

17th 3DBODY.TECH Conference & Expo

Lugano, Switzerland · 20-21 October 2026

Book of Abstracts

3DBODY.TECH 2026

17th International Conference & Expo on

3D/4D Body Technologies

Lugano, Switzerland, 20-21 October 2026

<https://3dbody.tech>

Editor and Organizer

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OPENING SESSION

3DBODY.TECH 2026 - Introduction - Welcome Speech from the Conference Director

Nicola D'APUZZO

Hometrica Consulting, Ascona, Switzerland

#00

3DBODY.TECH 2026 - The 17th International Conference & Expo on 3D/4D Body Technologies, took place on 20-21 October 2026, in Lugano, Switzerland.

3DBODY.TECH 2026 was held as a full in-person event with conference and expo taking place at the Lugano convention center, with all speakers presenting onsite and all contents streamed live online and recorded for later view. The large majority of attendees participated onsite, online participation was available for remote attendees.

3DBODY.TECH 2026 was organized by Hometrica Consulting - Dr. Nicola D'Apuzzo, Switzerland.

3DBODY.TECH Conference & Expo, the premier multidisciplinary international conference and expo on 3D/4D human body scanning, body data and body processing technologies, provides a platform of eminent professionals, entrepreneurs, academicians and researchers across the globe to present, learn and discuss the latest in 3D/4D human body scanning, body data and body processing technologies.

The multidisciplinary and international character of 3DBODY.TECH makes it unique and not comparable to any other meeting related to 3D/4D body technologies, , and its size makes it ideal for networking opportunities.

3DBODY.TECH website <https://3dbody.tech> gives all information related to this event.

The contents of the presented works at the conference are related, but not limited to, the following technical areas:

- 3D & 4D body and 3D & 4D face scanning methods, systems and technologies
- 3D & 4D body data use and processing, 3D & 4D body processing methods and technologies
- 3D body modeling, 3D body visualization, 3D body printing methods and technologies
- Digital humans, virtual humans, avatars
- Active and passive 3D & 4D scanning technologies for the human body (body, face, legs, feet, etc.)
- 4D scanning, volumetric capture and MOCAP technologies for the human body
- Mobile, portable and hand-held human body scanning and measurement systems, devices, solutions
- ML and AI for 3D & 4D body scanning, processing, modeling
- Full body scanning and measurement systems for apparel & fashion, workwear & uniforms
- 3D virtual fitting, 3D digital fashion, 3D cloth simulation, virtual mirrors
- Applications in medical sciences (plastic surgery, orthotics, prosthetics, forensics, dermatology, etc.)
- Foot scanning and measurement systems for footwear, sport and orthopedics
- Digital anthropometry, anthropometric studies
- Body data, body measurement and sizing campaigns
- Biometrics and applications in security
- Applications in sport, health and fitness
- Applications in VFX, games, entertainment, metaverse, virtual life
- Applications in social sciences, and communication

These proceedings gather all papers, abstracts, demonstrations and presentations of the 17th 3DBODY.TECH Conference & Expo.

The website <https://proc.3dbody.tech> is dedicated to the proceedings of the series of 3DBODY.TECH Conference & Expo on 3D/4D Human Body Scanning, Body Data and Body Processing Technologies and their contents.

The abstracts, papers and presentation videos (when available) of over 1K publications/presentations included in the proceedings of all conferences and workshops are accessible at the website. The full papers are freely available for download as single PDF documents. The recordings/videos of the single presentations and/or live demonstrations are freely accessible (when available).

The entire proceedings in digital form (html structure, PDF files, presentation videos, entire sessions recordings) are available for purchase.

TECHNICAL SESSION 1: Digital Anthropometry & Ergonomics/HF

How Human Factors Hardware Can Accelerate Product Development

Emily BARTLETT

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#07

Abstract not available

Development of a Study Design Generator for Standardized Anthropometric and Ergonomic Evaluation

Laura AHSMANN, Jelle HARBERS

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#11

Background: Ergonomic and anthropometric surveys require strict and consistent methodology to ensure long term validity, especially when it is used for occupational health and performance research. Although data collection is time-consuming, many large datasets have limited value due to missing data points (for a specific purpose) or deviation in measurement methods. Objective interpretation, comparison and repetition of ergonomic evaluations require a clear and standardized procedure. This procedure should state which anthropometric, mobility, and fit-related metrics should be included and a methodology on how to collect the data. To make a first step towards that end-goal, demonstrator toolkit was developed for the Dutch Defense Clothing and Equipment company.

Gap: Ergonomic and anthropometric surveys lack consistency in data collection methods and are often incomplete for the varied applications. Especially for the evaluation of clothing and Personal Protective Equipment (PPE).

Objective/Aim: To develop a digital toolkit that supports study protocol design and the collection of relevant anthropometric data for fit-related applications.

Methods: The study began with identifying the various protocols used in published research efforts - such as workspace accommodation, fit and mobility - and consolidating their study design parameters into a single datasheet. Next, a demonstrator toolkit was developed that provides a simple workflow for selecting key parameters based on user inputs, such as study goals and configuration variables. Anthropometric guidelines are based on ISO7250 and ISO8559. For some metrics - such as mass and stiffness - no formal standards exist; these are based on common practice reported in the literature. UX design was developed following several iterations of feedback.

Results: The process of building the study design generator-tool uncovered the complexity of standardization protocols, even within one topic such as anthropometry. The tool supports structured study design and reduces the risk of omitting relevant data to build a solid dataset that can be used for many years.

Conclusion & Impact: The AnthroMetric toolkit enables scientists and (Defense) physiologists from different (training) backgrounds to design and execute an anthropometric survey following a validated method. Improving the potential of anthropometric datasets increases its potential for more inclusive functional environments, clothing and equipment. Future iterations will include more types of standardized research, such as Concept of Fit and military standards, as well as simple statistical overviews for the user to make informed decisions on which metrics to include. While the toolkit is developed for a military use case, it is also applicable for civil applications.

Developing a Method for Measuring Fit Using State-of-the-Art 4D Body Scanning Technology: with Applications for Military Body-Borne Protective Equipment Evaluations

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#15

Soldiers are required to wear personal protective equipment and other body-borne load carriage systems (LCS). Objectively understanding the body-LCS interactions is important for understanding equipment fit and optimizing design. Improper fit can cause pain, reduce mobility, and impede a soldier's performance; this effect is disproportionately higher in female soldiers, as many LCS were designed using male anthropometric data. This paper presents methods to quantify the compression points and air gaps between the body and LCS. This was accomplished by recruiting 16 (9M; 7F) members of the Canadian Armed Forces (CAF). All participants were scanned using the MOVE4D

dynamic body scanning system in a static A-pose and while seated, in both slick (i.e., in form-fitting clothing) and equipped (i.e., LCS) conditions. All scans were processed using the MOVE4D proprietary model, generating a skin-tight homologous mesh. All slick and equipped meshes were moved into the same position and pose in 3D space, using Autodesk Maya retargeting software. The distances between the surface of the body and the surface of the LCS were computed, accounting for the regional thickness of the LCS. General fit metrics, such as the percent compression and percent air gaps, were measured, along with the sex differences at anatomically relevant regions of the body. It was found that females had a higher overall percentage of compression points, with significant differences observed across the chest. This study provides a proof-of-concept for objective fit evaluations and a useful resource for improving the design and manufacturing of military LCS.

In-Flight Anthropometry and Health Surveillance for Future Exploration Missions

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#53

As astronauts are exposed to microgravity their body shape and size change, which can affect suit fit, health surveillance, and hardware configurations. Previous studies on the International Space Station (ISS) and Space Shuttle have shown up to 3% stature and 6% sitting height change will occur due to microgravity exposure. While these studies provided critical data previously unavailable for space exploration, several limitations were also noted for Lunar and Mars Missions. Given the need for longitudinal monitoring and future mission relevant anthropometry data which was not fully available in the past in-flight crew anthropometry studies, a new measurement collection initiative was recently kicked off with NASA. This level of monitoring, in conjunction with medical requirements, is necessary to capture time-dependent anthropometric changes that occur across different mission phases, enabling more accurate modeling of crew body shape, posture, and volumetric changes in microgravity. The purpose of this publication is to summarize the development of the new in-flight anthropometry collection and surveillance initiative.

One of the key motivations for this new data collection effort is to incorporate crew medical monitoring components in addition to the traditional focus for suit and hardware fit. This data will be used in conjunction with body mass to determine if there is any correlation between the two sets of data to assist in detecting health and body changes in the absence of specialized body mass measurement devices during future exploration missions. The measurement collection timepoints were also adjusted from previous endeavors to capture both the transient phase and steady-state phases of crew anthropometric changes. Specifically, how quickly the body shape changes occur once in microgravity, prior to return to earth, and during post-flight recovery will be assessed. This is particularly important as the Lunar Missions involve more frequent gravity changes, such as 1-g to 0-g, then 0-g to 1/6-g.

Ideally, this data would be captured using 3d scan technology as in the ground laboratory. However, due to constraints, manual measurements using existing resources on ISS are currently being collected while scan technology is developed. As technology improves and hardware is developed that can potentially work on ISS or lunar surface, ground-based efforts continue to collect scan data preflight and postflight. Continued effort has been in progress to identify the optimal technology for in-flight body scanning, which can substantially improve the data resolution and accuracy with respect to the ground reference measurements.

TECHNICAL SESSION 2: Mobile 3D Body Scanning & Measurement

Body Composition and Measurement Improvements from Size Stream 3D Mobile Scanning

Steven C. HAUSER, Matthew S. GILMER, David BRUNER

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#04

Accurate body composition measurements are essential for assessing health risks and providing optimal health care outcomes. Key measurements include total body fat percentage and the mass of visceral adipose tissue, which are both associated with a wide range of metabolic and cardiovascular pathologies. Despite their importance, it is quite difficult to obtain reliable measurements for these quantities. Gold standard techniques such as dual energy X ray absorptiometry (DXA) require clinical visits, expose patients to ionizing radiation, and remain costly, limiting their accessibility. Consumer bioimpedance devices offer a more convenient alternative, but typically suffer from either limited

accuracy or high cost, and are entirely unable to estimate key metrics such as visceral fat or bone density. Recently, mobile 3D body scanning has begun to gain traction in measuring these critical quantities, providing a low-cost and at-home method to estimate both body composition and external measures. With Size Stream's latest improvements to our technology, we demonstrate enhanced capability in representing and predicting 3D body shapes, using both silhouettes and RGB color images. We also show improvements in predicting key metrics of visceral fat and appendicular lean mass, achieving high accuracy compared to DXA scanners. The study highlights the continuing promise of 3D mobile scanning as an easily accessible and much lower cost alternative to DXA scans for assessing body composition and measurements.

From Body Scan to Custom Fit: Enabling Personalized Sportswear with 3D Avatar Body

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#05

Abstract not available.

