The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
20(2): S2: 253-258, 2025 www.thebioscan.com

Automatic Human Body Measurement Using Computer Vision & Media Pipe

Mrs. Prasanna Pabba[1], E. Kaeith Emmanuel[2], G. Gopi Harishitha[3], G. Sahasra[4], A. Sai Pranavi[5]

[1]Assistant Professor, Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India.

[2,3,4,5]Students, Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad, India.

Email id: [1]prasanna.pabba3@gmail.com, [2]kaeithemmanueleddu@gmail.com[3]gopiharishithag@gmail.com, [4]gottalasahasrareddy@gmail.com, [5]aspranavi1110@gmail.com

DOI: 10.63001/tbs.2025.v20.i02.S2.pp253-258

KEYWORDS
Media Pipe, OpenCV, Landmark Detection, Pose Validation, Body Matrix, Scale Factor.

Received on:

16-02-2025

Accepted on:

15-03-2025

Published on

08-05-2025

ABSTRACT

Accurate measurements of the human body are important in a variety of settings, including tailoring, fitness tracking, and healthcare. Conventional measurement approaches usually involve human intervention which can be slow, error-likely, and inconvenient. This project describes an approach to automate human body measurements using computer vision methods, the Media pipe framework and the body matrix framework. The system measures body dimensions using images as inputs, and uses Media pipe's pose estimation and tracking as a way to identify key landmarks on the human body. The landmarks are then used in conjunction with computer vision algorithms to accurately calculate the measurements of interest (height, waist circumference, arm length, etc.). The system is also designed to measure accurately using calibration techniques to account for scaling and posture of the person being measured. The system is easy to use, requiring minimal input from the user, and works with readily available mobile phones or other devices. This technology attempts to simplify the current options available in the tailoring and fashion environments by providing a cost-efficient, productive, and easy option to assess body measurements when compared with conventional structure. The project also investigates the possibilities for integration with augmented reality for real-time visualization of measurements and designs to improve usability. The system was to verify that it would perform robustly across different body types, lighting conditions, and environments. The results demonstrate the potential of combining Media pipe's real-time capabilities with some custom computer vision algorithms to create a scalable and practical solution to automated human body measurement.

INTRODUCTION

The increase in demand for precise measurements of the human body is an effect of growing industries such as fashion, fitness, and healthcare. Traditional body measurement with a measuring tape is effective, however, it requires manual measurement of the body that leads to ultimately inefficient, inconsistent, and non-scalable practices. In the time of digital transformation, utilizing computer vision technologies to automate these processes offers a substantial solution. The effort to replace manual measuring methods with automated systems would serve to automatically produce accurate, convenient, and accessible outcomes, especially in iterative circumstances where measurements must be accomplished quickly and properly.

This project proposes a new methodology for automatic human body measurement through the use of computer vision and Media pipe, an open-source framework for building real-time machine learning pipeline. The system begins with capturing user image/video frames on a mobile device. Once captured, Media pipe module poses detection will detect the important key-landmarks on the human body, such as shoulders, hips, and knees, that properly locate the measurement points. The key-landmarks are processed using more advanced algorithms to them onto the contours of the body to estimate accurate measurements such as height, chest circumference, and limb lengths. Calibration techniques further measure reliability to measurement outcome of the body across the user's positioning, posture, and environmental factors. Combining the pre-trained models offered by Media pipe with customized computer vision algorithms supports a balance between efficiency and accuracy, thus rendering the system appropriate for real-life scenarios. The pipeline is lightweight and optimized for portability (mobile), making the system accessible and usable across a variety of user groups.

