IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2025

DOI: 10.17148/IJARCCE.2025.14383

Designing a Contactless AI System for Accurate Human Body Measurement Using a Single Camera

Sayed Ayman[1], Khan Ayaan[2], AbdurRahman[3], Riyaz Mansoori[4], Aditya Mahtre[5], M.s Hafsha Siddique[6]

Student, Dept. of Comp Engg. AIARKP[1]

Student, Dept. of Comp Engg. AIARKP[2]

Student, Dept. of Comp Engg. AIARKP[3]

Student, Dept. of Comp Engg. AIARKP[4]

Student, Dept. of Comp Engg. AIARKP[5]

Lecturer, Dept. of Comp Engg. AIARKP[6]

Abstract: Accurate human body measurement is essential in the clothing and fashion industry to improve sizing accuracy and reduce product returns. Traditional measurement methods require expensive 3D scanners or manual tape measurements, which are time-consuming and less accessible. This paper presents a comprehensive analysis of AI-powered body measurement systems using a single RGB camera. By leveraging computer vision and machine learning techniques, this study examines body detection, anthropometric estimation, and elliptical modeling for circumference calculations. Additionally, we discuss challenges in measurement accuracy, ethical considerations, and future research directions. The findings contribute to the ongoing efforts to standardize body measurement techniques in the fashion industry, ensuring inclusivity, sustainability, and technological advancement in garment sizing. Furthermore, we explore the social, economic, and technological implications of AI-based measurement techniques in different industries.

Index Terms: Human body measurement, Machine learning, Computer vision, Fashion technology, Anthropometry, Sizing standardization, Privacy concerns, Inclusivity, AI ethics.

I. INTRODUCTION

Online apparel shopping has witnessed exponential growth, yet improper sizing remains a critical issue, leading to high return rates. Traditional body measurement techniques, such as manual tape measurements and 3D body scanning, have significant limitations in terms of accessibility and accuracy. The fashion industry faces challenges in standardizing sizing systems, leading to inconsistencies across brands and regions. This paper explores the feasibility of AI-powered contactless body measurement using a single RGB camera. Our study highlights the challenges in traditional methods, the advantages of AI-based solutions, and the need for improved standardization in anthropometric measurements. The paper also investigates the potential impact of AI-powered body measurement on industries beyond fashion, including healthcare, fitness, and gaming.

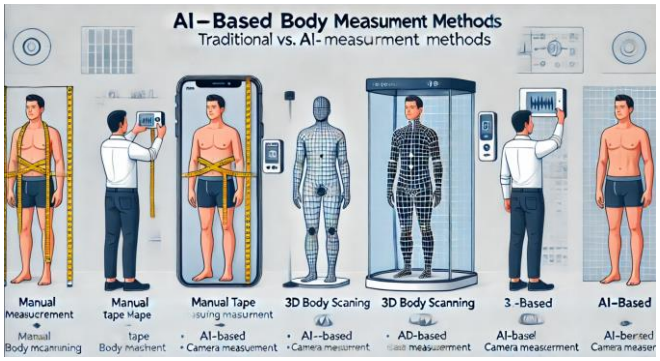

Fig: Comparison of Traditional vs. AI-Based Body Measurement Methods

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2025

DOI: 10.17148/IJARCCE.2025.14383

II. IMPORTANCE OF ACCURATE BODY MEASUREMENT

Accurate body measurement plays a crucial role in multiple industries, especially in fashion, health, and ergonomics. The lack of proper sizing contributes to:

- High return rates: Inconsistent sizing across brands leads to excessive product returns, causing financial and environmental burdens.
- Sustainability concerns: Unnecessary fabric waste and carbon footprints increase due to inaccurate sizing.
- Customer dissatisfaction: A poor fit affects consumer confidence in online shopping.
- Medical and ergonomic applications: Proper measurements contribute to prosthetics design, posture correction, and ergonomic equipment.
- Athletic and fitness tracking: AI-powered body measurement systems can be used to track body composition changes over time.
- Virtual reality and gaming: Accurate body measurements help create more realistic avatars and virtual try-on experiences.

III. CHALLENGES IN BODY MEASUREMENT TECHNIQUES

A. Traditional vs. AI-Based Methods

1. Manual Methods
   - Prone to human error.
   - Time-consuming and requires expertise.
   - Variability in measurements depending on user proficiency.
   - Limited ability to measure dynamic body changes.