One Platform, Different Fit Solutions: Smartphone Body, Hand and Foot Measurement for Garments, Gloves, Footwear and Medical Fitting

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#40

Mobile 3D scanning becomes valuable when it consistently produces outputs that downstream teams can use without debate or rework. We'll present Astrivis' approach to operationalizing capture, including how we validate performance in real conditions and how we connect scanning to production and ordering workflows. Short case studies illustrate what changes when 3D becomes part of day-to-day operations.

Operationalizing Mobile 3D Scanning: Evaluation, Deployment, and Workflow Integration

Olivier SAURER

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#02

Mobile 3D scanning becomes valuable when it consistently produces outputs that downstream teams can use without debate or rework. We'll present Astrivis' approach to operationalizing capture, including how we validate performance in real conditions and how we connect scanning to production and ordering workflows. Short case studies illustrate what changes when 3D becomes part of day-to-day operations.

TECHNICAL SESSION 3: 3D/4D Body Scanning for Health & Sport

Body Composition and Anthropometric Change in Real-World Weight Loss: An Exploratory Analysis of a Large Longitudinal Mobile-Scan Dataset

Matthew S. GILMER, Steven C. HAUSER, David BRUNER

Size Stream LLC, Cary NC, USA

#03

Survey data from our mobile body-scanning user base indicates that a substantial fraction of users is undergoing weight loss assisted by GLP-1 or similar medications. Longitudinal weight trajectories observed in our database corroborate this through their characteristic front-loaded loss pattern, matching what has been reported in pivotal GLP-1 trials. This real-world context motivates a careful look at how body composition predictions behave when applied longitudinally to individuals undergoing substantial weight loss. We have assembled a large longitudinal dataset spanning a wide range of weight-loss magnitudes, rates, and baseline body habitus. We characterize how the fraction of total weight change attributable to lean mass varies with magnitude, rate, and baseline BMI, and compare these patterns against expectations from established cross-sectional reference formulas applied longitudinally. We additionally examine other body composition metrics as well as anthropometric measurements along the same trajectory dimensions. Unlike the body composition metrics, which come from regressions trained on cross-sectional data, the anthropometric measurements are extracted directly from segmented images captured during the mobile scan process and therefore should naturally track longitudinal change. Additionally, they can help identify which specific measurements drive any trajectory-dependent patterns observed in the body composition metrics.

Alternative model formulations augmenting the standard cross-sectional inputs with weight-loss magnitude and rate are evaluated to surface testable hypotheses. These hypotheses are tested against a separate small-sample longitudinal DXA-paired study currently in progress at Pennington Biomedical Research Center in which participants are receiving GLP-1 therapy for weight loss, with the objective of determining whether trajectory information leading up to a scan can systematically improve body composition estimation in real-world weight-loss populations.

Longitudinal Evaluation of Mobile 3D Body Scanning for Body Composition Assessment During Pharmaceutical Weight Loss Therapy

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#29

Longitudinal assessment of body composition is of growing importance in the setting of GLP-1-mediated weight loss, where changes in total body weight may not adequately reflect the balance of fat and lean mass change. Dual-energy X-ray absorptiometry (DXA) is a well-established reference method, but its cost and limited accessibility constrain routine longitudinal use. Mobile 3D body scanning based on standardized front and side images may provide a practical and scalable alternative for repeated body composition monitoring. This study is an ongoing evaluation of the Size Stream body composition models against Hologic Horizon A DXA in a longitudinal study of 20 adult female subjects (all self-identified Black or African American) undergoing a 5-month course of Tirzepatide (weekly dose escalated by 2.5 mg each month, from 2.5 mg per week in month 1 to 12.5 mg per week in month 5) at the Pennington Biomedical Research Center. Each subject was scanned with DXA during at least two of three visits (S1, V3, V6), spaced approximately 75 days between apart. For each DXA scan, 1-2 corresponding scans were acquired in a booth with a mounted iPad running the Size Stream application MS1. Five body-composition metrics were evaluated (body-fat percentage (BFP), visceral adipose tissue (VAT), bone mineral content (BMC), and lean mass of the arms (LMA) and legs (LML)). Baseline cross-sectional agreement and longitudinal change agreement were quantified by bias, mean absolute error (MAE), root mean square error (RMSE), and sign-agreement rate.

BodyLoop - 3D Full Body Scanning and Applications (temp. title)

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#54

Abstract not available

Fuxi: From 3D Body Scanning to Personalised Simulation of Posture and Body Shape

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#56

Posture, spine-related features and body composition are commonly assessed in health, fitness and rehabilitation settings. However, the results are often shown as numbers and scores. These can be difficult for clients and other non-specialists to understand.

Fuxi turns these results into a personalised 3D body model. It combines a 3D body scan with bodycomposition data. The model preserves the person's recognisable body shape and can show the body in different layers, including the body surface, skeleton, muscles and fat distribution. Clients, coaches and clinicians can view the body from different angles, discuss the results together, and compare measurements over time.

This talk presents one complete posture case. It starts with the measured 3D geometry and shows how Fuxi builds the body model, presents the posture findings and explains their limits. It also shows how posture and spine-related features can be represented in the same model.

Fuxi can go beyond showing a single measured state. It can simulate the same person under aggravated and improved posture scenarios. It can also simulate controlled changes in body shape, skeletal alignment, muscle shape and fat distribution. This allows users to see the direction of possible change instead of understanding it only through numbers.

Fuxi clearly separates actual measurements, comparisons between real measurements taken at different times, and simulated scenarios. The simulated results are model-based estimates for illustration and communication. They are not predictions of a person's future condition, medical images or medical diagnoses.

3D-Scan-Calibrated CGI Stimuli for Quantifying the Effect of Body Composition on Bias in Male Body Size Estimation

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#61

Background: Inaccurate body size estimation is central to many disorders, including eating disorders and muscle dysmorphia, yet existing self-estimation methods are calibrated exclusively for adiposity, neglecting skeletal muscle mass variation, particularly salient in male morphology. We present a development and testing of 3D scan derived, anthropometrically calibrated CGI stimulus where muscle and fat mass are independently manipulated, for the investigation of body size estimation.

Study 1: Nine sets of ray-traced CGI male stimuli were generated across low, mid, and high muscle mass and muscle tone combinations, each varying continuously in 0.25 BMI increments across BMI range of 18.75-40. Calibration used a multiple regression model derived from 5,705 men in the Health Survey for England. 45 male participants completed a yes-no forced-choice psychophysical task across all stimulus sets. Point of subjective equality (PSE) and difference limen (DL) were computed via probit analysis.

Study 2: A 32-body matrix was built from high-resolution 3D scans and bioimpedance data from 176 men, statistically mapping 3D shape and body composition to independently varied body composition (muscle 0-55 kg; adipose 0-44 kg). In 258 men surveyed online, current body composition estimates closely matched UK Biobank norms, replicating known contraction bias and confirming psychometric contributions to self-estimation. Ideal body judgments converged on a high-muscle, low-adiposity phenotype, but with meaningful inter-individual variability driven by internalization of sociocultural muscularity/leanness ideals.

Conclusions: This work presents an approach integrating 3D anthropometric scanning, bioimpedance derived regression calibration, and photorealistic CGI rendering for stimulus creation. Unlike legacy somatomorphic matrices, line drawings with unvalidated muscle/tone morphs, this approach permits traceable conversion between rendered stimuli and real-world mass values. For sport, health, and clinical body image research, these results argue strongly for adopting stimulus sets and instruments that independently and quantitatively represent both muscularity and adiposity, enabling more precise characterisation of over and under estimation of body size, that can lead to muscle dysmorphia, and eating disorders.

TECHNICAL SESSION 4: 3D/4D Body Scanning for Apparel I

Modular Components for Scalable 3D Body Data and Applications: From Capture to Virtual Fitting

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#19

The 3D body technology framework presented by SIA DIVI Grupa (Latvia) has been developed within a "Capture-to-Virtual-Fitting" research and development project. In this contribution, we present it as a set of modular, interoperable components spanning the full body-data value chain, addressing hardware manufacturers, software providers, researchers, and application developers, including the garment industry.

The framework is designed to support both independent adoption of individual components and their integration into end-to-end workflows. The presented components include: a low-cost multi-camera capture setup enabling scalable acquisition of 3D body data, a 3D reconstruction and avatar standardization pipeline for consistent downstream processing, a data collection and validation framework based on anatomically defined landmarks, a measurement completion module for

predicting full anthropometric profiles from partial inputs, a measurement-conditioned 3D avatar generation approach ensuring metric consistency, and a batch virtual fitting workflow with population-level analysis capabilities.

Each component represents a distinct entry point into the ecosystem: capture providers, software vendors, data platform operators, and application developers can adopt individual modules without requiring the full stack. At the same time, the components can be combined into an integrated pipeline enabling data-driven workflows such as large-scale body data acquisition, digital twin generation, and virtual prototyping.

The presentation will illustrate how these modules interact, demonstrate selected components in isolation, and outline collaboration opportunities with hardware vendors, software platforms, and research partners. The goal is to highlight not only an integrated vision, but also practical integration paths for different stakeholders within the 3D body technology landscape.

The Myth of the Proportional Curve: Data, Perception, and the Realities of Inclusive Grading

Lara MAZZONI, Clementine BALDO

Bodi.Me Ltd., London, UK

#39

Bodi.Me is a UK-based fit technology company pioneering data-led sizing solutions for fashion, uniform and professional clothing. Through its Size-Me platform, Bodi.Me uses AI, machine learning and body-data intelligence to deliver personalised size and fit recommendations without requiring photos, scans or intrusive inputs, helping organisations improve fit accuracy, reduce returns and design for more diverse bodies.

This presentation challenges the industry habit of treating size grading as a simple mathematical enlargement of a sample size. Drawing on body-data insight and fit-technology practice, it shows how standard grading fails plus-size bodies by ignoring where volume is actually distributed: lower stomach, bust, upper arms, hips and other high-impact fit zones.

The talk then connects this technical failure to the current cultural moment shaped by Ozempic and GLP-1 weight-loss drugs, where the industry often appears more willing to "fix" bodies than redesign clothes. As body shapes, proportions and perceptions shift, inclusive grading must move beyond proportional curves and towards data-led, garment-specific fit systems that respect real bodies, comfort and dignity.

Developing Body Scan Ready Parametric Workflows from Traditional Drafting Methods

Simeon GILL, Renhao WANG, Lucy PARNELL

Department of Materials, The University of Manchester, Manchester, UK

#43

With the development of 3D body scanning and CAD technologies, conventional drafting methods are increasingly being transferred into digital and parametric environments. Existing studies have used CAD and body-scan data to improve pattern accuracy and body-to-pattern relationships, while others have explored CAD workflows from basic blocks to styled pattern outcomes. However, these areas are often treated separately: scan-driven studies rarely address how documented drafting methods should be translated and validated in CAD, while block-to-style studies often overlook the body-dependent logic needed to adapt blocks to alternative body datasets. A key challenge is that conventional drafting methods contain implicit proportions and construction assumptions derived from expert practice. These may be interpreted manually by pattern cutters, but in CAD they must be made explicit, parameterised and tested; otherwise, they can limit pattern adaptability and reliability.

