

3D Modelling of Outer Surface of Moulded Bra Cup

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Abstract

Based on the theory of forward engineering design, this paper deals with modelling the outer surface of moulded bra cup by using the methods of body measurement, data analysis and 3D modelling. In the study, thirty female college students who are 18-24 years old, born and grew up in the northwestern part of China were measured. On the basis of these body measurement data, the features of the human body, the relationship between the basic features of the breast form and the major detail size were analyzed. This is so that the relevant parameters of the chest which is used to describe the perfect female breast shape can be quantified. At the same time, these quantitative parameters were used in the modelling of the outer surface of moulded bra cup to obtain the bra cup which can correct, modify and beautify the breast shape. It has been demonstrated that the theory of forward engineering design is reasonable and possible to be implemented in the design of moulded bra cup, and in the 3D modelling of the outer surface of moulded bra cup the methods of line-face and face-face should be combined together to make the process of 3D modeling more effective.

Keywords: Moulded Bra Cup; Forward Engineering Design; 3D Modeling; Breast Shape

1 Introduction

Woman's breast, as the vital part in displaying femininity, forms the woman's body curve with the hip. Bra, as the stick formfitting clothes, makes the female body upright and beautiful, while protecting and supporting the women's breast. In the 1980s, the moulded bra appeared, and made the cup change from soft cotton cup to moulded cup. Because of its obvious advantages, the moulded cup gradually occupied the dominant position of the bra market [1, 2].

Moulded bra cup (moulded cup for short), with heated setting by the metal mold with heat resistant and plastic materials, is the major part of the bra. It is the most direct part to shape the breast curve, which is used to encase the breast and cover the breast directly. [2, 3] It is the outer surface of the moulded bra that influences the shape of female' breast, so the study of the outer surface of moulded bra cup is very necessary.

Currently there is a lack of a reasonable professional standard on modelling the outer surface of moulded bra cup. Enterprises design their products based on the theory of backward engineering

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design, and widely with the repetition method of modifying, they modify the digital plastic shell scanned from the real plastic shell (they do it themselves or obtain it from the database) relying on experience. It can be seen from this process that: (1) Design errors are great, because designers do not know the exact structure of the actual human body very well, cannot grasp the corresponding relation between the size of the key parts of bra and major detailed sizes of the breast very well. (2) Modifying repeatedly wastes lots of time and money (such as: the mold of the cup is costly), which is detrimental for improving the market competitiveness.

Forward engineering design is one common product design method. It is one creative theory and a process from the unknown to the known, from abstraction to concretion (Forward engineering design method is shown in Fig. 1). [4] In the process of designing the outer surface of the moulded bra cup, if the theory of forward engineering design can be used, designers can firstly analyze the function of the moulded bra cup, determine the concept of the product, then definitude the corresponding relationship between the outer surface and the breast based on the large number of body scanning and data analysis. At last they may model the digital moulded cup on the digital mannequin with appropriate software. It can make the design of the outer surface of the bra cup be reasonable, and ease the problems of the production.

The development history of the moulded bra is very short, there is currently nearly no study of the outer surface of moulded bra cup. However since the 30s of the last century, after the Warner American set the bra size and specification according to the different shapes of female breasts, UK, USA, Germany, Japan and so on have been on the study of body curve and bra. The institute of textile and garment of Chungnam National University found a way to measure the edge curve of the breast by 3D scanning 37 women' body, which not only provided the way to obtain the edge curve of the breast, but also accurately reflected the base area and volume of breast, providing a basis for determining the breast shape [5]. In 1996, Dong Hua University cooperated with Wacoal Japanese to study the body type of Chinese female in different regions and designed and produced corresponding products. The Xi'an Polytechnic University had scanned hundreds of people with the 3D body scanner system and particular software, and then did some researches about the mannequin, the breast shape and the bra.

This paper studied the relationship between the primary control position and the major feature size of the breast, and modelled the outer surface of moulded bra cup with the UG software on the digital underwear mannequin developed by our work team.

2 Analysis of Breast Features and Control Position of Outer Surface of Moulded Bra Cup

2.1 Extracting Breast Features

The detailed sizes of the breast are the base of the major detail sizes of the bra structure [6]. In the design process of moulded bra cup, we should fully consider the features of the breast, especially the feature points and feature curves. The feature points of the bra cup are shown as the black dots in Fig. 2 below:

There are 8 feature points (shown in the Fig. 3) of the female breast corresponding to the control points of the outer surface of the moulded bra cup, with each feature point defining according to the following: