Improvements in Mobile 3D Body Scanning and Body Measurements

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Abstract

As mobile 3D body scanning continues to provide cutting edge solutions in creating made-to-measure garments and tracking body health and fitness, Size Stream has continued to refine its technology to deliver a smooth, user-friendly scanning experience and high-quality measurements. In this presentation, we present information about our latest mobile scanning solutions with new technologies leveraging the human silhouette boundary by using machine learning and computer vision techniques. We will provide quantitative analyses of the measurement quality of our latest scanning solutions, comparing them to our previous mobile solutions and larger booth-sized body scanners. Our analyses show that our new solutions provide faster and more accurate measurements of key body areas, including the waist, stomach, and collar, which are essential for the creation of custom-fit garments. Measurement performance is consistent across a wide range of body types and sizes, and body shape is more accurately represented in the 3D avatar. The result is a highly accurate and efficient method for capturing body measurements that can be used for a variety of applications in the fashion and apparel industry, including virtual try-on and sizing recommendations, as well as Size Stream's own made-to-measure garment construction.

Keywords: 3D body scanning, machine learning, mobile scanning, apparel

1. Introduction

Although fixed-in-place booth scanners have provided highly accurate 3D body measurements for some time [1], recent efforts in mobile scanning technologies have begun to offer similar performance at a fraction of the cost and significantly easier installation and operation [2], [3]. Size Stream's technology continues to reach more and more end users; our most popular mobile application, Me Three Sixty, reached one million scans in July 2023. As the rate of scanning increases and retail stores begin to adopt mobile scanning technology for constructing made-to-measure garments, new challenges emerge which require novel approaches in computer vision and 3D body reconstruction.

In this work, we demonstrate the capabilities of new and upcoming advancements to Size Stream's mobile scanning solution, in which users are guided to take a front and side image of themselves with a smartphone or tablet device and receive a 3D scan and measurements. Improvements in image segmentation enhance the quality of front and side silhouettes and deliver higher quality data to users. Enhanced reconstruction algorithms also provide additional robustness to problematic scan poses that can lead to undesirable scan defects. We also achieve heightened accuracy in capturing body shapes, particularly for individuals with high BMI.

The advancements herein contribute to increases in both precision and accuracy in garment measurements obtained through our mobile scanning solution. We also outline future efforts to reduce the time it takes to receive a scan, with the aim of streamlining the process and increasing user satisfaction. In addition to health and fitness applications of 3D body scanning, preliminary results detailing customer return rates suggest our current measurement accuracy may also be suitable for constructing made-to-measure garments.

2. Results

2.1. Improved image segmentation quality for front and side silhouettes

Image segmentation serves two roles in our mobile body scanning technology: increasing the precision and accuracy of body measurements, as well as preserving customer privacy when users opt not to upload their photos. We have developed improved segmentation techniques combining both machine learning methods and more classical techniques to improve the quality of the boundary separating the scan participant from background. The result is the mitigation of many common issues associated with image segmentation, such as background clutter and gross errors within the body (Fig. 1.), both of which have historically been significant sources of scan failure. By overcoming these obstacles, our new segmentation methods significantly enhance the robustness and reliability of the scanning process.

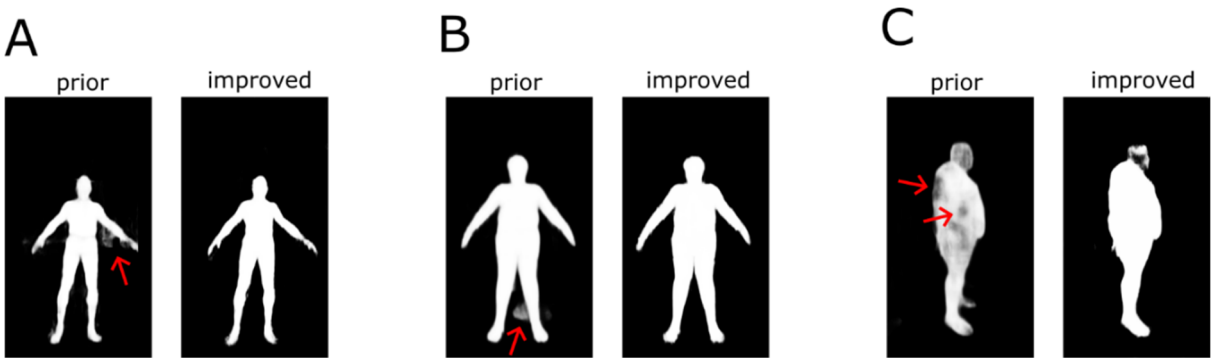

Fig. 1. Improved segmentation quality for mobile scan processing. New segmentation techniques reduce clutter in the background, increase silhouette sharpness, and reduce gross errors within the body. All segmented images A), B) and C) originally led to mobile scan errors; with improved segmentation, accurate 3D body models can be constructed for all 3 scans.