This research develops a reproducible CAD-based protocol for translating a published conventional drafting method into a parametric workflow based on body scan data. It examines how manual drafting logic behaves in CAD, identifies limitations emerging during parameterisation, and proposes amendments to support more reliable adaptation to alternative body measurement datasets, creating a foundation for integration of 3D body scan-derived data into block construction and style development.

Kershaw's documented pattern-cutting method was selected as the case study, because it provides both an upper-body block draft and the linear procedures for developing styled garment patterns. The basic body block was first translated into a parametric draft in open-source CAD software Seamly2D. This translation was structured into three main parametric components: (1) editable measurement inputs based on Kershaw's default EU38 body form, (2) design variables embedded within the draft, such as ease, and (3) formulas for organising measurements, variables and derived pattern dimensions. Enabling the future resizing of the draft to accommodate different measurement inputs. Three style variations were then developed from the same block to examine how the conventional

block-to-style transformation logic operates within a CAD workflow. Alva 40 measurements were subsequently imported to test the adaptability of the parameterised method to body variation. This enabled problematic dependencies, implicit proportions and style construction steps to be identified and amended. The process was then synthesised into a reproducible CAD workflow.

This study generated a parametric pattern for the basic body block and three style variations, preserving the drafting logic of the original method while allowing the draft to be resized using different measurement inputs. Importing the Alva 40 measurements to replace the default 38EU measurements caused distortions in both the basic body block and the three styled pattern outcomes, suggesting two main limitations. First, some parts of the method rely on proportional assumptions with limited body-dependent logic. Second, several fixed design variables do not scale reliably when the body measurement input changes. In response, the pattern was amended by introducing more direct measurement references into the construction logic and by resetting selected design variables proportionally according to the relevant body or pattern measurements. The study proposes a structured CAD workflow for adapting published drafting methods to parametric systems and provides a clear pathway for integrating more detailed 3D scan-derived body measurements into block construction and style development.

Modular Digital Presentation Avatars: Workflows for Digital Fashion

Kyra GIBSON, Penelope NORMAN, Jonathan BURGESS, Ben HEWITT
Arts University Bournemouth, Dorset, UK

#41

As the adoption of 3D digital workflows accelerates across the fashion industry, digital design reviews are becoming integrated into product development processes, enabling prospective products to be evaluated through 3D visualisation prior to physical sampling. Garments are developed on digital fit avatars and communicated through standardised multi-view snapshots. This integrated functionality enables efficient and consistent image iteration without requiring garments to be repositioned or re-simulated. However, avatar geometry can obscure and distort key product details, limiting clarity in design review and decision-making contexts. Existing solutions, such as removing the avatars or re-simulating garments on hangers are inefficient and disrupt established simulation accuracy. To maximise efficiency within fast paced product development environments, clear and consistent visuals are critical, highlighting the need for digital presentation methods that support established 3D product development processes.

This research, conducted through a UKRI-funded Knowledge Transfer Partnership (KTP) with British performance apparel brand ThruDark, explores the implementation of modular digital presentation avatars for design reviews. A commercial case study examines existing 3D design presentation practises using digital fit avatars and identifies limitations in garment visibility and visual communication. A modular avatar workflow was developed and piloted to present a new digital-first product range for design review. Qualitative evaluation with stakeholders provides comparative insights into garment presentation methods and assesses the communication value for decision making. Based on this research, integrated modular avatar functionality is proposed as a more flexible method for presenting digital garment during design review.

Invited Speaker

The Digital Tailor by Differently Enabled: Engineering a Parametric Pipeline for Complex Human Geometries

Craig CRAWFORD

Differently Enabled, London, UK

#46

Abstract not available

TECHNICAL SESSION 5: Anthropometric & Sizing Surveys

Capturing Human Diversity: New Anthropometric Survey Initiatives Around the World

Martin GROEBER

Humanetics Digital Europe GmbH, Kaiserslautern, Germany

#24

The presentation provides an overview of three major anthropometric survey initiatives: SizeEurope, SizeBrazil, and SizeMaternity. It highlights their objectives, target populations, and approaches to capturing high-quality and representative 3D body data.

The presentation will also explore how these initiatives contribute to a better understanding of human-centered product design, ergonomics, and digital human modeling.

Harmonized Anthropometric and Strength Data of European Children for Standardization and Guidelines for their Effective Use

Sandra ALEMANY 1, Toon HUYSMANS 2, Christiane SCHEFFLER 3, Gerd KUECHMEISTER 4, Sebastian LENTZ 5, Levent CAGLAR 6, Alice BULLAS 7, Renate DE BRUIN 2, Lye GOTO 2, Daan VAN EIJK 2, Sofia IRANZO-EGEA 1, Juan DURA-GILL 1, Enda FALLON 8

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2 Faculty of Industrial Design Engineering, Delft University of Technology, Delft, The Netherlands;

3 Institute of Biology and Biochemistry, Human Biology, University of Potsdam, Potsdam, Germany;

4 Kiel University of Applied Sciences, Kiel, Germany;

5 DIN German Institute for Standardization, Berlin, Germany;

6 FIRA International, Stevenage, UK;

7 Advanced Wellbeing Research Centre, Sheffield Hallam University, Sheffield, UK;

8 University of Galway, Galway, Ireland

#06

Anthropometric information is widely used to translate human variability into design requirements, safety criteria and standardization. However, most established reference frameworks have been developed around adult populations and cannot be directly transferred to children. Growth-related changes in body proportions and physical capabilities introduce substantial variation throughout childhood, particularly in regions such as the head, hands and feet. At the same time, existing European datasets are heterogeneous in terms of age coverage, measurement definitions and acquisition methods, and functional and strength data remain comparatively scarce.

To address these gaps, a harmonized anthropometric and strength study, promoted by the European standardization committee CEN/TC 122/WG 1 Anthropometry, was jointly developed and implemented in Spain and the Netherlands. The study covered the full developmental range from infancy to adolescence and combined traditional anthropometry, digital body scanning, dedicated hand and foot scanning, and strength measurements. Age-specific measurement protocols were defined to account for differences in cooperation, posture control and measurement feasibility. Strength assessment also required the development of child-specific measurement setups and age-adapted protocols, including dedicated fixtures and accessories scaled to children's body and hand dimensions. For younger children, the measurement programme was divided into different measurement blocks to limit session duration and participant burden, while more extensive body and head acquisition was possible for older children.

A common methodology was established across both countries for subject positioning, landmarking, measurement procedures and quality control. Traditional and digitally derived measurements were integrated within the same framework, using selected equivalent measurements to assess compatibility between methods and identify potential scanner-related bias. The digital workflow incorporated automated anatomical landmark detection, mesh homologation, artefact removal, measurement extraction and structured quality control procedures.

The resulting data provide the basis for new European references on children's anthropometry and strength, with statistical summaries reported in CEN/TR 18296-1, Ergonomics - Anthropometric and strength data of children in Europe - Part 1: Statistical summaries of the data. Based on these findings, application guidelines were developed and published in CEN/TS 18296-2, Ergonomics - Anthropometric and strength data of children in Europe - Part 2: Guidelines for the correct application of anthropometric and strength data, to support the ergonomically and biomechanically appropriate use of the data. The guidelines address the influence of biological factors, posture, movement, clothing and human-product interactions, supporting their application in design, safety assessment and standardisation.

The project therefore provides both harmonised reference data and a practical framework for their use in ergonomic design, product safety and standardisation.

YouthShape.US: 3D Anthropometry, Body Composition, Strength, and Physical Activity of Children and Youth in the United States

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#09

Background: Anthropometric data for children and youth are critical for the design of safe, comfortable, and accommodation products and environments, yet contemporary data for many populations is not available. The U.S. National Health and Nutrition Examination Survey publishes representative statistics on stature, body weight, and BMI by age on a four-year cadence, but these data lack the detail needed for product design. The last detailed, publicly accessible dataset for U.S. children and youth was published in the 1970s. The YouthShape.US study addressed this gap by measuring more than 5000 U.S. children and youth ages 3 through 17 years.

Methods: The study was conducted in three phases. In Phase 1, 650 male and female participants were measured in a two-hour laboratory session. Over 50 manual anthropometric measurements were taken using standardized methods. Body composition was measured using a bioimpedance scale. Grip strength in the right and left hands was recorded using a custom dynamometer, and lower-extremity power was calculated from force plate data obtained using counter-movement jump protocol. For a subset of participants, physical activity was tracked using a wearable device for 7 to 10 days.

Three-dimensional (3D) body shape data were obtained using four different systems, each selected to provide the best tradeoff between quality, scan time, and other factors. Whole-body scans were obtained using a laser scanner in 24 standing and seated postures, including supported seated postures with a range of recline. Clothed standing scans were recorded using a PassFit scanner. Head scans were obtained using a five-camera 3dMD head scanner. A unique probe method was used to obtain 3D scalp points during scanning, and scans were obtained with multiple facial expressions.

The shape of the right hand and forearm was recorded in the 3dMD scanner in more than 40 poses, including while gripping various objects. A 3D foot scan was obtained using a Revopoint handheld scanner while the participant stood on a transparent platform. Foot shape was measured both flat (weight bearing) and in a toe-off posture. Finally, the shape of the foot in motion during gait was recorded using a custom-designed system equipped with six depth cameras positioned above and below a transparent plate.

In Phase 2, three sub-studies were conducted at three locations to increase the number of Black (African-American), Hispanic, and East Asian participants. A total of over 900 participants were added through this phase. Different measures were taken at each location, but all included multiple whole-body scans, manual anthropometry, body composition, grip strength, head scans, and hand scans.

Phase 3 expanded the study to six additional locations in multiple U.S. states. The Phase-3 protocol included standing and seated whole-body scans, head scans, hand scans, body composition, and grip strength. Altogether, data from more than 5000 children and youth were obtained across the three phases. Outcomes: Analysis of the data is ongoing, but the manual measurements and other scalar data are publicly available for analysis online at <http://YouthShape.US/>. Three-dimensional data browsers and other tools utilizing the scan data are under development.

Child Growth Monitor: AI-Based Digital Anthropometry for Height Measurement & Malnutrition Screening in Low-Resource Settings

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Deutsche Welthungerhilfe e. V., Bonn, Germany

#38

Accurate child anthropometry is essential for detecting malnutrition, yet manual measurement remains difficult to standardize in low-resource field settings in low- and middle-income countries. We present the Child Growth Monitor (CGM), an AI-based digital anthropometry solution developed by Welthungerhilfe (WHH), a German humanitarian and development NGO, to estimate child growth indicators from Multiview RGB and depth scans.

GM combines an app-based scanning workflow, depth-sensing hardware, and machine-learning models trained on labelled anthropometric data to estimate child growth indicators, while ensuring appropriate data governance. It has been piloted in 8 countries across South Asia, Sub-Saharan Africa and Middle East, and has generated one of the largest known datasets of approximately 40,000

children, from 6-59 months, with more than 2 million images, including RGB images, depth maps, metadata, and validated reference measurements.

