Improvements in 3D Body Shape and Measurement Accuracy from Size Stream

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Abstract

Mobile 3D scanning offers a low-cost, user-friendly solution for capturing body measurements critical to health and fitness monitoring as well as the construction of custom made-to-measure apparel. Ongoing advancements to the Size Stream platform have significantly improved the accuracy of both 3D body shape and body composition estimates, particularly with respect to body fat percentage, an increasingly important metric in the context of semaglutide-based weight loss treatments. Since our last release, body fat mass (kg) estimates have achieved R^2 values of over 0.96, demonstrating substantial gains in accuracy. Improvements in silhouette-based 3D shape reconstruction also enable more accurate representation across a wider range of body types, with notable gains for users with high BMI. The measurement of various circumferences, areas, and volumes of crucial body features has also improved, especially in terms of repeatability, so users can better track their progress. This paper details the latest enhancements to our mobile platform and their impact on the precision and reliability of biometric measurements for both apparel and health applications. Mobile scanning continues to prove its value as an accessible tool for tracking body metrics over time.

Keywords: 3D body scanning, machine learning, mobile scanning, body fat measurement, body composition

1. Introduction

The three-dimensional shape of the human body offers critical insights into an individual's health and general well-being. Unlike simpler methods such as tape measurements, weight scales, or Body Mass Index (BMI) calculations, optical body scanning enables a more comprehensive assessment of factors like musculature, fitness, and fat distribution, while proving less invasive than X-ray or millimeter wave technology. Lately, mobile scanning with RGB images or depth sensors on smartphones or tablets has offered a more accessible alternative to larger booth scanners, leveraging technology that users already own and are familiar with. This technology has seen rapid adoption; for example, Size Stream's mobile platform, MeThreeSixty, currently performs nearly 100,000 scans per month. An additional advantage of mobile scanning is the ability to scan frequently, as often as weekly or daily, allowing users to track their health metrics over time. This makes mobile scanning an effective middle ground between infrequent office or clinic visits and continuous monitoring via wearables, which are not yet reliable for body composition assessment [1].

Mobile scanning is especially appealing for individuals monitoring body fat percentage, as other traditional at-home methods such as foot-to-foot bioimpedance devices are quite limited in accuracy and often cannot be used for clinical-level assessments [2]. The gold standard for body fat percentage estimation is the four-component (4C) method [3], which combines body volume, bioimpedance, and dual-energy X-ray absorptiometry (DXA). Of these, the DXA scan is often considered the most critical component and is commonly used on its own due to its accuracy. While DXA scans are becoming more accessible at medical spas and health clinics, they remain costly, and expose users to ionizing radiation. Mobile scanning, therefore, fills an important gap between these high-cost, high-accuracy scans and simple at-home methods, offering a low-cost, non-invasive, and repeatable alternative. With the increasing popularity of semaglutide-based medications, tracking body fat percentage becomes particularly important, as these medications may accelerate muscle and lean mass loss especially in certain conditions [4], and requires more continual monitoring.

Beyond body composition, 3D scanning also enables the measurement of circumferences and surface areas of various parts of the body for tracking fitness and enabling the construction of made to measure apparel, a historical focus of Size Stream. While accuracy is crucial, we find that our health and fitness users often prioritize precision and the ability to detect small, consistent changes over time. The algorithms for extracting these measurements from a set of images (or binary silhouettes, in Size Stream's use case) are constantly evolving, and we find that substantial gains in accuracy are still possible as the technology continues to be adopted.

In this paper, we present recent advancements in Size Stream's mobile body scanning technology, including improvements in 3D body shape capture, body fat percentage estimation, and measurement accuracy. We report results from two studies: one to evaluate mobile-based body fat estimation, and another conducted to assess improvements in measurement accuracy and repeatability on the MeThreeSixty platform. Our findings demonstrate that by leveraging cutting-edge AI algorithms, mobile scanning continues to improve in accuracy and reliability. Most notably, our latest body fat estimates show strong agreement with high-fidelity DXA measurements, unlocking a strong potential future for the use of this technology.

