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3D SCANNING AND DIGITAL ANTHROPOMETRY

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Annotatsiya: Ushbu maqolada 3D skanerlash yordamida inson gavdasidan o‘lcham olish texnologiyasining ishlash tamoyillari, afzalliklari va cheklovlari tahlil qilinadi hamda uning yengil sanoatda qo‘llash istiqbollari yoritiladi.

Kalit so‘zlar: 3D skaner, raqamli antropometriya, gavda o‘lchamlari, kiyim konstruksiyasi, masofadan o‘lchash, avtomatlashtirish, yengil sanoat.

Аннотация: В статье анализируются принципы работы технологии снятия мерок с человеческого тела с помощью 3D-сканирования, её преимущества и ограничения, а также перспективы применения в лёгкой промышленности.

Ключевые слова: 3D-сканер, цифровая антропометрия, размеры тела, конструирование одежды, дистанционное измерение, автоматизация, лёгкая промышленность.

Abstract: This article analyzes the operating principles, advantages, and limitations of body measurement technology based on 3D scanning and discusses its prospects for application in the light industry.

Keywords: 3D scanner, digital anthropometry, body measurements, garment construction, remote measurement, automation, light industry.

Introduction

In the modern light industry, digitizing production processes, improving product quality, and meeting consumers’ individual requirements are important objectives. In garment manufacturing in particular, accurately measuring the human body directly affects the fit, comfort, and appearance of the finished product.

Therefore, improving traditional measurement methods and automating them with modern technologies has become an important task.

In traditional anthropometric measurement, body dimensions are usually determined using a measuring tape and other measuring instruments. Although this method is practical and convenient, the results may be affected by the specialist's experience, the position of the measuring instrument, and the person's posture. In addition, measuring and recording each dimension separately requires time.

3D scanning technology offers important opportunities for addressing these issues. It makes it possible to create a three-dimensional digital model of the human body, analyze its shape, and determine the required anthropometric indicators using software [1]. As a result, the measurement process can be digitized, data can be stored electronically, and the information can be used in garment construction.

The essence of 3D scanning technology

3D scanning is the process of reconstructing the spatial shape of the human body surface from digital data. Depending on the device, optical cameras, specialized sensors, laser systems, or structured-light systems may be used. The data collected during scanning are processed by software to create a three-dimensional model of the human body [1].

The resulting model makes it possible to study the body's overall shape, the proportions between different body parts, and their geometric characteristics. While traditional measurement determines each indicator separately, 3D scanning collects a broader set of data about the body surface. The required measurements can then be calculated from these data.

To use a 3D model effectively in garment design, body parts must be segmented correctly, anatomical landmarks must be identified, and measurement-calculation algorithms must be applied. Markiewicz and co-authors studied methods for estimating measurements required for garment construction from 3D

anthropometric data [3]. This highlights the importance of converting digital scans into practical information for garment patternmaking.

Stages of measuring the human body

The process of taking measurements with a 3D scanner consists of several interrelated stages.

At the first stage, the device is prepared and scanning conditions are established. The person must stand in a predetermined posture. Bending the body, holding the arms too close to the torso, or allowing body parts to obscure one another may affect the completeness of the digital model. Therefore, it is important to keep the posture and scanning conditions consistent [3].

At the second stage, the scanner records data about the surface of the human body. Depending on the device design, data may be collected using several cameras or sensors, or from different angles. The collected data are combined to form a three-dimensional body model.

At the third stage, the digital model is processed. Where necessary, missing areas are identified, surface integrity is checked, and anatomical landmarks are marked. The operations performed at this stage can affect the subsequent measurement calculations [1; 3].

At the fourth stage, the required anthropometric indicators are calculated. These may include body length, width, circumferences of different body parts, and distances between anatomical landmarks. After verification, the measurements are stored electronically and used to develop garment constructions.

Automating this process reduces the need to enter measurements manually more than once and simplifies the use of the data. At the same time, measurement methods and scanning conditions must be monitored consistently to ensure the accuracy and reliability of the results.

The importance of digital anthropometry in garment construction

Anthropometric indicators are among the key data required for garment construction. They describe the dimensions and shape of the human body and help determine how a garment will fit the wearer.

3D scanning can be used to determine height, shoulder width, chest, waist, and hip circumferences, as well as other linear and transverse measurements. The digital model also allows the body's external contour to be examined in greater detail [1; 3].

The data obtained can be used to design made-to-measure garments, adjust patterns, and develop the construction of products made to order. This is particularly important when standard sizes do not fully correspond to an individual's body shape.