We outline the CGM workflow, technology setup, validation results from Nepal and India, and key learnings from field implementation. We also discuss CGM's future strategy, including the transition from a WHH-led technology solution towards a data and collaboration platform for digital child anthropometry research, validation and public-health applications.

TECHNICAL SESSION 6: Face/Body Modeling, Digital Humans & Avatars

Deterministic Measurement-Conditioned 3D Body Reconstruction for Precision Digital Fitting

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1 University of Latvia, Riga, Latvia;

2 DIVI Grupa Ltd, Riga, Latvia

#18

Custom tailoring and digital fitting require geometrically precise 3D body avatars, yet most existing approaches prioritize visual realism over quantitative accuracy. This paper presents a deterministic method for reconstructing three-dimensional human body meshes from a dense set of 47 anthropometric measurements - circumferences, heights, widths, and lengths - targeting geometric errors within a single standard clothing size gradation step (~40 mm), as defined by the European clothing standard EN 13402-3. The core contribution is the Direct Regression Network (DRN), a deterministic architecture that maps the measurement vector directly to residual vertex offsets on a sex-specific mean template mesh (6,890 vertices, SMPL topology), bypassing the need for stochastic latent spaces. The method integrates three key technical elements. First, per-dimension Fourier feature mapping projects each scalar measurement independently into a multi-frequency representation, preventing out-of-distribution (OOD) values from corrupting the entire conditioning signal. Second, Feature-wise Linear Modulation (FiLM) re-injects the measurement signal at every residual block, allowing the network to continuously adapt intermediate features to the target body shape. Third, scale augmentation - combining uniform and anisotropic scaling - synthetically expands the diversity of body proportions encountered during training, significantly improving robustness to unseen measurement combinations. Training uses pose-invariant geometric losses (edge length, Laplacian differential reconstruction, and segmented Procrustes alignment) rather than direct vertex comparison, preventing the model from encoding residual pose artifacts present in real scan data. An inverse-variance weighting scheme further de-emphasizes high-variance extremities (fingertips, toes) in favor of measurement-relevant torso regions. The model is trained on 400 real 3D body scans per sex from the BODY-fit dataset - a deliberately small dataset reflecting realistic data-acquisition constraints in anthropometric research. Despite this, the system achieves a mean measurement error of approximately 2 mm on in-distribution test samples, with worst-case errors bounded within a single size gradation step. Ablation experiments demonstrate that deterministic regression under dense conditioning outperforms a matched conditional variational autoencoder (CVAE), which suffers from latent smoothing that weakens measurement control: the CVAE exhibits more than twice the measurement error and 59.6% of its meshes showing at least one error above 20 mm, compared to only 3.9% for the DRN. OOD stress tests using the AGORA dataset confirm that, while ordinary least squares regression achieves marginally lower measurement error in-distribution, it produces geometrically degenerate meshes - collapsed limbs, inverted surfaces - under novel inputs. The DRN maintains anatomically plausible surfaces under the same conditions, as quantified by per-part volume error and cross-section convexity metrics. The work positions dense anthropometric conditioning as a practical alternative to generative models for precision digital fitting: when 47 measurements are available, the residual shape ambiguity is small enough that stochastic generation is unnecessary, and a deterministic mapping provides the repeatability required for reliable, session-consistent avatar generation. Future work will extend the pipeline to a custom mesh topology, incorporate non-geometric inputs such as age and weight, and conduct paired digital-physical measurement validation studies to bridge mesh-derived measurements with physical tape readings.

Beyond the Raw Scan: Production-Ready 3D Heads with Realistic Textures from Everyday Photos

Roman BELOV, Artem KOCHUROV

KeenTools, Yerevan, Armenia

#44

Producing a usable 3D head typically requires dedicated scanning hardware or hours of manual cleanup after capture. At KeenTools, we have developed a fully automatic, hardware-free and marker-free pipeline that turns ordinary photographs into production-ready 3D heads. The system morphs a generic head model to match the shape, facial features and expressions visible in the input photos, so every result shares the same clean MetaHuman topology, complete with PBR textures and ARKit blend shapes, in 1-3 minutes. Optional AI preprocessing covers missing angles, cleans up textures and removes hair. In this talk, we present the approach, show results across diverse subjects, and discuss current limitations and next steps.

Emotion-Driven Facial Avatars from Monocular Video

Lisa HORNUNG 1,2, Dirk HORNUNG 1, Nikita NIKIFOROV 1, Ismael BENITO-ALTAMIRANO 2,3

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2 eHealth Center, Faculty of Computer Science, Multimedia and Telecommunication, Universitat Oberta de Catalunya, Barcelona, Spain;

3 Department of Electronic and Biomedical Engineering, Universitat de Barcelona, Barcelona, Spain

#16

While recent approaches achieve high visual fidelity from easily accessible monocular video, controlling these avatars through rich, naturalistic emotional expressions remains largely unexplored. In particular, generating temporally coherent, emotion-driven animations that capture full neutral-to-peak trajectories has received limited attention in existing pipelines. In particular, controllable emotion-driven animation with smooth, temporally coherent transitions has received limited attention in this setting.

To address this gap, we present an end-to-end pipeline for reconstructing and animating photorealistic facial avatars from monocular smartphone video. Using a dataset of subjects performing the six basic emotions from neutral to peak intensity, our method employs VHAP for differentiable analysis-by-synthesis tracking to extract per-frame FLAME parameters. To drive expression synthesis, we train a Transformer to predict dynamic FLAME parameters frame by frame for any targeted emotion. At inference time, with Gaussian parameters fixed, our system enables real-time, controllable emotion playback from neutral to peak intensity.

Likeness at Scale: How EA Overcomes the Challenges of Capturing Talent Authenticity for AAA Games

Joel KUCEY

EA Create Capture, Electronic Arts, Burnaby BC, Canada

#48

Likeness at Scale: How EA overcomes the challenges of capturing talent authenticity for AAA games highlights how EA Sports efficiently creates thousands of hyperrealistic digital double assets every year to meet demanding annual game release schedules. By deploying custom, portable photogrammetry rigs, field teams rapidly, capture player likenesses across global leagues with minimal time per athlete. An automated processing pipeline then converts raw scan data into engine-ready game assets, drastically reducing manual artist workload while driving photorealistic visual quality.

TECHNICAL SESSION 7: 3D/4D Hand & Foot Scanning

Metric Improvement of Single Image Hand Reconstruction by 3D NIR Active Stereo and Model Based Surface Reconstruction

Yan ZHANG 1, Roland RAMM 2, Wang LIAO 1, Chen ZHANG 1, Gunther NOTNI 1,2

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2 Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF, Jena, Germany

#30

Metric hand reconstruction can support human-robot interaction and geometric annotation of sign-language datasets. However, current mainstream hand reconstruction methods rely on monocular images, and their predictions remain uncertain in absolute size and camera-relative position. We

present a method that combines pattern-projection-based near-infrared (NIR) active stereo with WiLoR (image-based hand reconstruction) for initialization and MANO (a parametric hand model) for surface fitting to reconstruct articulated hands in a calibrated camera coordinate system. WiLoR estimates an initial hand model from an unpatterned NIR image without NIR-specific fine-tuning. Scale initialization using a thumb-segment prior preserves the predicted image projection, and perspective-n-point fitting adapts the model to the calibrated camera intrinsics. Geometric optimization then aligns the hand with the measured point cloud through rigid registration followed by joint refinement of articulation, shape and global pose. Evaluation uses recordings across 23 acquisition conditions, covering hand motion, challenging orientations, gloves and two image-binning modes. Across 12,001 paired hand reconstructions, the point-weighted mean surface distance decreases from 68.985 to 3.286 mm, a reduction of 95.24%. Exploratory motion analysis characterizes surface errors across estimated-speed intervals. The results demonstrate improved agreement with measured hand surfaces.

Foot Shape Classification of Indian Military Personnel Using 3D Scanning for Footwear Design

Annu KUMARI 1, Prashant TRIPATHI 2

1 Footwear Design and Development Institute Chandigarh, India;

2 Footwear Design and Development Institute Rohtak, India

#20

A well-fitting military boot is essential for comfort, mobility, and foot health during prolonged marching, running, and load-bearing activities. However, conventional footwear sizing relies largely on foot length and width, which may not fully reflect the three-dimensional variation of the human foot. Although previous studies have examined individual foot dimensions and footwear-fit problems, limited work has focused on identifying broader foot-shape patterns within the Indian military population. This highlights the need to look beyond foot length and examine the overall shape of the foot for military footwear development. This pilot study explores broad foot-shape patterns among Indian Army personnel using three-dimensional anthropometric data. A dataset of 118 participants was analysed using 10 normalized foot-shape indices. Principal component analysis was used to identify the major dimensions of variation, followed by Ward's hierarchical clustering, with K-means used as a complementary analysis. Two broad foot-shape patterns were identified, differing mainly in foot breadth, height, and girth characteristics. The findings suggest that foot length alone may not adequately represent the morphological variation relevant to military footwear fit. The study provides an initial basis for developing an India-specific military footwear sizing and shape system, while further research with a larger and more diverse sample is needed to validate and refine the identified morphotypes.

From Phone Photo to Insole: Plantar Sole Reconstruction with a Fine-Tuned Sapiens2

Andres PRADA GONZALEZ

Footprint Technologies GmbH, Berlin, Germany

#49

Custom insoles are shaped to the 3D geometry of the plantar surface, which today requires a dedicated foot scanner. We ask whether a single RGB photo of the sole, taken with a phone, is enough. We build on Sapiens2, a vision-transformer foundation model from Meta pretrained on human images that already predicts per-pixel 3D pointmaps, and adapt it to this narrow domain.

No public dataset pairs sole photos with aligned 3D ground truth, so we are building one. It currently has over 300 scan sessions from a commercial 3D foot scanner, and collection continues toward 500. We segment each sole with a detector trained on human-corrected annotations. We then register every photo to its mesh by fitting a pinhole camera that minimizes the silhouette chamfer distance. Two constraints keep the fit honest: a focal-length prior, and a normal-orientation check that rules out the mirror-image solution, which would otherwise swap the medial and lateral sides. The result is a per-pixel depth map in millimetres for each photo.

Zero-shot, the pretrained model already recovers the sole's overall convex shape. It misjudges how pronounced the relief is, though: some feet come out exaggerated and others nearly flat, and relief is exactly what an insole depends on. We fine-tune on our pairs with an L2 plus gradient loss and evaluate on a held-out, session-disjoint split. We report scale and shape error separately, with metrics chosen for insole design rather than generic depth accuracy. At inference, a paper foot-length measurement fixes the metric scale, reducing single-image scale ambiguity to a simple rescaling step. We present the dataset pipeline, the zero-shot analysis, and the (preliminary) fine-tuning results.

