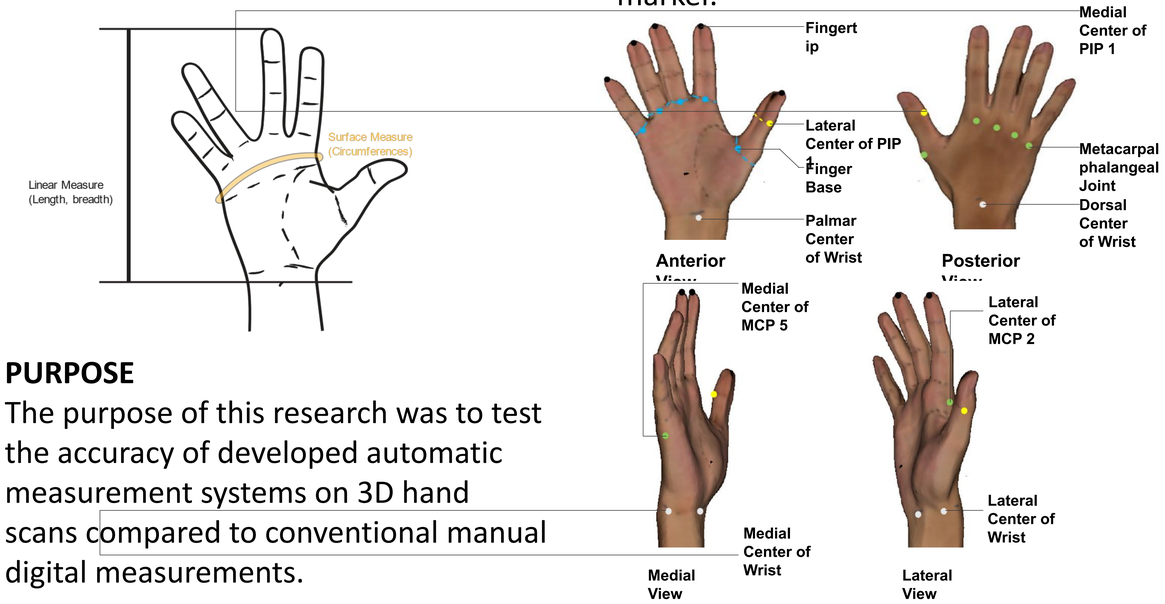
Human Dimensioning Lab

Make It Easy- Reliability of Automatic Measurement for 3D Hand Scanning

Arif Bhuyan (bhuya007@umn.edu) & Dr. Linsey Griffin (lgriffin@umn.edu)

INTRODUCTION

Using 3D technology to scan hands is a relatively new tool where challenges exist with adopting 3D technology because hands can be difficult to scan and time-consuming to measure and analyze. There is a need to develop and test automated measurement systems to expand the functionality and acceptance of 3D hand data for the industry.

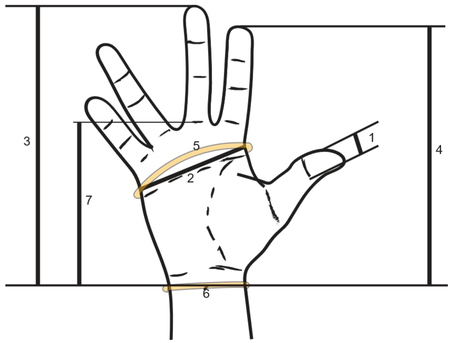


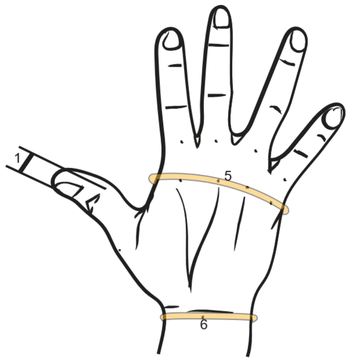
PURPOSE

The purpose of this research was to test the accuracy of developed automatic measurement systems on 3D hand scans compared to conventional manual digital measurements.

METHOD

Participants were selected from a database of 800 3D hand scans that was collected during 2019 Minnesota State Fair. Fifteen 3D, full-color right- handed scans were selected based on manual hand breadth percentiles (min/ 5%/ 25%/ 50%/75%/95%/max). All scans are scanned using Artec Leo. Prior to scanning, the hand of the participants was landmarked with a washable marker.





1. Thumb Breadth	2. Hand Breadth	3. Hand Length
4. Wrist-Index Finger Length		
5. Hand Circumference	6. Wrist Circumference	7. Palm Length

Seven measurements taken in Manual and automatic measurements using the same digital landmarks. For manual measurements, each measurement was taken 3 times in Anthroscan and recorded. Anthroscan 2018(version 3.6.1) by Human Solutions GmbH was used for digital landmark placement and extracting the dimension. Programs for automatic measurements were developed in Visual Studio (Microsoft) using VB script.