2.2. Improved accuracy for problematic scan poses in mobile scanning

Our mobile scanning solution requires a front and side silhouette to create a 3D scan. Deformations of these silhouettes can introduce defects into our scanning process and are key contributors to scan failure. Common pose errors that obscure parts of the body in the side profile, such as the arms or elbows blocking the shape of the back, as well as the hands obscuring the thighs, are especially problematic. To address these issues, we incorporated additional algorithms designed specifically to safeguard against and correct these distortions. Visually, our enhanced scanning process yields large improvements in the representation of the scanned body (Fig. 2.), and in addition, the improvements lead to more accurate measurements and less failed scans.

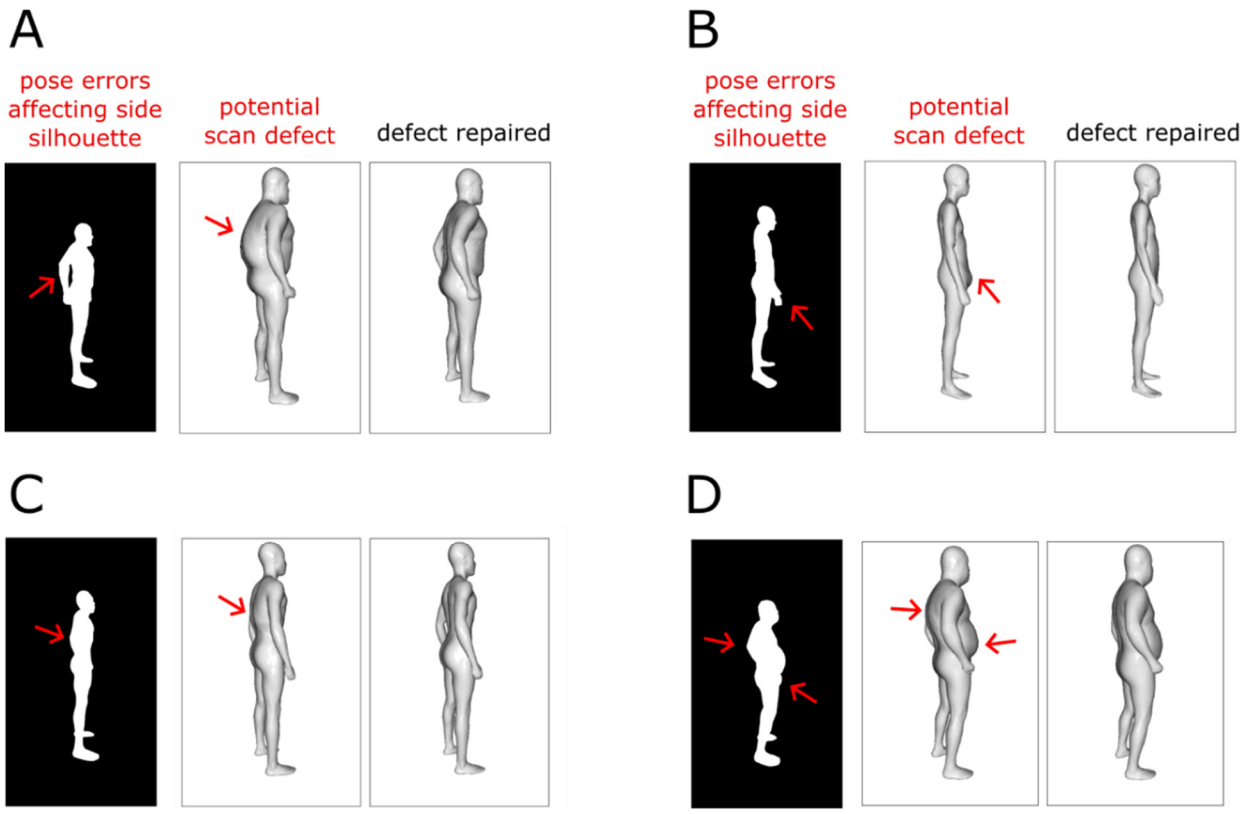

Fig. 2. Improved robustness to pose errors during mobile scanning. Poses which cause significant disruption in the side silhouette can normally lead to scan defects; however, new techniques allow for better scanning in these conditions.