Do Sneaker and Hiking Shoe Toe Boxes Match Female Forefoot Shape? Evidence from 3D Scans of European Women

Ales JURCA 1,2, Saso DZEROSKI 3,2

1 Volumental AB, Stockholm, Sweden;

2 Jozef Stefan Postgraduate School, Ljubljana, Slovenia;

3 Jozef Stefan Institute, Ljubljana, Slovenia

#64

Proper footwear fit depends on the correspondence between foot geometry and the internal shape of the shoe. This study investigated how well the toe-box shapes of women's hiking footwear and sneakers correspond to the forefoot shape of medium-width European female feet. Forefoot geometry was derived from 3D foot scans and represented using convex hull contours of the toe region. Shoe toe-box shapes were estimated from top-view product images using a standardized procedure designed to approximate the internal toe-box geometry and enable consistent scaling between feet and footwear. Average toe-box contours were calculated separately for hiking footwear and sneakers and compared with the average female forefoot contour and its variability. The proposed method enables quantitative comparison of foot and footwear geometry using large datasets of 3D foot scans and readily available shoe images. The findings provide insight into differences in toe-box design between footwear categories and demonstrate an approach that could support more anatomically informed footwear design and fit assessment.

TECHNICAL SESSION 8: 3D/4D Body Scanning for Apparel II

Body-to-Pattern Relationships in the Neck–Shoulder Region: A Comparison of 3D Scan-Derived Body Measurements and Fitted Bodice-Block Dimensions

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Department of Materials, The University of Manchester, Manchester, UK

#12

Three-dimensional (3D) body scanning provides detailed anthropometric data, but how individual scan-derived dimensions are re-expressed in a fitted two-dimensional (2D) pattern remains unclear, particularly without deliberate ease. This exploratory study examined selected pattern-body relationships in the neck and shoulder regions of fitted female bodice blocks.

Three Alvanon mannequins (sizes 10, 12, and 24) were each scanned five times using a Size Stream 2020 scanner, and the mean value of each selected scan-derived measurement was used in the analysis. Close-fitting calico bodice blocks were draped without a predefined ease allowance, aligned with scan-derived landmarks, flattened, and digitised in Seamly2D. Body and pattern dimensions were paired by shared landmark endpoints and matching geometric functions, and pattern-to-body ratios were compared descriptively. An angle-matched reference construction evaluated the angular component associated with the open bust dart in front shoulder drop.

Across all cases, the front and back neck-depth pattern-body ratios ranged from 77.12% to 85.25% and from 47.73% to 61.61%, whereas the corresponding neck-width pattern-body ratios ranged from 104.68% to 115.01% and from 114.38% to 122.51%. Front shoulder length remained near numerical equivalence (98.61%-100.00%), while back shoulder length was greater (117.90%-119.41%). The unadjusted front shoulder-drop pattern-body ratio ranged from 141.67% to 208.79%; the angle-referenced range was 76.92%-83.62%, reducing the cross-case range by approximately 90%.

The selected dimensions were therefore not transferred through uniform scaling. Body-pattern differences may include flattening- and construction-mediated positional effects and should not automatically be classified as garment ease. The proposed landmark-aligned procedure supports systematic examination of 3D-to-2D dimensional translation, but based on three mannequin cases, does not establish universal ratios or a predictive pattern-construction method.

Validating Virtual Garment Prototypes through High-Fidelity Anthropometry and Material Characterization

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TTK University of Applied Sciences, Institute of Engineering and Circular Economy, Tallinn, Estonia

#32

The aim of this study is to develop a framework for virtual garment prototyping by integrating 3D anthropometric data with the representation of anisotropic mechanical properties of woven textiles. The study investigates the influence of fabric anisotropy and grainline orientation on virtual garment

drape morphology and examines the importance of accurately representing directional fabric behaviour in digital garment development. Five woven fabrics with different mechanical properties were selected from the Optitex digital material library: A-Linen, B-Chambray, C-Denim1, D-Denim2, and E-Crepe. A semi-circular skirt was simulated in two grainline orientations: 45° to the warp direction (bias) and 0° aligned with the warp direction (straight grain). The simulations were performed using a 3D human body model in Optitex, whose anthropometric dimensions were adjusted to correspond to those of the Humanetics virtual mannequin. The mechanical parameters provided within the digital fabric definitions, including warp- and weft-direction bending and shear properties, were used to examine their influence on drape morphology, air-gap distribution, and cross-sectional geometry. The findings demonstrate that differences in warp–weft mechanical properties can substantially influence simulated garment morphology, with more pronounced effects observed for highly anisotropic fabrics such as Crepe. These results highlight the importance of incorporating orientation-dependent textile mechanical properties into virtual garment simulation to improve the reliability of digital prototypes. The proposed framework supports further development of digital twin applications in garment development and has the potential to reduce physical prototyping iterations and associated pre-production material waste.

Algorithmic Generation of Bespoke Trouser Sewing Patterns Using Mesh Parameterisation

Harriet BOEING

Atelier Niabon, London, UK

#23

With accurate 3D body scans becoming more widely accessible, making use of 3D body models to generate bespoke sewing patterns for anyone has become a possibility. This will allow better fitting clothes to be produced at a lower cost as well as cater to specific needs, such as those of wheelchair users and plus-sized people. Existing bespoke pattern drafting systems rely on obtaining a small set of body measurements, which are fed into a pattern drafting recipe made by an expert to generate sewing patterns. This parametric approach is limited in its accuracy by the number of body measurements considered, as well as by how ease and shape are encoded in the pattern, which limits the method to human bodies with near-median dimensions.

These limitations tend to make multiple fittings necessary until the desired fit is achieved, thus making the process of producing bespoke garments more labour-intensive and costly.

A different approach to parametric pattern drafting is to use a 3D body scan in its entirety to automatically generate the optimal 2D representation of the body shape and use this 2D representation to develop a basic block pattern, the starting point for flat pattern drafting.

This approach has an equivalent traditional method in haute couture - the making of a moulage - where fabric is draped directly on a customer and a skin tight fit is obtained for a bodice, skirt or trousers on which the development of the client's garments will be based. Starting the process of pattern drafting from a moulage has proven itself to be more accurate than with a pattern that has been drafted using only a few measurements, since it contains more information about the 3D body shape of the client's body.

I propose a method of pattern generation based on 3D mobile body scans which offers similar advantages to traditional moulage methods, but in an automated and cost-effective way. My method involves slicing a 3D body scan along the intended seam lines. The 3D mesh slice is unfolded into 2D by using a method of mesh parameterisation with low distortion. The resulting pattern provides a skin tight fit, which ease can then be added to, yielding a well-fitting garment. I have created an automated implementation of this approach, which I have tested for women's basic trouser blocks on different body types. This approach is a step towards more cost-effective and better-fitting patterns, which can meet the needs of those who struggle to find well-fitting and functional garments within the standardised sizing system of the fashion industry.

One Selfie, One Fitting Room: (Real) Virtual Try-On for Online Retail

Cosmin CIOCIRLAN 1,2

1 Vesto 3D, Bucharest, Romania;

2 Esenca Sizing, Bucharest, Romania

#57

A selfie, a height, and a weight are enough to show a shopper the garment they're looking at, on their body, in their size and every other size. The talk walks through the four things a shopper checks in the first second (face, garment, color, photograph), what broke on real garments, and what it took to fix, measured on synthetic testers.

TECHNICAL SESSION 9: 3D/4D Body Scanning in Medicine & Health I

AVE3D One Shot 4D Technology to Capture Metric Geometry and Movement Simultaneously

Przemyslaw ZAWADZKI, Pawel WOZNIAK

AVE 3D - B3D s.c., Poznan, Poland

#25

Traditional 3D body scanning systems are designed to capture static geometry, while motion analysis typically requires separate tracking technologies and complex post-processing workflows. AVE3D One Shot 4D introduces a novel approach that enables the simultaneous markerless acquisition of precise three-dimensional geometry and dynamic movement data within a single capture event. Our technology is based on very well known within industrial applications structural light scanning with the magic touch of AI.

The technology combines synchronized multi-camera-projectors imaging with advanced reconstruction algorithms to generate temporally consistent 4D datasets, providing both accurate surface measurements and motion trajectories of the human body. With a single unit, multiple acquisition systems, or repeated measurements, the solution simplifies data collection while preserving metric accuracy.

This presentation introduces the principles of OneShot 4D acquisition with AI driven structured light, discusses system architecture and data processing methods, and presents selected applications in biomechanics, medical research, rehabilitation, sports science, and digital human modeling. Particular attention is given to the potential of the technology to bridge the gap between conventional 3D scanning and motion capture, enabling comprehensive analysis of shape and movement within a unified dataset. AVE3D One Shot 4D represents a new generation of human body measurement technology, opening opportunities for more efficient and clinically relevant assessment of dynamic anatomical structures and functional movement.

One Scan for Simultaneous 3D Reconstruction of Body and Skeleton: The INBODY - Instant Body Scan from BeyondShape

Stanislao GRAZIOSO

Beyondshape Srl, Naples, Italy

#37

Abstract not available.

A Portable 3D Scanner for Scoliosis Screening

Hideto KAMESHIMA

Spacevision Inc., Tokyo, Japan

#58

Abstract not available.

From 3D Scanning to 3D Printing: Complex Clinical Cases and New Design Applications in Custom Orthopedic Corsets

Francesco CIRIELLO

Archimed s.r.l.s., Ortopedia 3D, Acquaviva delle Fonti (BA), Italy

#62

Ortopedia 3D develops digital workflows for the design and additive manufacturing of custom orthopedic devices, integrating 3D scanning, patient-specific modelling and 3D printing. The presentation will focus on real and complex clinical cases involving custom orthopedic corsets, including applications for scoliosis, spinal deformities and vertebral collapse. The cases will illustrate the main challenges encountered throughout the digital workflow, from body acquisition and corrective modelling to additive manufacturing and final device production. The presentation will also explore how the same technologies can extend into new design applications, presenting a multidisciplinary fashion-design case study based on digital body acquisition and additive manufacturing.

Algorithmic Aspects in the Evaluation of 3D-Bodyscanning-Data for Scoliosis Therapy

Anselm NAAKE, Felix KUNZELMANN, Yordan KYOSEV

Chair of Development and Assembly of Textile Products, ITM, TU Dresden, Germany

#45

The diagnosis of scoliosis and subsequent treatment decisions are largely based on X-ray images. Since the use of X-rays exposes patients, most of whom are minors, to radiation, there is considerable interest in reducing the use of X-rays as much as possible. 3D laser scanning techniques have been used in this field for over 30 years. Although the necessary analysis and evaluation methods have been established and validated in other fields, such as RGB imaging and depth sensors, they are not widely used in 3D body scanning. In this paper, we present an open-source implementation of the methods required for scoliosis analysis based on 3D scans and evaluate the suitability of various 3D scanner principles in this regard.

TECHNICAL SESSION 10: 3D/4D Capture, Technologies & Applications I

From Still Shots to Live Volumes: Building Reliable 4D Capture Studios

Thomas DETJEN

Emergent Vision Technologies Inc, Port Coquitlam, BC, Canada

#01

Abstract not available.