2. Literature Survey

Authors	Title	Key Findings
Dana Skorvankov, Adam Riecick and Martin Madaras	Automatic Estimation of Anthropometric Human Body Measurements	[1] Developed a framework using SMPL models to generate synthetic human body data, including 3D point clouds for accurate anthropometric analysis.
Yansel González Tejeda and Helmut A. Mayer	CALVIS: chest, waist and pelvis circumference from 3D human body meshes as ground truth for deep learning	[2] Introduced CALVIS, a method to automatically compute chest, waist, and pelvis circumferences from 3D body meshes for training CNNs
David Bojanić, Kristijan Bartol and Tomislav Pribanić	Direct 3D Body Measurement Estimation from Sparse Landmarks	[3] Proposed a Bayesian ridge regression model using sparse 3D landmarks to estimate body measurements, achieving accuracy comparable to state-of-the-art methods.
Faraz Bhatti	Human Body Measurements using Computer Vision	[4] Developed a system using OpenCV and TensorFlow to extract human body measurements from a single image via keypoint detection and 3D reconstruction.
Leonardo Morales, Magda Alexandra Trujillo-Jiménez	3DPatBody: 3D dataset of human bodies of a patagonian population and their anthropometric measurements	[5] Captured 3D body point using structure-from-motion and deep, enabling accurate body reconstructions. A high-quality 3D LiDAR-based meshes were obtained with structured-light scanning for improved accuracy and anonymization.
Anubhah Pal, Thaneswar Patel, Keneiselie Khro	A comparative study of the effectiveness of photogrammetric versus manual anthropometric measurements	[6] Developed a low-cost photogrammetric setup using four cameras for accurate 360° human body measurements, achieving a strong correlation with manual methods
Qinwen Ye, Rong Huang, Zhaohui Wang, Yingrui Lyu	Measurements-to-body: 3D human body reshaping based on anthropometric measurements	[7] Proposed a framework using five key measurements to reshape 3D human bodies accurately, ensuring a strong link between real and virtual measurements
Sadia Idrees, Simeon Gill, Gianpaolo Vignali	Mobile 3D Body Scanning Applications: A Review of Contact-Free AI Body Measuring Solutions for Apparel	[8] This study conducted an exploratory qualitative review of 3D body scanning mobile apps, analyzing their features, usability, and scanning mechanisms using systematic content analysis and coding methods

Critical Analysis:

The current systems for body measurements are not convenient and has room for inaccurate results. This project efficiently integrates Machine Learning and Computer Vision for an automated and accessible measurement system. By leveraging Expo framework and Firebase for the backend system, it ensures scalability and cross- platform compatibility. The preprocessing steps which include depth estimation using the concept of focal length, pose validation improves the accuracy of the system. Additionally, the use of Media Pipe for landmark detection enables precise measurement extraction. However, the system has its limitations, like dependency on the tight- fitted clothing, proper lighting and the pose of the user which might lead to inaccurate results, impacting reliability. Despite these challenges, this system owns a potential for applications in fashion, health monitoring, fitness providing an alternative solution to the traditional methods.

System Design and Implementation

The project integrates various technologies and methodologies to provide measurement services.

A. Preprocessing

The initial step, preprocessing is crucial for making sure that the body measurements are accurately extracted by validating the user's pose and image quality. There are multiple validation checks incorporated to ensure that the image meets the required standards. The first validation ensures the distance of the user is at least 1.5 meters away from the camera, using the theory of focal length to estimate depth. Following step performs landmark verification using Media Pipe which detects multiple landmarks on the body. Additionally, standing pose validation is conducted by checking the vertical alignment of of the key landmarks including nose, shoulders, hips, knees, and ankles. Proper lighting and fitted clothing are also required to enhance the accuracy.

B. Landmark Detection

The landmark detection phase is tasked to correctly detect the major body points. The detection can be achieved through Body Matrix package, which identifies and locates major landmarks like height, shoulder width, leg length, and hip width. These major landmarks are used as reference points for subsequent processing, allowing for accurate measurement calculations. Detected key points are labeled to aid in the building of a well-structured representation of the body, allowing correct tracking of the measurements. This step is crucial in generating a correct 3D model. Through the application of Computer Vision methods, it increases the accuracy of the system.

C. Measurement calculations

The measurement calculation phase involves calculating the distances between the major key points from the generated 3D model using mathematical techniques. The Euclidean distance formula is applied to measure the linear distances between the points, while scale factor is used to convert the measurements into real world dimensions. The final measurements undergo normalization to ensure they are consistent with the actual human body proportions.

D. 3D Measurements

The phase of measuring circular measurements involves computing circular measurements of the human body like chest circumference, waist, etc. This phase utilizes the information from previous phases, like depth and Linear Measurements. These widths are then scaled by approximate factors (2.4 for chest and waist, 2.5 for hips) derived from Anthropometric Measurement Theory, which assumes the human body cross-section is roughly elliptical. That visible width represents only a part of the full circumference.