2.3. Improved body shape for high-BMI scan participants

Novel body reconstruction algorithms in development have yielded significant improvements in the level of detail captured on scan subjects, particularly among individuals with high BMI. Such individuals can be especially challenging to represent accurately in 3D, but our analysis demonstrates notable enhancements in several key regions, including the chest, stomach, and waist (Fig. 3.). Among the most noteworthy outcomes, we observed a significant improvement in our system's capacity to generate accurate measurements for pants, opening up additional avenues for tailoring custom-fit clothing. Additional accuracy is also important for healthcare and fitness applications, as many use 3D scanning for tracking and managing body composition information.

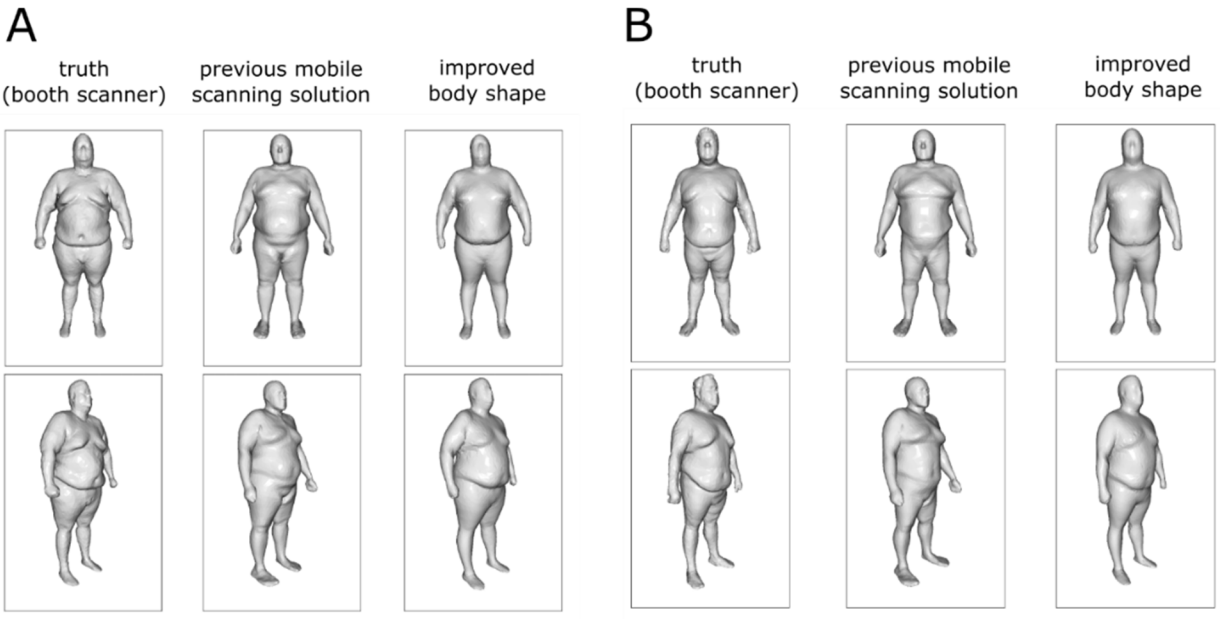

Fig. 3. Improved body shape accuracy for high BMI scan participants. Two example high BMI scans are shown (A, B). The chest, waist, stomach and legs are notably improved visually, with more accurate measurements as well.

2.4. Improvements in body measurements and made-to-measure garment construction

For body measurements used to construct garments, our current algorithm provides the highest level of measurement precision yet achieved by Size Stream, reaching approximately 1% CV (Coefficient of Variation) for our key measurements (Fig. 4.). Amidst individual scan variability, more consistent measures across scans help to validate measurement accuracy and enhances user trust in the system. In addition to the repeatability of measurements, the accuracy of our mobile system relative to fixed booth scanners has also increased, with the latest scan technology improving key measurements by 5-30% over the last year (Fig. 5.).

Our current level of measurement accuracy appears sufficient for the construction of custom-fit garments in a few preliminary datasets. Early in 2023, Size Stream began deploying our mobile technology scan solution for men's made-to-measure clothing into retail men's clothing stores, where it is now in use at over 20 locations. Shirt return rates from these stores are currently running in the low single digits, demonstrating high customer satisfaction and general quality of fit. In addition, a small internal study of 13 participants was conducted to specifically assess the performance for high BMI individuals; all 13 participants were satisfied with their made-to-measure shirts. We plan to conduct further analysis of garment return rates as we collect it along with our retail partners.