CAMERA in Motion: How We Capture Movement from Lab to the Field

Jake WILLOTT, Harry DAVIES

CAMERA, University of Bath, Bath, UK

#50

CAMERA, (The Centre for the Analysis of Motion, Entertainment Research and Applications), is a multi-modal capture facility at the University of Bath, England, dedicated to pushing the boundaries of motion capture.

With a one-of-a-kind capture studio powered by 36 Vicon Valkyrie cameras, 48 machine vision cameras, multiple scanning rigs and a virtual production stage, we specialise in recording and analysing complex human movement.

In this talk, we will discuss our past challenging and diverse motion capture projects, scanning acquisitions and experiences in elite sport.

3D Body Scanning for Space Anthropometry: Technology Exploration and Development

K. Han KIM 1, Pouyan SABAHI 2, Dan NGUYEN 1, Karen YOUNG 1, Nate NEWBY 3

1 Leidos Inc., Houston TX, USA;

2 Trinzic Inc., Houston TX, USA;

3 NASA Johnson Space Center, Houston TX, USA

#52

Exposure to different gravity environments induces physiological and biomechanical changes in the human body. Past space flight reported various observations, including spinal elongation, fluid shifts, muscle volume loss, and altered neutral body posture (NBP). Accurately capturing these changes is critical for human-system integration, space habitat design, and optimizing spacesuit fit.

Historically, in-flight anthropometry during Space Shuttle and International Space Station (ISS) missions relied on manual measurements (e.g., caliper or tape measure based) or multi-view stereo photogrammetry. Although these multi-camera setups successfully estimated linear body dimensions (e.g., stature, shoulder height, torso length) and even NBP, they fell short of providing high-resolution 3D volumetric data directly comparable to ground laboratory reference body scans.

Deploying commercial off-the-shelf 3D body scanners in spaceflight or reduced-gravity training analogues presents significant technical challenges. Structure-from-Motion (SfM) scanners, such as handheld or turntable types, often require several minutes of scan time, which may be incompatible with a body floating in microgravity or transient gravitational cycles (20-30 seconds each) in reduced gravity simulation aircraft. Furthermore, space habitats or vehicles like Orion often do not have sufficient interior volume to set up a dedicated scan booth. Multi-sensor extrinsic calibration is extremely difficult to achieve and maintain due to misalignment from structural vibrations or physical

contact from floating crewmembers. Lastly, the flight-ready certification process is a substantial hurdle, regardless of the underlying scanner architecture.

While NASA has been continuously seeking commercial solutions, a recent in-house development effort has also demonstrated novel hardware and algorithm configurations tailored for 0-g and 1/6-g environments. The new prototype relied on a low-cost depth sensor paired with an RGB camera. An ArUco marker-based visual recognition method effectively eliminated the burden of extrinsic calibration and reliance on controlled manual sensor maneuvering operation as with the common handheld scanner. This architecture substantially reduces crew setup overhead and operational constraints.

Although technical challenges still remain, proof-of-concept testing successfully verified that the prototype produces surface models comparable in quality to ground-based reference scans.

Overcoming these operational hurdles enables rapid, reliable whole-body surface scanning in space flights and habitats. Beyond supporting traditional data needs for suit sizing and hardware design, 3D body scan can provide key medical monitoring biomarkers, such as non-invasive insights into fluid shift, muscle atrophy, and underlying musculoskeletal composition changes over long-duration missions.

Furthermore, these scanning technologies have a significant potential for broader exploration needs, such as real-time interior occupancy analysis and Extravehicular Activity (EVA) operation planning.

Acknowledgement: This research was supported by NASA Human Research Program (HRP) Omnibus. Approved for public release (NASA STRIVES 20260008380).

Microwave Imaging & AI for Anthropometry: From Feasibility to Fully Automatic Through-Clothing Body Measurement

Christoph BAUR 1, Miriam SENNE 2

1 Rohde & Schwarz GmbH & Co. KG, Munich, Germany;

2 TU Munchen, CAMP (Chair for Computer Aided Medical Procedures), Munich, Germany

#51

Rohde & Schwarz (R&S) Microwave Imaging captures the human body through clothing noninvasively, free of respiratory motion artifacts and without requiring people to undress or hold still for more than a few seconds. In this talk, R&S presents their advances in coupling this imaging modality with AI-based surface reconstruction to fully automatically deliver 3D avatars & body measurements, and outline the application space this opens up.

4D Gaussian Splatting - From Capture to 4D Digital Human

Azad ABBASI, Richard DESTINE

GeniusXR, Montreal QC, Canada

#55

Abstract not available.

PLENARY SESSION – KEYNOTES

Invited Speaker

Why Google Developed a Parametric 3D Human Model and Open-Sourced It

Thabo BEELER

Google, Zurich, Switzerland

#59

In this keynote I will present our vision to build a modular open digital human ecosystem. I will introduce our Generative aNthropometric Model (GNM), explain how we developed it, what we are using it for within Google, why we decided to open-source the model, and where we see things going from here.

Invited Speaker

Beyond the Technology: Turning Human Data into Human Potential

Fabian SCHWEIZER

APEX Athlete Product Excellence, adidas, Germany

#66

Discover what we can learn when we listen to elite athletes and look beyond conventional product development.

Explore how body data, movement and athlete perception can help translate individual needs into meaningful product innovation.

Understand why the future of performance will not be driven by technology alone, but by the connection between humans, science and ambition: creating products that help athletes become world champions, break world records and redefine what is possible.

TECHNICAL SESSION 11: 3D/4D Body Scanning in Medicine & Health II

Forensic 3D Avatars - AI-Assisted Injury Detection and Interactive Digital-Twin Visualization

Michael THALI

Virtopsy Research Lab, Institute of Forensic Medicine, University Zurich, Zurich, Switzerland

#47

In this talk, Prof. Thali, co-founder of the Virtopsy Project, presents the study recently published in Forensic Science Medicine and Pathology (<https://doi.org/10.1007/s12024-026-01200-1>). The work demonstrates that combining a dermatology-based 3D full-body scanner system (Canfield Scientific VECTRA WB360) with artificial intelligence software enables rapid, color-accurate forensic 3D avatars that automatically detect, locate, and measure simulated injuries.

Feasibility and Utility of Digital Anthropometry:

Applications in Clinical Practice for Precise Management of Surgical Patients

Marco A. MINETTO 1, Chiara BUSO 1, Elisabetta QUILICO 1, Marta ANDRIGHETTI 1, John A. SHEPHERD 2, Steven B. HEYMSFIELD 3, Angelo PIETROBELLI 4

1 Division of Physical Medicine and Rehabilitation, Department of Surgical Sciences, University of Turin, Italy;

2 Department of Epidemiology, University of Hawaii Cancer Center, Honolulu HI, USA;

3 Pennington Biomedical Research Center, Baton Rouge LA, USA;

4 Paediatric Unit, Department of Surgical Sciences, Dentistry, Gynecology and Pediatrics, University of Verona, Verona, Italy

#10

We aimed to investigate in different groups of surgical patients the feasibility and utility of digital anthropometry for body size and composition assessment.

Two convenience samples of patients were recruited: the first sample consisted in 56 patients with late-stage knee osteoarthritis (scheduled to undergo primary total knee arthroplasty), while the second sample consisted in 42 post-bariatric patients (scheduled for plastic surgery).

The digital anthropometric assessment was performed before surgery in the first sample of patients, while it was performed before and 3 months after abdominoplasty (in 26 patients) and thighplasty (in 16 patients) in the second sample of patients.

In the first sample of patients, the median values of body fat percentage, fat mass index, and appendicular lean mass index were 28.3%, 7.8 kg/m², and 8.4 kg/m² in males (n=19) and 40.0%, 12.5 kg/m², 6.8 kg/m² in females (n=28). Most of the patients had fat mass index higher than the cut-points for excess fat, while 2 male patients and none of the female patients had appendicular lean mass index lower than the cut-point for low mass.

In the second sample of patients, significant pre-post-intervention decreases in waist and hip circumferences were observed in the abdominoplasty subgroup: the median decrease was 3.3 cm ($P < 0.0001$) for the waist circumference and 2.6 cm ($P = 0.002$) for the hip circumference. Significant pre-post-intervention decreases in thigh circumferences and leg volumes were also observed in the thighplasty subgroup: the median decreases of the left and right thigh circumferences were 1.7 cm ($P = 0.001$) and 1.5 cm ($P = 0.003$) and the median decreases of the left and right leg volumes were both 0.4 l (P values: 0.007 and 0.02).

Body composition characteristics in patients with knee osteoarthritis and surgical outcomes in patients undergoing plastic surgery can be quantified through digital anthropometric assessments. The availability of pre- and post-intervention avatars can be useful for both surgeons (for surgical planning and documentation of the surgical outcomes) and patients (for visualization of the surgical outcomes).

Improving Optical Body-Composition Estimates with a Standardized Hand Photograph: a DXA-Referenced Study

Matthew S. GILMER 1, Chiara BUSO 2, Marta BOCCARDO 2, Marco A. MINETTO 2, Steven C. HAUSER 1, David BRUNER 1

1 Size Stream LLC, Cary NC, USA;

2 Division of Physical Medicine and Rehabilitation, Department of Surgical Sciences, University of Turin, Turin, Italy

#28

Low-burden, scalable body-composition assessment is of growing interest for clinical and consumer use. Optical methods that estimate composition from body silhouettes are an established low-friction option, but the value of a single localized image, such as a photograph of the hand, has not been characterized. We evaluated whether a standardized hand photograph can improve the body-composition estimates produced by Size Stream's MS1 application, which estimates composition from height, age, weight, and gender together with front and side silhouettes, using dual-energy X-ray absorptiometry (DXA; Hologic Horizon Wi) as the reference. In 50 adults, two MS1 scans and two hand photographs were collected per subject; after MediaPipe landmark detection and segmentation, a homography rectification mapped the photograph to millimeters and 31 hand measurements and shape ratios were extracted and reduced to 17 by an a-priori collinearity screen. MS1 outputs were calibrated onto the DXA scale, and for each metric the residual (DXA minus calibrated MS1 estimate) was modeled from the hand features, the MS1 estimate itself, and gender. TabPFN (a Tabular Prior-data Fitted Network, a pretrained tabular foundation model) and an interpretable ordinary-least-squares (OLS) correction were fit on the same nested-selected features and evaluated by leave-one-out cross-validation (LOOCV). The interpretable OLS correction was the preferred model for most metrics, with TabPFN offering only a marginal, VAT-specific advantage. Lean mass of the arms (LMA) improved ~45% in mean absolute error (MAE, $p < 0.001$), visceral adipose tissue (VAT) ~33-37% in MAE and dispersion ($p \approx 0.01-0.05$), and lean mass of the legs (LML) ~24% ($p \approx 0.02-0.04$); bone mineral content (BMC) improved ~19% in MAE with a significant precision (SD) gain on the paired t-test. Body-fat percentage (BFP) showed only a small, non-significant gain, and its correction selected no hand feature at this sample size. A standardized hand photograph is therefore a useful additive signal for optical body-composition assessment, especially for lean and bone compartments

AI-Assisted Diabetic Foot Ulcer Surveillance: Integrating 3D Wound Measurement into Clinical Care

Alexander PEREZ, Artem SEMJANOW, Jeremy DUBLON

NextStepCare.ai, Fishers IN, USA

#63

Diabetic foot ulcers (DFUs) may deteriorate between in clinic care visits, particularly in patients with multiple comorbidities including but not limited to: peripheral neuropathy, peripheral arterial disease, hypertension, etc. Which would then impair sensation, circulation, or healing. This prospective case series will examine the integration of mobile 3D foot scanning, wound measurement, and artificial intelligence (AI) into a provider-directed clinical surveillance workflow. Patients or caregivers will use a smartphone to capture multiangle images of the foot. The images will be processed into point clouds and aligned with a three-dimensional foot model, enabling longitudinal measurement of the ulcer. Wound measurements will be combined with signals, including activity, patient-reported symptoms, comorbidities, and changes from the patient's baseline (i.e. changes in inflammation, color, necrotic tissue, exudate, etc.).