2. Methods

2.1. Experiment to evaluate prediction of body fat percentage as compared to DXA

For assessing the efficacy of Size Stream body fat mass estimation, a study was conducted with 46 participants (21 male, 25 female). The participants' "true" fat mass was determined after scanning with a dual energy X-ray (DXA) device (GE Lunar Prodigy, Encore v17 software). After scanning with DXA machines, the participants scanned twice using Size Stream's mobile application MeThreeSixty, and measurements for body fat percentage and body fat mass were compared. Two algorithms for determining body fat percentage were assessed; Size Stream's production technology reporting body fat percentage from January 2025, versus the latest algorithm released in June 2025. Summary statistics for demographic data from the participants in the study are presented below (Table 1).

Variable	Statistic	All	Female	Male
Subjects	n	46	25	21
Height (cm)	Min	148.2	148.2	156.0
	Max	190.9	174.5	190.9
	Mean	168.90	163.84	174.91
	Std	8.99	6.17	8.15
Weight (kg)	Min	44.5	44.5	59.7
	Max	130.9	130.9	116.2
	Mean	77.09	73.09	81.86
	Std	18.63	19.85	16.26
BMI	Min	18.1	18.1	22.4
	Max	49.0	49.0	43.5
	Mean	29.00	27.60	30.67
	Std	6.81	7.17	6.09
Age	Min	18.0	19.0	18.0
	Max	65.0	53.0	65.0
	Mean	38.67	37.08	40.57
	Std	11.62	9.64	13.61

Table 1. Population summary statistics for the body composition study.

2.2. Experiment to determine improvements in anthropometric measurements

A cohort of 60 participants were tested at Size Stream HQ in Cary, North Carolina (30 male, 30 female), with a range of BMI and height values. All participants were scanned 3 times using a Size Stream SS20 booth scanner. Between scans the participants were given approximately 30 seconds to 1 minute and asked to relax then readjust their posture using the hand and foot guides in the system. Each of the three scans used the 5x multiscan setting on the SS20, where 5 snapshots are combined into one composite scan. The measurement values for circumferences, areas, and volumes were extracted using Size Stream's proprietary SizeMeasure software, and median values were selected as truth for determining accuracy.

After scanning with the booth scanner, all 60 participants were subsequently scanned with a Size Stream MS-1 scanner, a self-guided system which produces 3D scans from front and side images taken with the ultrawide angle camera of a tablet device. A subset of 40 (20 male, 20 female) were additionally scanned with our equivalent mobile phone application (MeThreeSixty) using the front-facing camera. Each scan was repeated 5 times to assess precision (repeatability) and produced measurements directly to be compared to the SizeMeasure measurement output from the SS20 scans. Two algorithms were used to produce measurements from the scans: our production system from pre-January 2025, and the latest system as of August 2025.

Size Stream provides an expansive list of 241 different measurements related to circumferences, areas, and volumes of various parts of the body identified by landmark features. The predictions of these 241 measurements were compared in aggregate, using mean coefficient of variation (CV) percentage to assess precision (repeatability) of the measurements, and using standard deviation in percent error (SD) of the predictions as well as mean absolute percent error (MAPE) of the predictions in order to assess accuracy. A few core measurements were also compared individually; collar, chest, stomach max, seat circumference, bicep, waist, and sleeve length. Body fat percentage is also shown for precision (repeatability); but, no "truth" data for body fat was collected in the study, so accuracy metrics could not be determined for this measure.

3. Results

3.1. Improvements in Body Fat Estimation

The performance of our latest mobile phone body fat percentage is plotted below, achieving new benchmarks for Size Stream performance by leveraging current advancements in AI techniques. Presented in a prior work [5], our algorithm as of January 2025 utilized a calculation from a series of physical body measurements referencing circumferences and areas predicted from our system [6]. However, the latest algorithm predicts body fat percentage from the mobile images directly. We find the new system to offer even greater accuracy: in terms of body fat percentage, our predictions improve from R^2=0.834 to R^2=0.881, which is on par with high-cost octapolar bioimpedance machines [2]. The correlations are even greater for fat mass, where we improve from R^2=0.947 to R^2=0.962. Biases are slightly larger in the new system, but still remain under 1 kilogram. Standard deviations of errors are 3.46% and 2.46 kg, respectively.