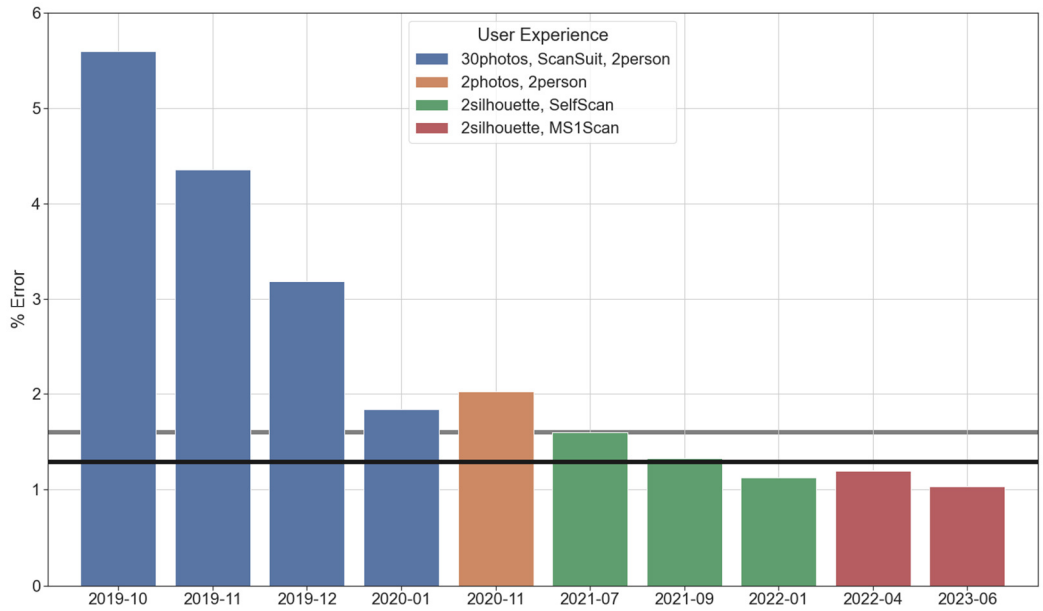

Fig. 4. Improvements in precision of Size Stream mobile scanning solutions over time since 2019, as compared to traditional booth scanners (black and grey lines). Reported is the mean CV% (Coefficient of Variation) for 7 key body measurements: Collar, Chest, Waist, Thighs, Biceps, Sleeve length, and Shoulder width. Precision is favorable to prior solutions including custom scan suits and RGB photo solutions.

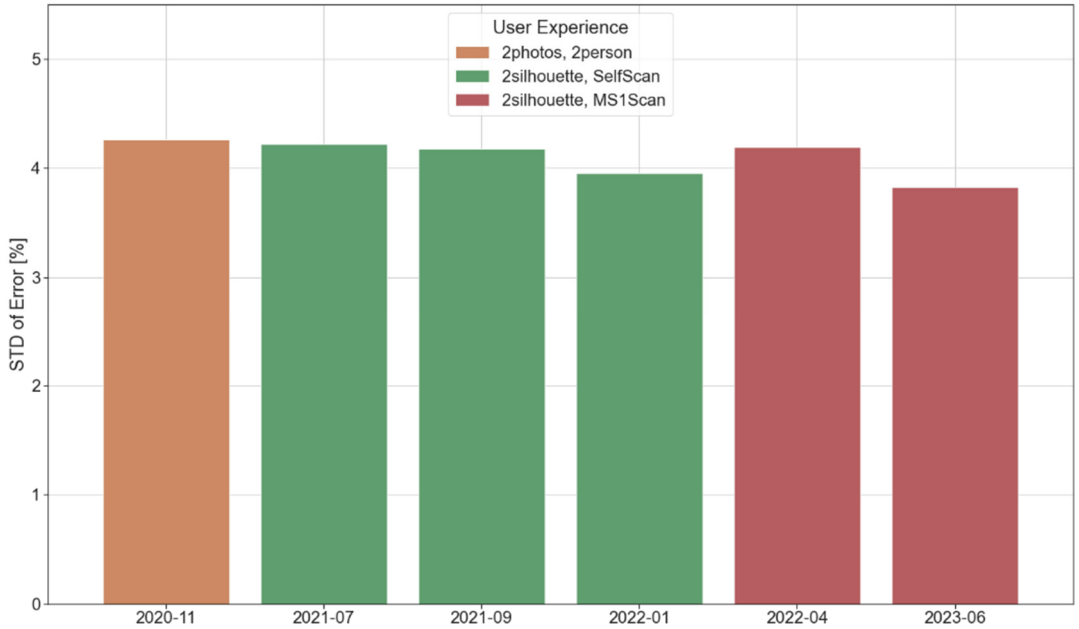

Fig. 5. Improvements in measurement accuracy for Size Stream's mobile scanning solutions since 2020. Reported is the standard deviation of % error for 7 key body measurements: Collar, Chest, Waist, Thighs, Biceps, Sleeve length, and Shoulder width.