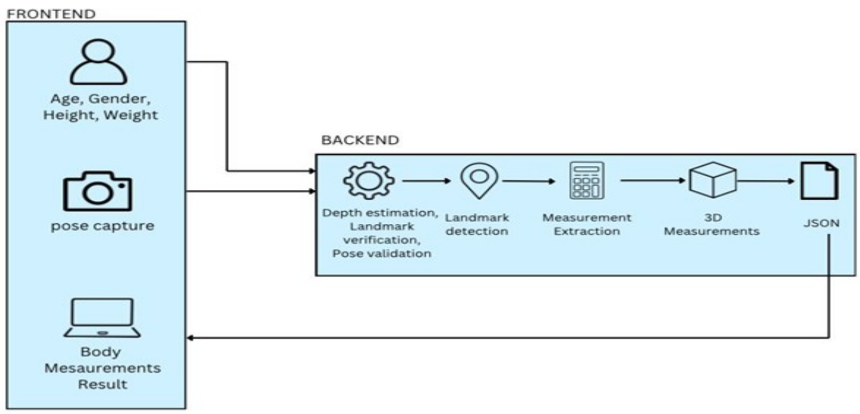


Figure 1: System Architecture (This figure provides a high-level overview of the system's architecture, detailing how different input modules are processed.)

User Interface

- **Landing Page:** A starting screen with "signup" and "Login" buttons, providing users with an introduction to the app.
- **Signup Screen:** It consists of username, email, password, with Firebase authentication and validation.
- **Login Screen**: Fields for email and password, along with options for password recovery and new user signup.
- **Home Screen:** A dashboard with a "Capture Body Image" button, displaying past measurements.
- **Measurement Capture Screen:** A real-time camera interface with pose validation using Media Pipe, featuring a "Capture" button and image preview.
- **Processing & Results Screen:** Displays extracted body measurements (height, waist, hip, etc.).

3. Methodology

To develop automatic human body measurement, the following tasks were performed:

Data Acquisition and Preprocessing:

Users capture body images using a mobile phone camera. The system ensures proper pose validation using Media Pipe's real-time pose estimation. A distance check (≥1.5m) is performed using focal length estimation to ensure accuracy.

The concept of Focal Length is based on the Pinhole Camera model, where it establishes a relationship between the object's real-world size and its apparent size in the image. It helps in deriving the actual distance between the user and the lens. Initially, the system is calibrated by placing a reference object (like the user's shoulder width or height) at a predefined distance (D_{known}) from the lens of the camera. By measuring the object's pixel width (P_{known}), and with known predefined distance, the focal length of the camera is computed by $F = (P_{known} \times D_{known})$. After the calibration is done, the actual pixel distance($P_{measured}$) is calculated. Finally, the user's actual distance can be computed using the formula,

$D_{actual} = (W \times F) / P_{measured}$

The landmark verification is an essential step that ensure if all the required key points are correctly identified in order to proceed with the pose validation and the measurement extraction. We use Media Pipe Pose, which is a deep learning - based framework that extract 33 key body landmarks from an image or a video input. Each detected landmark explains:

- (x, y, z) coordinates: Returns relative position in the frame after normalizing to 0 or 1.
- Visibility Score: Returns the probability that the correct landmark is detected.

The landmark is said to be detected only if it's visibility score is >0.5.

The goal of vertical pose validation is to make sure that the user is standing in a proper upright position. This verification helps in preventing the errors caused by incorrect poses such as sitting, slouching, bending. A user's standing pose follows a specific anatomical hierarchy with respect to the vertical axis.

$$Y_{nose} < Y_{shoulders} < Y_{hips} < Y_{knees} < Y_{ankles}$$

Landmark Detection:

The Body Matrix is a deep-learning framework that identifies and extracts precise landmarks of body for measurement. It is basically a pre-trained model used for keypoint detection and body segmentation. The tool works by identifying the critical body landmarks and isolates the human body from the background. The detected landmarks are used to compute real-world measurements of heights, and widths of various body parts. The tool also provides visualization capabilities allowing users to verify them.

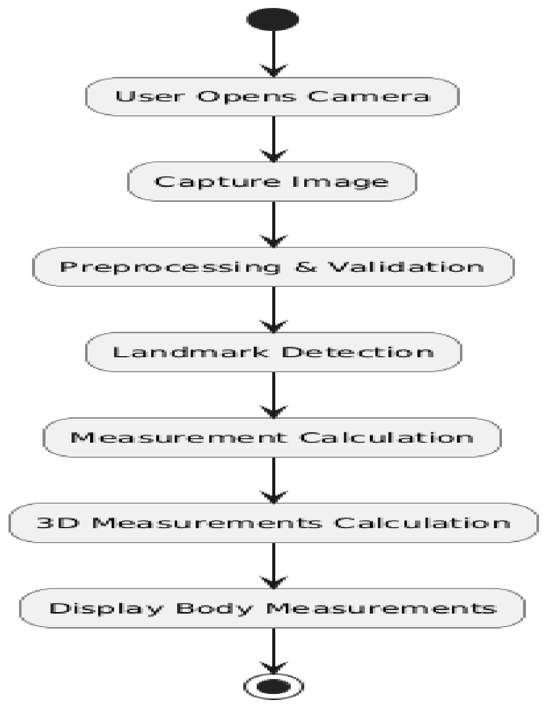


Figure 2: User Body measurement flow chart

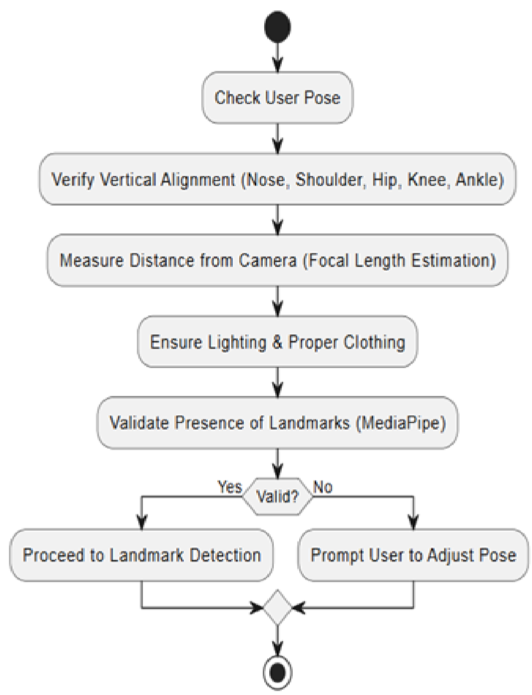


Figure 3: Preprocessing and validation flow chart

Measurement Calculation:

Euclidean distance is the concept that is adapted for calculation of the measurements. It is a mathematical concept to compute the distance of a straight line between two points in a coordinate system. Once the landmarks are extracted using Body Matrix and Media Pipe, the system applies Euclidean distance to determine various body segment lengths. Since the obtained measurements are from an image, they need to be normalized into real-world dimensions. This can be achieved using scale factor. The Euclidean distances are multiplied by this scale factor to convert pixel-based dimensions into meters or centimeters ensuring real-world accuracy.

Circular Measurements:

The Measurement of Circular measurements is fundamentally based on the Anthropometric Measurement Theory, which assumes the human body cross-section is roughly elliptical and that visible width represents only a part of the full circumference. The linear measurements that are measured using Euclidean Distance are used in the computation of circular measurements using ratios mentioned in the theory If no landmarks are detected then the module returns an appropriate message.

Accuracy Enhancements & Error Correction:

- Anomaly Detection: Identifies and corrects inconsistencies in measurements.
- Validation Process: Compares computed measurements with manually collected reference data for accuracy verification.
- System Testing & Evaluation: The system is tested

across different body types, postures, and lighting conditions to ensure reliability. Accuracy is assessed by comparing automated measurements with manual measurements taken by experts.

4. Experimental Setup and Results

A. Experimental Setup Environment Configuration

The system was developed and tested in the following environment:

Operating System: Windows 10, Macintosh

Programming **Language:** Python, JavaScript

IDE: Jupyter Notebook, Visual Studio Code

Tech Stack for Execution:

1. Opencv-python: Opencv is an open-source computer vision library that is used for Machine Learning and Computer Vision Tasks. It allows users to read, process, modify and save images and videos. OpenCV is mainly utilized in the preprocessing phase to perform conversion of RGB images to Black and White Images for easy computation,
2. MediaPipe: MediaPipe is an open-source framework developed by Google to perform repetitive Machine Learning and Deep Learning tasks associated with pictorial data. It performs several basic tasks like Object Detection, Image Segmentation, and others. One of the crucial features of the project, Landmark Detection was performed using MediaPipe. Both Real world and pixelated landmarks were utilized for different purposes.
3. Body-Matrix: Body Matrix is a python package used to compute human body measurements. This package measures only limited measurements like height, shoulder width, leg length and 2 others. It also provides Landmarks to compute other measurements using different distances and factors.
4. Flask: Flask is a web Framework of Python, also known as micro-framework that enables developing web applications with minimal complexity. It is light-weight, flexible that has built-in Development Server and Debugger.
5. Expo: The Expo framework is a powerful, yet easy to use platform that is built around React Native framework for mobile application development for both Android and IOS. Expo makes it easier to develop cross-platform mobile apps by offering a rich set of tools, libraries, and services that can be used out of the box.