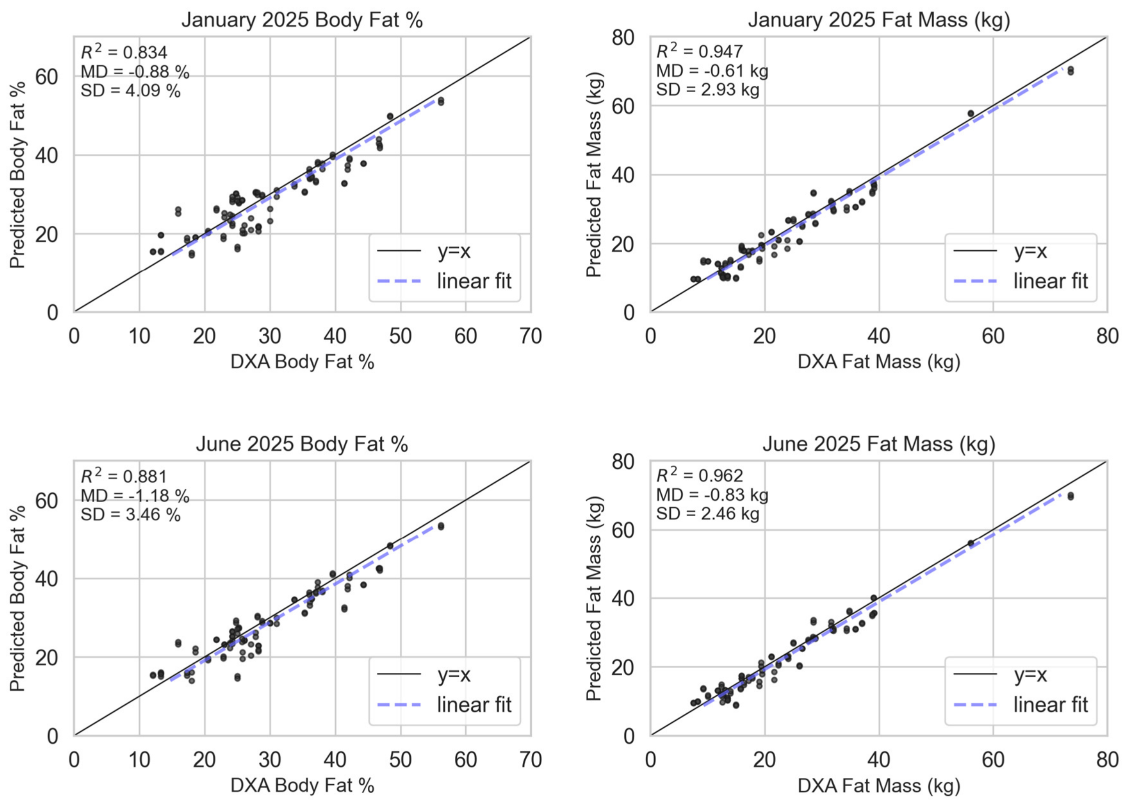

Fig. 1. Performance of the latest regressor for Body fat mass (kg) and Body fat percentage from mobile phone scans (n=46 individuals).

The predictive relationship is mostly consistent across a range of values, although there is a small tendency to overpredict low body fat percentages and underpredict high body fat percentages (Figure 2). There are small negative biases present in all systems along the order of 1%. For the latest algorithm June 2025, the limits of agreement were 6.9% and 4.9 kg for body fat percentage and body fat mass, respectively.

