 4: BA plot for WG*

Out of the data from 7 participants, CG for 3 participants and WG for 6 participants stayed within the 1% TEM in the first two trials.

## Discussions:

Based on the results from ICC and BA we can say the anthropometric measurements are reliable. This study confirms the reliability of 3D scanners used for anthropometry and supports the finding of (Kremer, 2020).
 BA plot has increased variance with higher average values which could indicate a flaw in experimental design due to unaccounted factors. For CG 57.14% of the data did not fall within the 1% TEM, whereas for WG the system shows more reliability with 85.71% of the data falling within the 1% TEM.
The study can be improved to see if the reliability is different for males and females by recruiting more participants and by seeing reliability for other anthropometric measures.

## Conclusions:

KinectV2 and Kinect fusion based 3-dimensional human-body scanner for kinanthropometry survey of calf girth and waist girth is reliable.

# References

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**Word Count:** 547 words (Excluding references)