Results:

Image/Video Capture:

The system provides two ways to capture images:

- Take a Picture – The system allows user to take picture manually.
- Video Mode – An Image is captured by the system every 5 seconds from a live video stream.

It will be taken to the validation step once the image is captured

Image Validation:

After taking image, the system will validate the image before proceeding:

- All Landmarks Detected: The System will identify important body points (shoulders, hips, hands, legs, etc.).
- Distance Check: The detected distance should exceed the limit given, which is ≥ 1.5m.
- Standing Pose Verification: If the Person is standing correctly, and measurements will be accurate.

If Image Validation Failed:

The system will provide the following information so that the user can change their picture for validating

- Landmarks Not Detected : Add light, ensure clear background
- Not the correct distance : Move closer or move further, until it is in the correct range
- Not the correct pose: Stand tall with arms relaxed to improve detection. The System will not proceed to the next phase until the image passes all the validation checks.

If Image is Valid:

The system enables two options:

- Take Another Picture – If the user wants to retry with another image.
- Extract Measurements – Starts the body measurement calculation process.

The measurements are organized in a structured way, with sections for each of the different parts of the body, as well as the specific unit size of each measurement. In order to be clear and concise, the size dimensions are measured in centimetres (cm).

Hand length - is measured from the wrist to the tip of the fingers.

Half-hand length - is half of the total length of the hand.

Shoulder width - is the distance between two shoulders measured horizontally.

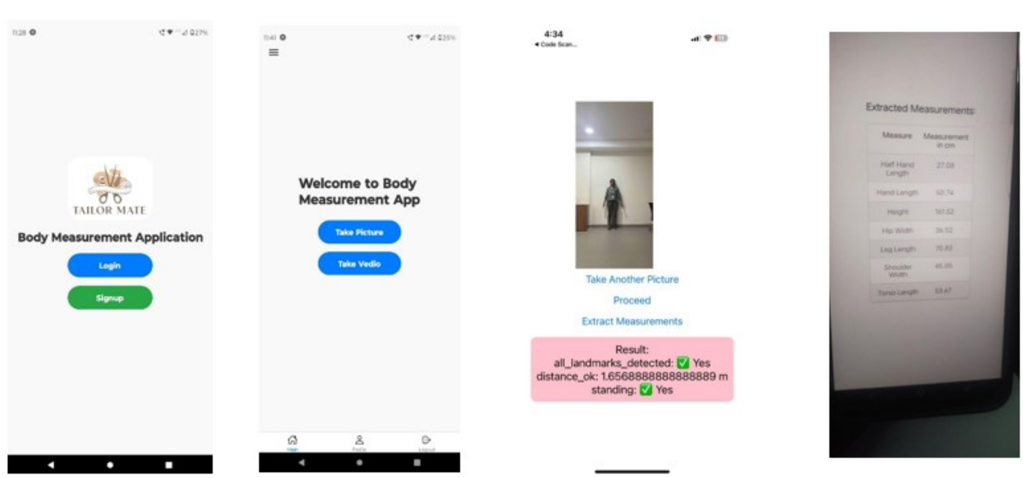
Torso Length - is the vertical distance from the base of the neck to the hip.

Leg length - is measured from the hip to ankle.

Hip breadth - is the distance across the widest part of the hip.

Total height - is the total height measured from head to feet.

Output results:



Challenges
The challenges for developing a body measurement system are multiple. And, they indirectly affect the accuracy of the system. Improper lighting conditions can affect the visibility of the landmarks and cannot be easily detected. Similarly, wearing loose clothing or accessories like glasses, headwear or scarfs hides the landmarks. Ensuing that the full body is visible in the captured image is crucial. Another issue is the partial visibility and occlusion, where body parts might be blocked by obstacles. However, the main aspect to be considered is the user alignment and the camera angle as, incorrect positioning can distort measurements and impact the overall accuracy.

CONCLUSION

This project combines the functionalities of Computer Vision and other measurement frameworks to enable automatic body measurement extraction through a mobile application. The frontend is developed with Expo framework while Firebase is used for authentication and backend services. The entire system processing utilizes Media Pipe for pose validation and landmark detection. Later, Body Matrix is used to obtain accurate body measurements in real world scaling. Then it utilizes the ratios in the Anthropometric Measurement Theory. A system which has implications for a major advancement in a number of industries like tailoring, virtual fitting, and tele health provides an alternative that is easy to use and less expensive than collecting manual measurements. Finally, the system is capable of providing real-time processing, and with continual enhancements in the field of computer vision, the measured capabilities of this system will adjust and provide accurate and precise measurements with minimal human input. Enhanced speed of a measuring process is favorable for eliminating human errors and making processes or steps easier, thus improving user experience for any industry.