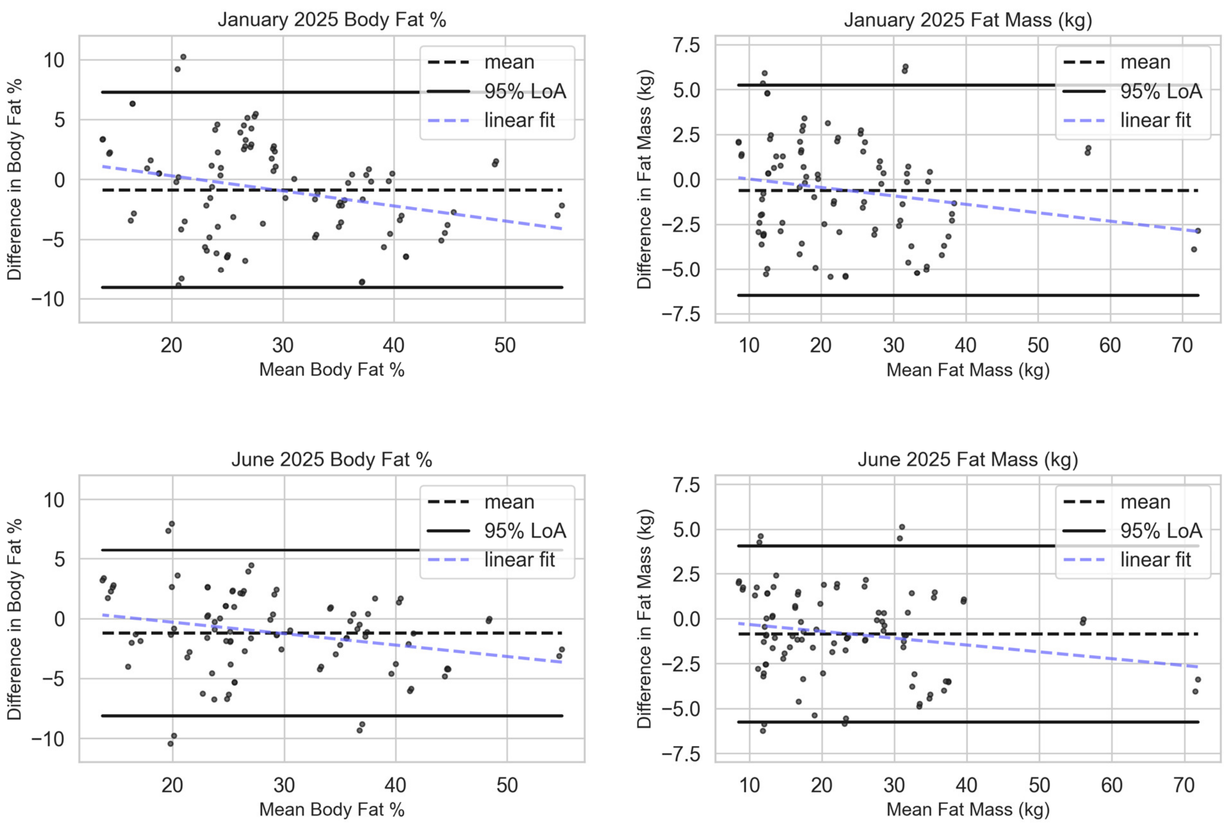

*Fig. 2.Bland-Altman plots for body fat percentage and fat mass for both the January and June 2025 releases of MeThreeSixty. Differences on the y-axis for each plot are shown as our predictions minus the DXA measurements. LoA: limits of agreement at 95%, determined as mean +/- 2*standard deviation. A linear fit is also shown to show the overall trend of the relationship.*

3.2. Improvements in Body Shape representation

Further advancements to the Size Stream's algorithms have provided additional detail for reconstructing body shapes in 3D, especially with respect to high BMI individuals with complex body geometry. Shown are examples of select scans from the measurement improvement experiment (2.2), where SS20 booth scan data is shown along with reconstructions from synthetic front and side silhouettes of the scan (Figure 3). Both the pre-June 2025 and post June-2025 updates are shown, with increased detail and better alignment with the original geometry. Also depicted are current in-progress efforts at Size Stream to add further detail and accuracy to the geometry.

3.3. Improvements in body measurements

Size Stream's body measurements include an extensive list of circumference, area, and volume measurements which can be useful for individuals tracking progress to achieve health, fitness, or weight loss goals. The measurements are also useful in creating custom made-to-measure apparel. Latest advancements have resulted in greatly increased repeatability: performance is boosted by up to 50%. We additionally find that this increased repeatability did not greatly impact accuracy; leading to only a small 4% decrease in males, but an increase of around the same in females (Figure 4.).