2.5. Future efforts to reduce scan time

Current research efforts are underway to provide substantially improved scan times by reducing processing time in the cloud. With the planned improvements, we hope to achieve up to a 67% reduction in scan time, with a full scan returning to the user in approximately 30 seconds. With additional planned efforts we hope to achieve even greater reductions, with scans processing in only a few seconds (Fig. 6.).

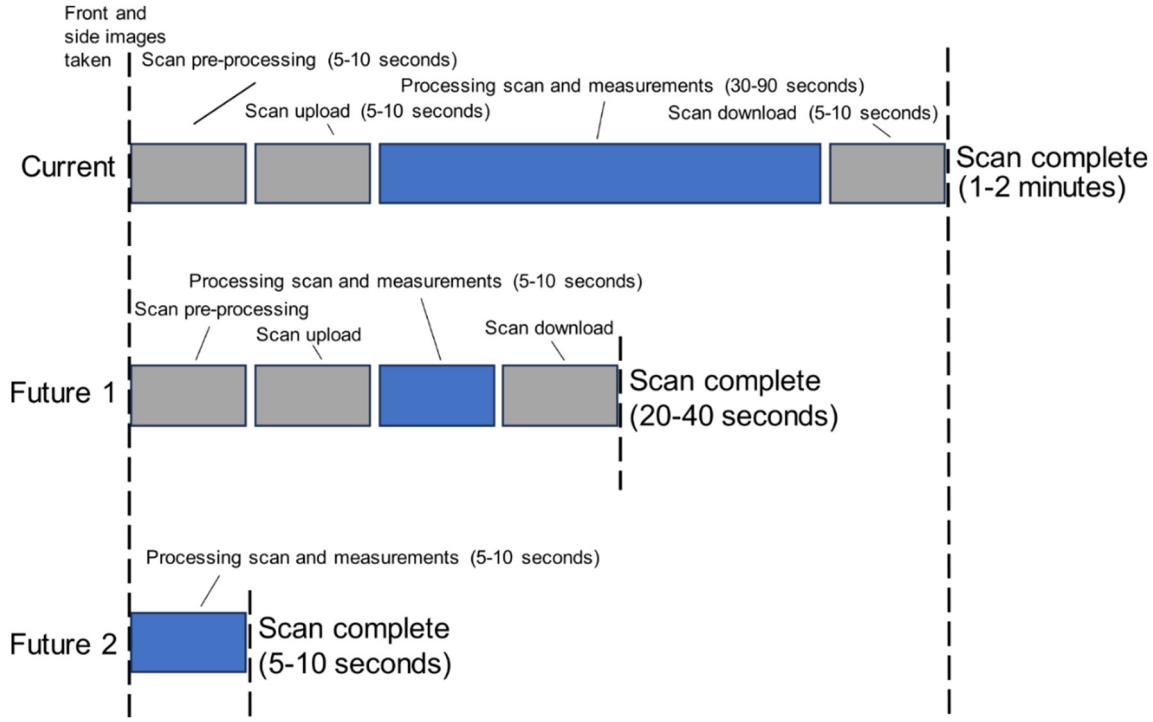

Fig. 6. Future efforts to decrease scan time. With current research, we expect to be able to reduce total scan time from 1-2 minutes down to 30 seconds (Future 1), and eventually to under 10 seconds (Future 2)

3. Discussion

Size Stream continues to innovate in the space of mobile scanning technology, with the latest systems rivaling the accuracy of traditional booth-size scanners at a fraction of the cost and substantially greater ease of use. In July of 2023, we reached 1 million scans on our largest mobile application, Me Three Sixty, which is primarily used to track health and fitness goals. In tandem, we are beginning to see positive results in using mobile body scan data to construct made-to-measure garments, with high customer satisfaction in our early results.

As our technology reaches more users, we continue to develop new strategies to increase both the ease of use and accuracy of scanning. With improved image segmentation, users can get high-quality scans whether at home or in retail stores, and with the development of more advanced and complex body models, we can accommodate more shapes and sizes of individuals with greater accuracy. Additional efforts help to reduce the frustrations of scan failures by relaxing pose guidelines for image capture, and future work will see users receive their scan data more quickly. Overall, mobile scanning shows great promise as an alternative to fixed booth scanners to provide rich and detailed 3D body information for health, fitness, and custom made-to-measure apparel applications.

References

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