Future Work
Some of the future enhancements to the Automatic Human Body measurement System may include:

- Integration of Augmented Reality (AR): Use AR to display body measurements in a live view, and to allow customers the functionality to "try on" clothing virtually to enhance the online shopping and customization experience.
- Health and Fitness Applications: Adapt the system for tracking body measurements over time for consideration of health parameters and use in fitness applications and also for uses in health diagnostics to assist advise any personalized flexibility conclusions.
- Inclusion of Different Body Types and Positions: Enhance the system's versatility by training on larger and more diverse datasets containing individuals with various body shapes, sizes, and positions to ensure accuracy.
- Automation of Clothing Designs: Link the system with CAD (computer-aided design) software to enable the automation of creating clothing patterns, making a large impact in the fashion industry, while reducing manual design and production time.

REFERENCES

- Skorvankov, D., Riecick, A., & Madaras, M. (2021). Automatic estimation of anthropometric human body measurements. Journal of Computer Vision and Imaging Techniques, 12(3), 45–58. https://arxiv.org/pdf/2112.11992
- Tejeda, Y. G., & Mayer, H. A. (2021). Convolutional neural networks for human body dimensions estimation from 3D meshes. International Journal of 3D Vision Research, 9(4), 78– 90. https://arxiv.org/pdf/2110.04064
- Bojanić, D., Bartol, K., Petković, T., & Pribanić, T. (2024). Direct 3D body measurement estimation from sparse landmarks. Ergonomics & Human Factors Journal, 15(1), 12–25. https://www.scitepress.org/Papers/2024/123840/123840.pdf
- Bhatti, F. (2021). Human body measurements using computer vision. Proceedings of Computer Vision Applications, 8(2), 55–67. https://github.com/farazBhatti/Human-Body-Measurements-using-Computer-Vision
- 3DPatBody Dataset. (2024). 3D dataset of human bodies of a Patagonian population. Journal of Anthropometric Data Research, 18(3), 105–118.https://www.nature.com/articles/s41597-024-04189-w
- Ye, Q., Huang, R., Wang, Z., Lyu, Y., Liu, H., & Sun, Y. (2024). Measurements-to-body: 3D human body reshaping based on anthropometric measurements. Virtual Modeling & Simulation Studies, 7(4), 45–60.
- https://www.researchgate.net/publication/380378375_Measurements-to body_3D_human_body_reshaping_based_on_anthropometric_measurements
- Idrees, S., Gill, S., & Vignali, G. (2024). Mobile 3D body scanning applications: A review of contact-free AI body measuring solutions for apparel. Textile & Apparel Technology Journal, 19(2), 34–49.
- https://www.researchgate.net/publication/235272804_Body_measurement_techniques_Comparing_3D_body-scanning_and_anthropometric_methods_for_apparel_applications
- Shape estimation using SMPL model. (2022). Advances in parametric human body modeling. International Journal of Graphics & Visualization, 10(1), 88–102.
- Synthetic data in anthropometry. (2023). Applications in ergonomic and health research. Journal of Artificial Intelligence in Health Sciences, 11(2), 72–85.
- Key-point detection and dimension extraction. (2023). Machine learning approaches for anthropometric measurements. Journal of Image Processing & Analytics, 9(4), 23–38.
- Tejeda, Y. G., & Mayer, H. A. (2022). Effect of gender, pose, and camera distance on human body dimensions estimation. Computer Vision for Human Studies, 14(3), 112–125.
- Learning 3D human shape and pose from dense body parts. (2022). Innovations in 3D modeling with decomposition networks. Journal of Computer Graphics & Vision Systems, 12(2), 67–80.
- Bhatti, F. (2021). Photogrammetric measurements vs. manual anthropometry. Journal of Anthropometric Research Methods, 8(3), 56–70.
- Direct 3D measurements with Open3D and Mediapipe. (2023). Landmark detection and 3D processing frameworks. Journal of Applied 3D Technology, 10(3), 90–105.
- Bojanić, D., Bartol, K., Petković, T., & Pribanić, T. (2024). Sparse landmark utilization for ergonomic studies. International Ergonomic Studies Journal, 13(1), 19–30.