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Prediction of Bust and Waist Size Based on Two-dimensional Images ⋆

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Abstract

Human body measurement based on two-dimensional images has been widely applied in the clothing industry due to its cost and operational advantages. However, the current accuracy of human body circumference measurement is low. This article aims to propose a high-precision method for measuring human body circumference, taking bust circumference and waist circumference as examples, and based on 120 virtual simulations of human bodies, proposes a method to extract human body bust circumference size from front and side angles images. Using the feature value pixel size to calculate the trapezoid perimeter and the ellipse perimeter, and comparing them with the difference of bust circumference and waist circumference sizes, machine learning is applied to build a size prediction model, thus obtaining the values of bust circumference and waist circumference. The experimental results show that the average prediction errors of bust girth and waist girth by the proposed method are 0.26 cm and 0.24 cm, respectively, indicating good prediction performance and applicability for practical production. The proposed method effectively reduces the measurement errors of girth dimensions in image measurement and provides methods and ideas for non-contact human body measurement research.

Keywords: Anthropometric dimension; Girth measurement; Neural network; Linear regression

1 Introduction

The human body shape is the basis of garment structural design [1]. Human body size is the basis for judging body shape. The application of human body measurements in the clothing field is extensive, such as clothing structure design, customisation, virtual online fitting, personalised virtual character production, etc. Human body size measurement includes two methods: contact measurement and non-contact measurement. Technological advances have made non-contact

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measurement popular due to its speed, accuracy, comprehensiveness and efficiency [2]. At present, non-contact measurement methods include three-dimensional scanning and two-dimensional imaging. Three-dimensional scanning relies on large-scale scanning equipment, has a high cost, and is limited by environmental and spatial factors. It is not easy to move [3] making it difficult for large-scale promotion and use. The two-dimensional imaging method involves taking several images of the human body from the front, side and other directions. Body measurements are obtained through three key technologies: contour extraction, feature point detection and size estimation [4]. This method has low equipment requirements, is simple to operate, and is low-priced. For some lightweight enterprises and online shopping consumers, using the two-dimensional image method to obtain human body size data is convenient, fast, and effective.

Deng et al. [5] use the image difference method to separate the subject from the background regarding contour extraction and feature point detection. The image was then binarised and denoised to obtain the human contour. Feature points were defined and extracted using a human proportion method. This method can obtain a limited number of points, and the fixed proportion method does not take into account the differentiated characteristics of human body structure; Hu et al. [6] use colour separation and Sobel operator edge detection to obtain the human contour and ABSS (Adaptive Body Structure Segmentation) algorithm for human body structure segmentation; Jiang et al.[7] used the Canny edge detection method to obtain the human contour and performed custom encoding using the Freeman8 encoding method. Both studies [6, 7] used local edge curvature methods to extract feature points. However, this method cannot eliminate the interference of clothing, and some special body shapes cannot be accurately extracted. The practical application is limited.

In measuring human body size, length and width can be obtained directly from the pixel distance between photo feature points. Therefore, the research difficulty and focus are concentrated on measuring circumference size. At present, the primary methods for measuring circumference include linear regression [8, 9], elliptical fitting [10], and neural networks [11, 12]. The circumference measurement method based on linear regression needs to collect a large amount of human body data to fit the circumference calculation equation. The speed is fast, but the circumference of the human body will be affected by many other size parameters of the human body. Therefore, it isn't easy to define the circumference mathematically with a unified equation. Different body types greatly affect the circumference measurement method based on elliptical fitting and have a poor measurement effect for some special body types. The circumference measurement method based on a neural network uses two-dimensional image feature data for machine learning to predict circumference size. However, this method is affected by the sample data, which leads to large measurement errors in human body size.

In summary, there are still many problems with the measurement of human body dimensions using two-dimensional images, mainly reflected in the following aspects:

- The contour extraction method is limited, mainly affected by lighting and the clothing worn by the subject.
- Most feature point detection is based on the human body contour for feature point positioning. Due to the error of contour extraction, the feature point positioning is inaccurate, which affects the measurement of human body dimensions.
- The measurements of human body dimensions in width and length are relatively accurate. However, the measurement error is large in circumference measurement, especially in im-