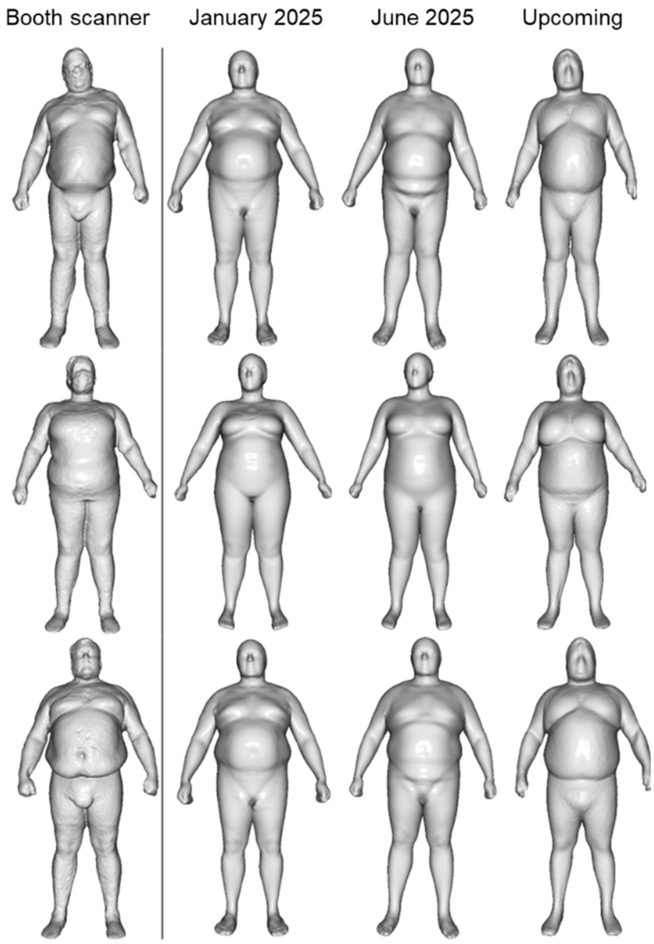

Figure 3. Comparison of new body shape progression for latest Size Stream mobile scanning solution, comparing booth scanner results using an SS20 booth scanner to processed results from front and side images taken with the mobile phone app MeThreeSixty. Increased detail and asymmetries show progress in body shape representation, especially for high BMI individuals.

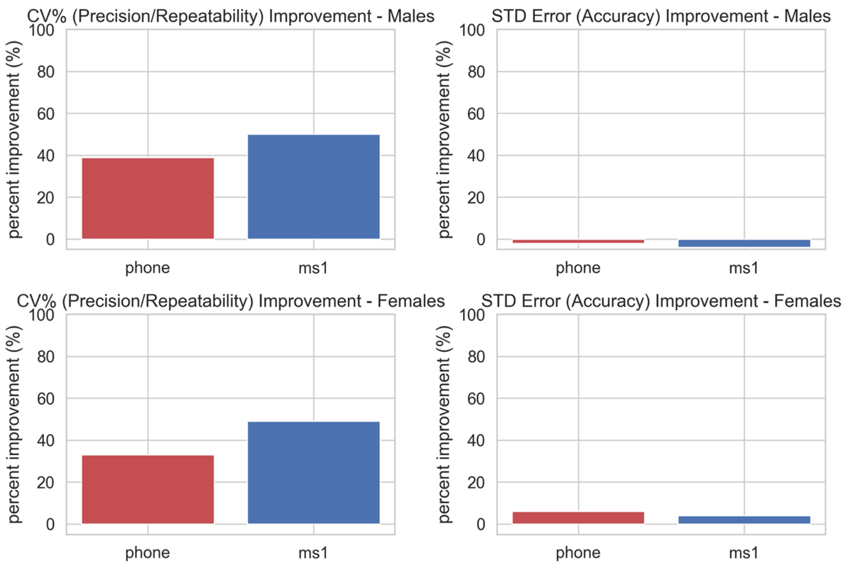

Figure 4. Aggregate improvements in Size Stream's algorithm from pre-January 2025 to post-January 2025 averaged across the full suite of 241 measurements that Size Stream provides. Phone refers to performance of our mobile phone application MeThreeSixty, while ms1 refers to the performance of our equivalent tablet-based system MS1. Left column: Increase in coefficient of variation, expressed as a percentage, showing enhanced repeatability. Right column: Change in standard deviation (accuracy) compared to measures from SS20 booth scanner.

