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Classification and Identification Model of Young Women's Torso Shape Based on Human Surface Curve Features

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Abstract

Human body shape analysis is an important reference basis for garment sizing and modification. The study of human body shape is to better master the relationship between the size and shape of different body parts and the overall shape of the garment. In this paper, 245 young women aged between 18 and 24 years in school in northern China were selected as the study subjects by applying the 3D human body measurement technology. Using the statistical software SPSS, principal component analysis, correlation analysis and R-type clustering were performed to evaluate 16 variables, including height, girth, and body surface angles. Five body angles were extracted as classification indexes: chest angle, back inclination, dorsal angle, body lateral angle, and buttocks angle. These indexes were critical in explaining the characteristics of the torso surface curve. Consequently, the body types were divided into three categories using K-means clustering. More detailed characteristics of the eight body types Y_{II} to B_{III} were classified by combining the chest-waist drop of the Chinese National Standard classification indication. Then according to the classification results, a recognition template that can automatically classify body shape was created through the Baidu AI EasyDL development platform. Experimental results showed that the average precision of the body type recognition model reached 91.7%, among which the recognition accuracy for Type III S body shape was over 95%, providing a meaningful reference for body type classification research.

Keywords: Torso Shape; Body Angles; Body Shape Classification; Deep Learning

1 Introduction

In recent years, consumers have had increasingly high aesthetic requirements for clothing, personalized, intelligent customization, and well-fitting clothing are becoming more popular among consumers. Therefore, body shape analysis is crucial for identifying garment sizes and making patterns. Many scholars explore different perspectives to classify and identify body types. The main methods found in the literature are as follows: research on specific body parts, especially for persons with unique body shapes like shoulders and backs [1-4]; by calculating the body model index to reflect the proportion of different human body parts [5, 6]; intercepting the cross-sectional

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curve of the human body by 3D scan and extracting the value of body characteristic parts to refine the classification index [7-10]. The most popular way to classify body size is using circumference size and circumference difference as classification indicators, mostly used for size customization in various countries. Peng Li [11] defined waist girth as the most important dimensional variable of the female torso, and chest-waist drop and waist-hip drop as the most important shape variables. However, Zouhour [12] mentioned that information such as circumference cannot fully describe the shape of the human body. Considering only dimensional information such as body circumference and body proportions in the design of garment structure and ignoring the body surface curve form can cause reduced fitness of garments. In addition, the angle variable also contains a certain amount of information about the thickness of the human body The body silhouette curve mainly records the human body shape, and the body angle variable can represent its morphological changes. Wang Xiaoxia [42], by studying the relationship between young women's upper body and paper samples, proposed that the human body surface angle corresponds to the dart angle of the prototype of the garments, and that the body surface angle parameter can be used to predict the angle value on the prototype to improve the fit of the garments. Hence, the importance of human body surface angles for improving the fit of garments can be seen. However, only a few studies have been published concerning investigations into body angles as important indicators of body shape characteristics.

The human body can be considered as a multifaceted geometry, and there are many indicators to describe the geometry [13,14]. In this paper, we extract the longitudinal curves to obtain the body surface angle values that best explain the body shape characteristics. As a result, our method is more intuitive and clearer to reflect the three-dimensional human morphology with two-dimensional data. Our data analysis and screening extract a few angular variables that reflect the human body's local and overall morphological characteristics. A more detailed classification is determined according to the chest-waist drop of the Chinese National Standard classification index. The detailed classification uses the size index and shape indices to jointly define women's body shape, effectively distinguishes individual body surface morphological differences and provides the basis for developing basic paper patterns for clothing.

In addition, as technology advances, access to information related to clothing and body type gradually moves from text to images, with increasingly more retrieval recognition moving to more convenient visual image data [15]. This technological advancement in the field of research is based on deep learning, where physical images are trained and analyzed to form a discriminatory mechanism similar to the neural network of human brain perception, classifying new objects based on existing experience. Several researchers have used deep learning approaches such as BP neural networks, radial basis networks (RBF) [4], support vector machines (SVM) [16], and extreme learning machines (ELM) [10] to train body shape recognition models [17]. Traditional BP neural networks were widely used in body type recognition and have been developed relatively maturely given the early age of research. However, traditional BP neural networks are constrained by the training sample base and the complexity of the training samples, which can easily reduce the learning rate due to the prolonged training time. Neural networks require large-scale training samples to achieve a more desirable recognition accuracy, which needs to be improved. Sun [18] uses the Adaboost algorithm based on BP neural network to recognize the body size of young women, combining multiple weak neural networks into one BP neural network. It yields better generalization ability and high robustness. Li [19] uses the automatic classification method of convolutional neural networks, and experiments prove that convolutional neural network can effectively extract the features with good representation in the original image. Yao [9] uses R