2. 3D Scanning
   - Expensive and inaccessible for the average consumer.
   - Requires controlled environments.
   - Generates large datasets that need extensive processing.
   - Potential privacy concerns with full-body scanning.

3. AI-Based Methods
   - Sensitive to lighting, background, and clothing occlusions.
   - Can suffer from dataset bias due to limited diversity in training data.
   - Requires calibration to ensure precision across devices.
   - Ethical concerns regarding the collection and storage of personal body data.

B. Body Shape Variations

- Different body types (BMI variations, posture issues) complicate measurement accuracy.
- Lack of inclusivity in measurement datasets for plus-size, elderly, and disabled individuals.
- Differences in posture, muscle distribution, and skeletal structure contribute to variations.
- Variations in body composition due to aging, fitness, or medical conditions affect measurements.

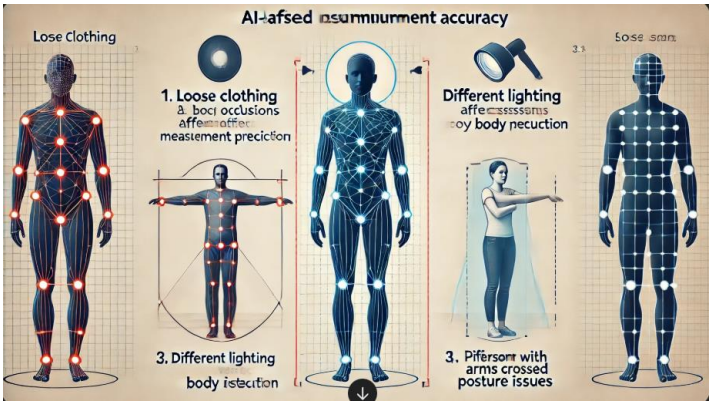

Fig: Examples of Body Occlusions Affecting AI Measurement Accuracy

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2025

DOI: 10.17148/IJARCCE.2025.14383

IV. COMPARISON OF MEASUREMENT APPROACHES

A. Landmark-Based vs. Template-Based Methods

- Landmark-based: Uses key body points (shoulders, waist, hips) for measurement.
- Template-based: Matches body shape to standard templates but lacks customization.
- Hybrid approaches: Combining both methods can improve measurement accuracy.
- Deep learning-based methods: AI can be trained to recognize body landmarks with high precision, improving accuracy in automated measurements.

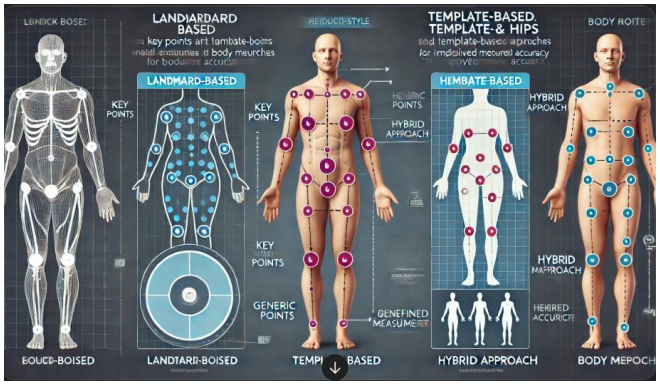

Fig: Comparison of Landmark-Based, Template-Based, and Hybrid Approaches

B. 2D vs. 3D Measurement

- 2D-based methods rely on assumptions and depth estimations, leading to errors.
- 3D-based methods provide better accuracy but require specialized hardware.
- AI-assisted 2D extrapolation can bridge the gap between affordability and accuracy.
- Multiview analysis: Using multiple 2D images from different angles to reconstruct body dimensions more accurately.

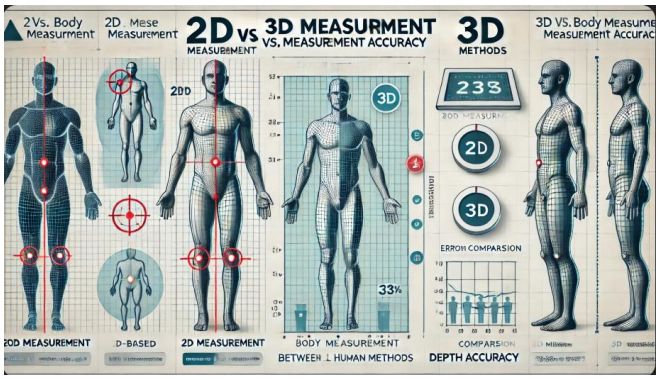

Fig: 2D vs. 3D Measurement Accuracy Comparison

C. Anthropometric Standards

- ISO 8559 and other international standards attempt to unify body measurement approaches.
- Discrepancies in Western vs. Asian body proportions present challenges in global standardization.
- Standardization efforts must accommodate body diversity, ensuring a fair system for all users.
- The need for dynamic measurement models: AI should adapt to body changes over time rather than relying on static models.