Measurement	CV (Male)	MPE (Male)	STD% (Male)	MAPE (Male)
Collar	0.74	−3.38	4.19	4.27
Chest	0.68	−0.68	3.37	2.78
Max Stomach	0.78	−1.67	2.53	2.62
Seat	0.55	0.08	2.94	2.10
Bicep	1.04	−1.11	3.77	3.15
Waist	0.72	−0.18	3.15	2.55
Sleeve Length	0.41	−0.31	1.61	1.34
Body Fat %	2.10			
Measurement	CV (Female)	MPE (Female)	STD% (Female)	MAPE (Female)
Collar	0.76	−2.15	6.72	5.02
Chest	0.56	−1.01	3.31	2.73
Max Stomach	0.67	−2.94	2.16	2.90
Seat	0.48	−0.99	2.10	1.89
Bicep	0.87	−1.07	5.23	4.08
Waist	0.69	−3.50	4.10	3.88
Sleeve Length	0.51	−0.84	1.85	1.49
Body Fat %	1.09			

Table 2. Results from experiment 2: Size Stream's latest numbers for expected precision and accuracy from the MeThreeSixty mobile phone system for a set of critical measurements. CV: coefficient of variation, expressed as a percentage: defined as standard deviation divided by mean for 5 repeated scans by the same individual. MPE: mean percent error, depicting bias in the measurements. STD%: the standard deviation of percent error, assessing the accuracy of the measurements relative to the SS20 booth scanner. MAPE: the mean absolute percent error, another view of accuracy relative to the booth scanner. MPE, STD%, and MAPE are not shown for Body Fat %, as no truth data was collected for body fat % in this experiment.

Accuracy and precision metrics for the production system of MeThreeSixty (as of August 2025) are shown in Table 2 for a set of 7 most important anthropometric measurements and body fat percentage. In terms of precison/repeatability, we achieve under a 1% variation for the majority of measurements, showing a high degree of measurement consistency. Biases are also quite small and typically fall under 2%, assessed by MPE. In terms of error, we find that mean absolute percent error is between 1.3% and 5% across the board as compared to Size Stream's prior booth scanning system (SS20). Overall, we find the current production level to be sufficient for both tracking health/fitness changes as well as constructing made to measure garments.

4. Discussion

Recent advancements in Size Stream's algorithms have enhanced the functionality and accuracy of mobile phone–based 3D body scanning technology. Key improvements include more accurate body composition estimation, more repeatable anthropometric measurements, and enhanced 3D body shape reconstruction. A particularly significant development is the improvement in body fat estimation: the updated system demonstrates performance comparable to that of high-end, research-grade bioimpedance devices. Specifically, the algorithm achieves a standard deviation of error of just 2.46 kg for fat mass and a correlation of R^2=0.96. Importantly, this level of precision is attained without the need for supplementary hardware or increased cost, thereby improving accessibility and broadening the potential applications of body composition analysis.

Enhancements in the reliability and consistency of anthropometric measurements are also noteworthy. For users of the MeThreeSixty platform, tracking subtle changes in waist circumference, muscle definition, and overall body shape is particularly valuable. The integration of AI-driven algorithms has yielded a more than 40% improvement in measurement precision compared to earlier Size Stream versions, while maintaining strong alignment with outputs from the SS20 booth scanner system. The majority of measurements vary by under 1% after repeated scanning, and have error standard deviations of under 5%.

Progress has also been observed in the domain of 3D body shape reconstruction from mobile scans. Unlike other platforms that rely on RGB image data, MeThreeSixty employs only front and side silhouette inputs to preserve user privacy, which introduces additional challenges in reconstruction accuracy. Nonethless, recent algorithmic refinements have substantially improved shape extraction from silhouettes with particularly notable gains observed in scans of individuals with higher BMI, which may present especially challenging body geometries.

Overall, mobile scanning technology occupies a unique and promising position between continuous-monitoring wearable devices and high-cost, clinical-grade assessment tools such as booth scanners or DXA machines. In the context of body fat estimation, mobile 3D scanning offers a compelling alternative to other at-home solutions, demonstrating both high accuracy and scalability. As the technology continues to evolve, it is poised to play a growing role in personal health monitoring and longitudinal tracking of body composition.

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