However, body measurements are not directly equivalent to the dimensions of a finished garment. Garment construction must take into account the product type, fabric properties, the ease required for movement, and the intended use. Thus, 3D scanning helps provide accurate initial data, but garment-construction principles must also be followed to produce a high-quality garment.

Comparison of traditional and digital measurement methods

The main advantages of traditional measurement methods are their simplicity, relatively low cost, and widespread use. However, manually determining and recording a large number of measurements can be time-consuming. Results may also depend on the specialist's experience, the placement of the measuring instrument, and the conditions under which measurements are repeated.

3D scanning makes it possible to create a digital body model, calculate numerous measurements through software, and store the data electronically. This can speed up measurement tasks and facilitate integration with digital design systems.

A systematic review by Rumbo-Rodríguez and co-authors found that measurements obtained with 3D body scanners were highly correlated with traditional anthropometric measurements in many cases. However, notable

differences were also observed for some measurements [4]. These findings indicate that 3D scanning cannot be assumed to provide the same level of accuracy under all conditions.

Therefore, when implementing 3D scanning technology, it is important to verify the results, compare key measurements with those obtained using traditional methods, and determine whether the technology meets specific production needs. Its effectiveness depends not only on measurement speed but also on the accuracy of the data produced and the ability to use them in practice.

Production efficiency and reduction of material consumption

Integrating 3D scanning with digital garment-design systems strengthens the links between measurement, construction development, and product manufacturing. Transferring digital measurements to software can reduce the time spent re-entering data manually [2; 3].

Producing garments to individual measurements can improve product fit. If measurements are taken accurately and the construction is developed according to the relevant requirements, the need for remaking or altering garments may be reduced.

Yusupov and Maqsudov discuss how 3D technologies can simplify production processes, reduce material waste, and enable individual product customization [2]. These opportunities demonstrate the practical importance of the technology in the light industry.

Nevertheless, reducing material consumption does not depend solely on the use of 3D scanning. Efficiency also depends on how effectively patterns are developed, fabric is cut, production is planned, and product quality is controlled. Higher efficiency can therefore be achieved when scanning technology is integrated with other digital solutions throughout the production process.

Remote measurement and customized orders

One important prospect of 3D scanning is the ability to obtain body measurements remotely. A customer's body can be scanned using a specialized device or a suitable digital tool, and the resulting data can be sent electronically to the manufacturer.

In their article, Yusupov and Maqsudov highlight the potential of remote measurement technologies to make services more convenient for customers, expand customized orders, and support the development of online retail services [2]. This approach may reduce the need for the customer and tailor to be in the same location and enable consumers living in different regions to order custom-made garments.

At the same time, the reliability of remote measurement depends on the device used, image quality, body posture, and data-processing algorithms. An incorrectly captured image or insufficient data may affect garment construction. It is therefore important to provide users with clear instructions, verify the collected data, and allow rescanning where necessary.

Furthermore, a digital model of the human body may contain personal data. Privacy and information-security requirements must therefore be strictly observed when storing, transferring, and processing such data.

Measurement accuracy and standardization

The accuracy of measurements obtained using a 3D scanner depends on several factors. These include the technical capabilities of the device, scanning conditions, body posture, identification of anatomical landmarks, and data-processing algorithms [1; 4].

International standards are important for regulating these issues. ISO 20685-1:2018 specifies evaluation protocols for anthropometric measurements extracted from 3D body scans [5]. This standard provides a basis for evaluating the reliability of measurements and applying a consistent approach when using different scanning systems.

When using 3D scanning in light-industry production, it is important to configure equipment correctly, define scanning conditions, verify the accuracy of measurement algorithms, and, where necessary, compare results with traditional measurement methods. This approach enables digital anthropometric data to be used reliably and effectively in garment construction.

Conclusion

3D scanning and digital anthropometry are promising approaches for improving methods of determining human body measurements in the light industry. These technologies make it possible to create three-dimensional digital models of body structure, identify important anthropometric parameters, and use the collected data in garment-design and construction processes.

Although research indicates that many measurements obtained through 3D scanning correspond closely to traditional measurements, differences in some indicators confirm the need to verify results [3; 4]. Therefore, when introducing this technology into practice, attention should be paid to scanning conditions, measurement algorithms, and compliance with international standards.

3D scanning expands opportunities for producing garments to individual orders, accepting orders remotely, storing digital information, and coordinating production processes. At the same time, achieving the intended results requires the coordinated development of technical equipment, software, and garment-construction methods.

Overall, combining 3D scanning with scientifically grounded anthropometric approaches and digital design tools can improve the quality of finished garments, simplify the fulfillment of custom orders, and support the wider adoption of digital technologies in the light industry.

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