Automatic Measurement (A)

For automatic measurements, the physical landmarks were relocated digitally. Then, the system extracted the dimensions automatically using a program written in Microsoft Visual Studio.

Conventional Measurement (C)

For conventional measurements (C), physical landmarks and dimension measurement were done manually on Anthroscan by a skilled measurer. Each measurement was measured three times to avoid measurer's error.

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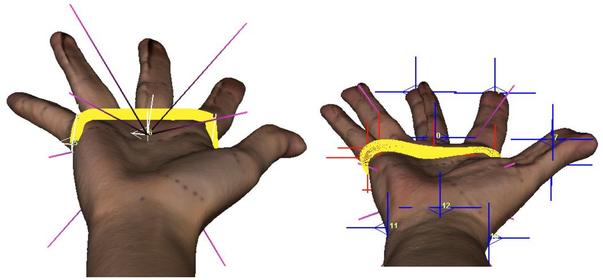
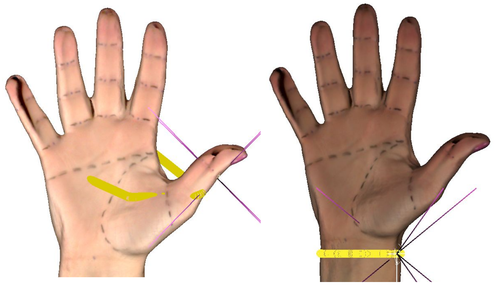
Semi-Automatic Measurements (Sa)

Here, the automatic measurements are applied first and if there was significant aberration from expected course of measurement then, it was adjusted by an operator to follow the intended path as much possible.

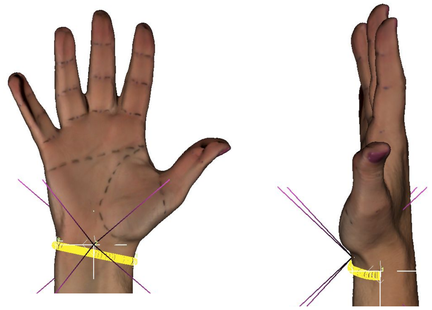


Split in Circumference

During automatic measurement for circumference measure using 'takeClosedTapeMeasure', it was found that the tape took undefined path.



So, the circumference measurement divided into halves to connect all landmarks. 'takeOpenTapeMeasure' function used for the measurement.



RESULT

- Basic statistics and mean difference for Conventional (C), Automatic (A), and Semi-Automatic (SA) measurements were calculated. The type-I error rate was assumed to be α= 0.05. For conventional and automatic measure, no difference was found for linear measures. But for circumference measures, a statistically significant mean difference found between conventional and automatic technique. The reason found to be the taken unintentional path in automatic measuring system.

Dimensions	Mean Conventional Measure MCM	Mean Automatic Measure MAM	Mean absolute difference MAD(A)	MD (A)=(MCM-MAM) t-test	SD of MAD(A)	SD of MD(A)	CV of MD(A)	Percent difference (MCM-MAM)
Hand Breadth	8.59	8.59	0.00	0.00	0.00	0.00	NaN	0.00%
Hand Circum.	20.38	21.20	0.82	-0.82***	0.48	0.48	-0.59	-4.02%
Hand Length	10.67	10.67	0.00	0.00	0.00	0.00	NaN	0.00%
Palm Length	10.67	10.67	0.00	0.00	0.00	0.00	NaN	0.00%
Thumb Breadth	2.21	2.21	0.00	0.00	0.00	0.00	NaN	0.00%
Wrist Circum.	16.80	17.49	0.69	-0.69***	0.37	0.37	-0.54	-4.11%
Wrist-Index Finger Length	17.64	17.64	0.00	0.00	0.00	0.00	NaN	0.00%

*p<0.05, **p<0.01, ***p<0.001

- So, semi-Automatic system used for the circumference measurement by manipulating the landmark position slightly keeping the physical landmark aligned. After analysis, there is still statistically significant difference for mean difference of circumference measures. But it has an improved result compared to automatic measurement

Dimensions	Mean Conventional Measure MCM	Mean Semi-Automatic Measure MSaM	Mean absolute difference MAD(Sa)	MD(Sa)= (MCM-MSaM) t-test	SD of MAD(Sa)	SD of MD(Sa)	CV of MD(Sa)	Percent difference (MCM-MSaM)
Hand Circum.	20.38	20.83	0.45	-0.45***	0.24	0.24	-0.53	-2.21%
Wrist Circum.	16.80	17.46	0.66	-0.66***	0.40	0.40	-0.61	-3.93%

*p<0.05, **p<0.01, ***p<0.001

*MCM= Mean Conventional Measure ; MAM= Mean Automatic Measure; MAD = Mean absolute difference; MD= Mean Difference

CONCLUSION

For linear measurements of 3D hand scans, automatic measuring technique is an accurate and reliable method when for circumference measurements and surface measurements, a semi-automatic measurement method showed improved result. Automating measuring process will make 3D scanning affordable for industrial use.