In this framework, the platform functions as a digital biosensing system: AI synthesizes inputs over time to identify patterns associated with wound deterioration or complications. The output will not independently diagnose complications or direct patients to the emergency department. Instead, it will provide clinicians with interpretable changes and risk signals to support decisions regarding continued monitoring, patient contact, expedited examination, or emergency evaluation if needed. Clinicians will retain responsibility for validating measurements, interpreting risk, and determining escalation. Across cases, the team will assess scan quality, measurement consistency, signal usefulness, alert relevance, clinical response, workflow burden, and reasons for escalation. Patient and provider feedback will guide iterative refinement of capture instructions, risk thresholds, dashboard presentation, and communication pathways. This work aims to define a clinically responsible approach to AI-assisted DFU surveillance that may enable earlier intervention, ultimately reduce complications, and limit preventable emergency-care utilization and emergency costs.

TECHNICAL SESSION 12: 3D/4D Body Data & Body Processing Technologies

IEEE 3141-2026, IEEE Standard for 3D Body Processing, Accompanied by an Example of Data Processor Architecture

Carol MCDONALD 1, Katherine SCHILDMEYER 2

1 Gneiss Concept, Tacoma WA, USA;

2 Design Cycle Solutions, Salt Lake City UT / New York NY, USA

#35

Institute of Electrical and Electronics Engineers (IEEE) are publishing in 2026, a new standard for 3D Body Processing, IEEE 3141, to help ensure interoperability of data and clarity of quality and fidelity of data. The benefits of new standard are: industry standard - dedicated 3DBP lexicon offers clarity, interoperability, and transparency to best match provider to vendor and encourage greater adoption of products; clarification for administrative and descriptive metadata tags (mandatory and optional) to provide for interoperability, transparency, and accessibility; and clarification on cybersecurity procedures and data access control for the "data subject".

IEEE 3141 is proposing to be the start of a family of standards, best practices and guides focusing on 3D Body processing. The standard was begun in 2017 and as the technology and understanding of humanoid data kept changing, content of the standard expanded as well. The content of the standard expanded from booth scanners and scanned humans to include phone apps and 4D scanners, digital models, parametric models, and deep fakes.

The context of the 3D Body processing environment provides understanding of the impact of pose, posture, attire (covers) and technologies on the subsequent fidelity and quality of humanoid data. Using the terms "Human" and "Humanoid" describe the transformation of human body data to modeled humanoid along with the terms "Cover" and "Coveroid" describe adornments on the human or humanoid.

Design Cycle Solutions has updated some of their existing scans to meet the IEEE 3141 standard. The person who was scanned was instructed to wear certain attire and to have a requested hairstyle. The scanner produces point-cloud which is then processed into a mesh. The mesh can be specified as tri-mesh. Since a scanner was used, human data is obtained from a point cloud which will pick up the posture of the person for the pose that has been instructed. The next step is setting up outputs that can be in various formats with the mandatory meta listed.

The administrative metadata of the version of IEEE 3141 timestamp, UUID, HUID, Cipher suite, natural language, and data processor's name. The descriptive metadata of length units, coordinate system type, coordinate system orientation, number of data elements, humanoid data encoding software, along with software version, captured posture, captured pose, and record of humanoid transformations. The italicized text is metadata related to IEEE 3141 that is native in the scanner program. The non-italicized text are fields of data that were required to be added to the file to meet IEEE 3141. In the instance that a more secure process is required, a cipher in the form of user keys can be used to connect to a data asset management (DAM) system and user specific sandbox. Any use of AI must be built into the permission structure by the data subjects, including the sandbox methods and code testing. The security of personal data shall follow the IEEE 3141 procedure with the human identified with an UUID and the humanoids with HUID and the secured processes.

A Humanoid Captured State Framework Supportive of Data-Driven Body-to-Product Pipelines

Emma SCOTT 1, Alfredo BALLESTER 2, James SCOTT 1

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2 IBV Instituto de Biomacencia de Valencia, Univ. Politecnica de Valencia, Spain

#22

Three decades of 3D body scanning have produced increasingly precise human geometry, yet its integration into body-to-product manufacturing pipelines remains largely unrealized. A central obstacle is the absence of a formal geometric definition of the human at the moment of data capture. Standards infer a static reference condition for anthropometric acquisition, but globally inconsistent landmarking practice makes practical application challenging. Downstream automated body-to-product pipelines therefore continue to struggle to consume non-standardized 3D body processed (3DBP) data.

Humanoids assume a static reference condition for anthropometric acquisition, but globally inconsistent landmarking practices mean that data derived from a scan may be delivered as clones (preserved pose, posture, and shape) or as twins (normalized pose, posture and shape). The twin proxy is widely used across body-to-product pipelines for virtual try-on, size selection, and

anthropometric measurement, raising the question this work addresses: is the twin fit for 'static' body-to-product purposes?

We propose the Captured State Framework (CSF), a geometric definition of the human as recorded at acquisition that preserves the individual's pose, posture, and shape rather than normalizing them. The CSF anchors surface geometry to deterministic landmark correspondence, derived rig joints, and designates a subset of those landmarks as attachment points through which a body-worn product can be correlated to the body.

To gauge the twin's fidelity to the clone, we pass five subjects through a body-to-product pipeline in both clone and twin states and track the difference through successive stages: humanoid geometry, posture, landmarking, the scan-to-pattern block, and the simulated garment. Because both blocks are drafted by the same method and assessed against the same clone, any difference is attributable to the humanoid state from which the block was generated. The twin diverges from the clone in the shape and posture factors that determine fit, and the divergence carries downstream to the pattern block and the simulated garment.

A twin observes population similarity, but every fit decision rests on subject uniqueness. Therefore, the captured clone is the reference against which fit should be assessed. Any fit assessment based on the twin proxy might start from a place of error. The CSF builds on established standards to present a framework for recorded subject uniqueness as a clone. This provides a ground-truth record of the individual suited to automated body-to-product pipelines and to higher-order analysis of posture, deformation, and dynamic fit.

A Case Study of Anthropometric Segmental Body Heights Variability Across Age Groups: Implications for Development in 3D Body Modeling and Pattern Making

Ziwen QIU 1, Katy SCHILDMEYER 2

1 Humanetics Digital, Cary NC, USA / Kaiserslautern, Germany;

2 Design Cycle Solutions, Salt Lake City UT / New York NY, USA

#34

This research uses a case study to explore how anthropometric databases can be translated into an apparel use-case-specific avatar and rig system, aiming to develop a segmental proportion variation matrix organized by height and age. This collaborative case study is between Humanetics Digital (Humanetics) and Design Cycle Solutions (DCS), combining complementary areas of expertise. Humanetics contributes extensive anthropometric body data and expertise in the analysis and interpretation of population-based body measurements, while DCS contributes specialized expertise in apparel fit, avatar development and rigging for apparel applications. Using selected female participants aged 18-75 years from the Size NorthAmerica database through iSize platform, the study investigates variability in segmental body heights among women of similar stature and explores how these findings can be translated into a new rigged-avatar application. The sample was in six age groups and three narrowly defined height groups. A frequency-based approach was applied to investigate common waist, hip, mid-hip, crotch, knee and rise height combinations. This approach can be generalized to investigate body characteristics impacted by other demographic or behavioral factors. Such data can be integrated into new and more narrowly defined population averages to identify potential morphotypes and phenotypes. iSize, with access to statistical data from in-market anthropometric databases, can assist this process by supporting data analysis and comparison of population groups. Based on the current findings, this study suggests that lower-body garment guidelines account for a vertical tolerance of approximately 3 cm where relevant to fit, to accommodate segmental body height variation. The identified body measurements were also translated into a demo rig architecture, to showcase technological possibilities of having better control over avatars' posture and shape during overall or segmental height adjustment. In the future, a foundational dataset and drawing conclusions based on available evidence or reasoning models can be established to enable 3D body platforms to generate statistically informed and proportionally accurate avatar body types across diverse global populations. Potential applications include parametric avatar systems, digital human rigging, and fit-predictive tools.

Utilizing 3D Body Data and Size Distribution Metrics for Material Quantification and Circular PLM Modelling: The AIDESIGNTEX Framework

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R.M. Chandima RATNAYAKE 3, Katarzyna GRABOWSKA 2

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3 Department of Mechanical and Structural Engineering and Materials Science,
University of Stavanger, Stavanger, Norway

#36

This paper presents a conceptual framework developed within the AIDESIGNTEX microproject to transform 3D body data applications from individual garment fit to macro-level resource planning. By integrating order-specific size distribution percentages into the 3DExperience PLM ecosystem, the framework automates material volume forecasting and lifecycle pre-evaluation. The results demonstrate a predictive pipeline that quantifies raw material demand and regulatory compliance indicators at the pre-contractual stage.

TECHNICAL SESSION 13: 3D/4D Capture, Technologies & Applications II

Capturing Realistic Human Body 3D Data:

An Open Dataset and Pipeline for Absolute Anthropometric Measurement

Trine KIRKHUS 1, Marianne BAKKEN 1, Martin Eek GERHARDSEN 1, Peter Ornulf IVARSEN 1,
Jonatan Kjekshus WINSVOLD 1,2, Gard SPREEMANN 1, Oyvind Gloersen HAGA 1

1 SINTEF Digital, Oslo, Norway;

2 University of Oslo, Oslo, Norway

#26

In order to make realistic and individualized digital human body models, absolute real-world measurements are needed. We share an open dataset consisting of 360° 3D scans, including raw point cloud data, 2D silhouette images and anthropometrics from twelve individuals. The dataset spans a wide range of human shapes and body mass indexes.

We present a portable 3D imaging rig that captures 360° point clouds of humans at up to 30 frames per second. The system is designed to balance data quality, acquisition speed, cost and ease of setup and use. We introduce an automated online extrinsic calibration using jointly observed landmarks to simultaneously calibrate all 3D cameras and tools to perform anthropometric measurements from the point cloud data.