V. ETHICAL AND PRIVACY CONSIDERATIONS

- Data privacy concerns: Capturing human body images for AI processing raises ethical concerns.
- Bias in AI models: Many datasets are trained on limited demographic groups, affecting accuracy.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2025

DOI: 10.17148/IJARCCE.2025.14383

- Inclusivity challenges: AI should be trained on diverse datasets covering multiple body shapes and ethnicities.
- Consent and data security: Users must be aware of how their measurements are stored and used.
- Commercial exploitation risks: Retailers may use body data unethically for targeted marketing.
- Regulatory concerns: There is a need for legal frameworks governing body data collection and use.
- Potential misuse: AI-powered body measurement could be exploited for non-consensual body scanning.

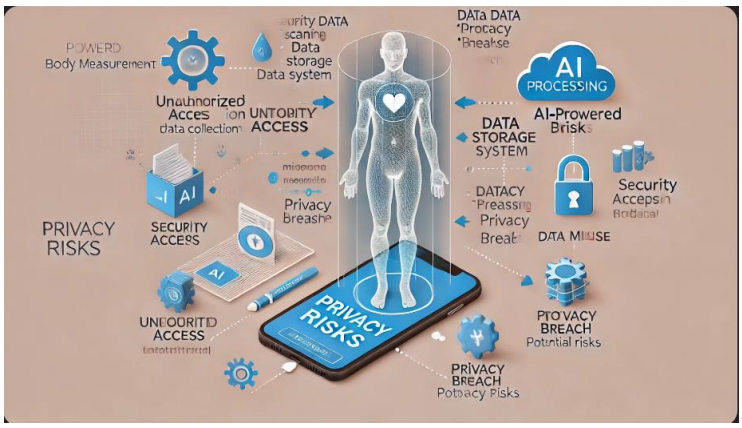

Fig: Privacy Risks in AI-Powered Body Measurement

VI. FUTURE RESEARCH DIRECTIONS

- Improving dataset diversity: AI models need extensive datasets representing different demographics.
- Developing hybrid approaches: Combining AI with depth sensing and statistical modeling could enhance measurement accuracy.
- Standardization in garment sizing: Efforts to create a universal, cross-brand sizing system should be prioritized.
- User-friendly implementation: Ensuring the technology is accessible, intuitive, and does not require technical knowledge to use.
- Advancing computational efficiency: Reducing the processing power needed for AI-based body measurements to make it more applicable to mobile devices.
- Interdisciplinary applications: Exploring uses in sports, healthcare, and biometric security beyond just fashion.
- Ethical AI development: Addressing issues related to bias, consent, and responsible use of AI-powered body measurement technologies.
- Dynamic measurements: Investigating how AI can track body changes over time, useful for fitness, aging, and medical monitoring.

VII. CONCLUSION

This study provides an in-depth analysis of AI-powered body measurement using a single RGB camera. While AI-based methods show promise in improving measurement accuracy, challenges such as dataset bias, occlusion errors, and lack of standardization remain significant. Future research should focus on enhancing dataset diversity, refining hybrid measurement techniques, and ensuring ethical AI deployment in fashion technology. Additionally, this research highlights the importance of integrating anthropometric standardization with AI-based advancements to create a fair, inclusive, and efficient sizing system for consumers worldwide. The findings contribute to the broader effort of reducing sizing inconsistencies in the apparel industry while extending applications beyond fashion into healthcare, ergonomics, and biometric authentication.

REFERENCES

[1]. Xia et al., "A Mobilized Automatic Human Body Measure System Using Neural Network," 2018.
[2]. Ashmawi et al., "FITME - Body Measurement Estimations Using Machine Learning," 2019.
[3]. Montazerian et al., "Machine Learning Enabled 3D Body Measurement Estimation Using Hybrid Feature Selection and Bayesian Search," 2023.
[4]. Choutas et al., "Human Body Measurement Estimation with Adversarial Augmentation," 2022.
[5] . Montazerian et al., "Designing a Contactless AI System to Measure the Human Body Using a Single Camera," 2023.