The dataset is available as <https://doi.org/10.82923/h5fd-s294>.

Bridging the Digital Grid and Embodied Musicality:

A Didactic-Driven 3D Visualization Framework for Bulgarian Folk Dance Education

Anna Maria BOLYA 1, Attila GILANYI 2, Ivan JANKELIC 2

1 Hungarian Academy of Arts, Research Institute of Art Theory and Methodology, Budapest, Hungary;

2 University of Debrecen, Faculty of Informatics, Debrecen, Hungary

#21

This paper introduces an innovative 3D visualization framework designed to resolve longstanding didactic challenges in folk dance education, specifically focusing on the perception of a polyrhythmic mindset: the divergent progression and phase shifts between dance and music, and the internalization of non-isochronous or asymmetric or aksak rhythms in Bulgarian traditional dance. Developed through a multi-year interdisciplinary collaboration between the Hungarian Academy of Arts Research Institute of Art Theory and Methodology (HAA RIATM), the Arts and Research Ltd., and the Faculty of Informatics at the University of Debrecen, the project transitioned in 2024 to a markerless studio setup utilizing Move AI to extract 3D skeletal data from three synchronized hardware-locked video camera streams. Working with technical execution partner Digitalis Legendarium Kft. (2025) and international academic collaborators (Academy of Music, Dance and Fine Arts "Prof. Asen Diamandiev", Plovdiv), an interactive 8-module micro-learning curriculum was built, presenting Gankino horo (11/16 meter, 2+2+3+2+2) as a core case study.

Optimized for the Sketchfab 3D rendering engine and fully synchronized with the audio material, the framework features a neutral grey dancing avatar mesh, interactive 360-degree free-orbit spatial camera controls, and a single visualizer orb pulsing to the 2+2+3+2+2 pattern. Crucially, the system employs color-coded dual metric floor tracks beneath the dancer to visually display the divergent

progression, phase shifts, and variation of periods between the acoustic timeline and kinetic step cycles, successfully bridging the somatic sensation of the dancing body with spatial awareness and embodied musicality. Preliminary user evaluations demonstrate significant performance gains across university professional dance students, Western European Balkan club enthusiasts, and diaspora heritage preservation groups.

Interpretable Facial Motion Analysis Using Geometric Features Based on Facial Metric 3D Information

Wang LIAO 1, Shiyao GAO 1, Yan ZHANG 1, Chen ZHANG 1, Gunther NOTNI 1,2

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2 Fraunhofer IOF, Jena, Germany

#27

Dynamic facial motion appears as local geometric deformations developing over time. Although 2D image-based and deep learning methods can recognize facial actions, their outputs often lack direct physical scale and clear geometric interpretation. This work evaluates a metric 3D geometric representation for interpretable dynamic facial motion analysis. Synchronized RGB images and metric point clouds were acquired at 15 Hz using a high-speed camera system with a near-infrared GOBO structured-light projector. By mapping MediaPipe detections to metric point clouds, 468 metric 3D facial landmarks were extracted. Guided by facial muscle anatomy and the Facial Action Coding System (FACS), 62 geometric features, including distances, angles, areas, and plane displacements, were defined across six facial regions covering 20 Action Units (AUs). Evaluated on 963 action-phase samples from ten participants, feature sequences effectively tracked motion progression from onset through apex to offset, achieving a mean absolute Pearson correlation of 0.8530 with annotated reference curves across all 20 AUs. In cross-participant action unit classification using a Random Forest classifier under leave-one-participant-out validation, the representation achieved Top-1, Top-3, and Top-5 accuracies of 62.51%, 88.68%, and 95.22%, respectively. Feature importance and confusion patterns directly correspond to the defined facial regions and local geometric changes, supporting the physical interpretation of model decisions and identifying discrimination limits among similar facial motion patterns.

TECHNICAL SESSION 14: 3D/4D Body Scanning for Apparel III

Examining Anthropometric Variables Used in Bra Sizing through 3D Body Scanning

Qiantong CHEN, Kristina BRUBACHER, Simeon GILL, Lei ZENG

Department of Materials, University of Manchester, Manchester, UK

#08

Traditional bra size classification is primarily based on bust and underbust girths. Although these measurements describe overall body dimensions, they do not show how the corresponding circumferences are distributed across the anterior and posterior torso. This study investigates variation in front arc proportions at the bust and underbust levels among women classified in the same bra size and considers the relevance of regional measurements to bra pattern development. Existing 3D body scans of 30 women aged 18-25 years classified as size 75A were analysed. Front and back arc measurements were generated by the Size Stream system, and front arc proportions were calculated at both measurement levels. The findings revealed considerable variation in front arc proportions at both the bust and underbust levels within the same size group. Comparisons between selected participants further showed that identical or almost identical total girths could be associated with different distributions of the corresponding circumferences across the anterior and posterior torso. These findings demonstrate that conventional bust and underbust girths do not fully represent regional body dimension distribution within a bra size. Regional arc measurements obtained from 3D body scans can therefore provide additional anthropometric information when considering how pattern dimensions are allocated between the front and back sections of a bra.

Effect of 3D Body Shape Variation on Sensor Performance in Pregnancy Monitoring Garments

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3 Department of Clinical Physiology, Karolinska University Hospital, Stockholm, Sweden;

4 Department of Medical Technology, Karolinska University Hospital, Sweden

#17

Sensorized garments enable continuous monitoring of pregnancy health parameters through wearable sensors integrated into textile structures. During pregnancy, the female body undergoes continuous anthropometric changes, particularly in the abdominal region. These changes are not uniformly distributed across the body, as the abdomen, waist, and hips often show disproportionate growth compared with other body regions. As pregnancy progresses, abdominal growth alters torso dimensions and surface geometry, which may affect garment fit and the consistency of contact between the sensor and skin. Stable sensor-skin contact is essential for wearable monitoring garments, since variations in contact pressure, placement, or movement between the sensor and the body may influence sensor performance, signal stability, and data quality. This highlights the need for a better understanding of the relationship between abdominal shape variation, garment adaptation, sensor-skin contact, and signal quality in pregnancy monitoring garments.

The aim of this study is to evaluate how changes in abdominal shape during pregnancy can be characterized using 3D body scan data and how this information can support the design of sensorized garments for pregnancy monitoring. The focus is on understanding how changes in abdominal size and shape affect garment fit, sensor placement, and the stability of sensor-skin contact, which are key factors for reliable signal acquisition.

The study uses 3D body scan data to analyze changes in the torso and abdominal region across different stages of pregnancy. Abdominal circumferences and lengths over the abdomen are used to describe changes in body dimensions, while abdominal projection is used to describe variation in abdominal shape.

These body-shape characteristics show how abdominal growth modifies torso proportions and surface geometry, which are relevant for sensorized garment fit and sensor positioning.

This information is then translated into consideration for designing sensorized garments; addressing two main aspects: suitable areas for sensor placement and appropriate fit levels. Sensor placement is considered in relation to areas where stable sensor-skin contact is needed, while fit levels, such as tighter and looser fit, are used to examine how the garment adapts to changes in abdominal size and shape. The fit is evaluated in defined body postures and with simple controlled movements, maintaining wearer comfort without compromising garment-body contact, and sensor-skin interaction.

The study examines how 3D body-shape data can be translated into design strategies for sensorized pregnancy monitoring garments. It considers the role of garment fit and sensor placement in maintaining stable sensor-skin contact, and how these contact conditions may influence signal quality. Although final results are not concluded, the expected contribution is to provide design-knowledge that supports the development of sensorized garments, accommodating abdominal shapes relevant during pregnancy while maintaining both wearability and reliable signal acquisition.

The Impact of Technology on the New Product Development Process for Intimate Apparel

Cassie LAMBERT, Elizabeth EASTER

University of Kentucky, Lexington KY, USA

#31

This research aimed to better understand how 3D CAD Software impacts the new product development process for intimate apparel. As a category, Intimate Apparel lags behind other categories in adopting new technology. Interviews with industry professionals explored their adoption and use of 3D CAD Software. Two case studies also compared the adoption strategies of a small and a large company. Coding of the interview and case study data revealed similar relationships and common themes across all participants. Findings show that the strategic implementation of 3D CAD Software reduces sample iterations and lead time, enhances cross-functional team communication, and supports earlier decision-making on fit, pattern adjustments, and material selection. The research also identified barriers to technology use and adoption. These include limitations on material

digitalization, training time, and reduced fit model input. The study contributes a practical framework for integrating 3D CAD software into the New Product Development Process of Intimate Apparel.

Algorithmic Aspects of Clothing Recognition on 3D Scans

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Institute of Textile Machinery and High Performance Material Technology (ITM),
TU Dresden, Germany

#33

The identification of garment and exposed-body regions of the human body in 3D or even 4D scans will allow significant improvements in the engineering methods used for fit evaluation and enhancement. At this point it is a complex and time-consuming process, but first approaches of leading researchers in computer graphics are already reported, such as CloSe: contributing both a state-of-the-art neural network architecture (CloSe-Net) and a publicly available dataset with ground-truth segmentation labels (CloSe-Di). In this work, the architecture and dataset were adapted and utilized for training of three models based on different datasets (real, synthetic, mixed) and consequently tested with real scan data in form of a static A-Pose, obtained from the Move4D scanning system. As a first proof-of-concept, it is shown that training of such neural networks with even basic synthetic data can yield successful results in the recognition of clothing on real data.

CLOSING SESSION

Closing Speech from the Conference Director and Announcements for 3DBODY.TECH 2027

Nicola D'APUZZO

Hometrica Consulting, Switzerland

#CS

3DBODY.TECH 2026 - The 17th International Conference and Expo on 3D/4D Body Technologies was successfully closed in Lugano on the evening of 21st October 2026.

The program of the conference was structured, during two full days, in 1 opening session, 14 technical sessions in dual track, 1 plenary keynotes session and live demonstrations sessions, accommodating in total over 80 technical and scientific presentations, grouped according to various topics and application areas.

The conference confirmed also this year to be the most important international event focused on 3D & 4D body scanning, body data and body processing technologies.

The proceedings of the conference are available for purchase in digital form. The proceedings, organized as a website, provide details of the technical sessions, and give access to all abstracts, to all published papers (as single PDF documents), to all recorded presentation videos and to all recorded sessions (opening session, technical sessions, exhibitors' live demonstrations).

3DBODY.TECH 2027 - The 18th International Conference and Expo on 3D/4D Body Technologies, will take place on 19-20 October 2027, in Lugano, Switzerland.

3DBODY.TECH 2027 will be held as a full in-person event with conference & expo taking place onsite in Lugano, with all speakers (100%) and the large majority of attendees onsite (80-90%). Online participation will be available for remote attendees (10-20%). All contents of the conference will be live streamed and recorded for later view.

Our goals/expectations for 2027 are:

200+ onsite & 50 online participants

80+ presentations

25+ exhibitors

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