Interval prediction of 3D body shapes by semantic values using regression model

Sayaka Imai, Sakaori Fumitake

Abstract — Recently, human body modeling or human pose modeling is a hot topic in many studies. Several statistical methods have been proposed for biometrical analysis and computer graphics, and few works for apparel. In this study, we propose a statistical method which reconstructs human body shapes from height or various semantic values, e.g., height, waist-girth and chest girth, and takes dispersion of human body shapes into account using principal component analysis and regression model.

Keyword: principal component analysis, regression model, confidence interval.

1 Introduction

Recently, human body modeling or human pose modeling is a hot topic in many studies. Several statistical methods have been proposed for biometrical analysis and computer graphics (e.g., Anguelov et al. (2005); Hasler et al. (2009); Seo and M. T. (2004)), and few works for apparel. Wang et al. (2003) constructed feature human model by unorganized cloud points obtained from laser scanners. Chu et al. (2010) proposed the method to generate standard 3D human body shape like mannequin from semantic parameters (e.g., height, chest-girth, waist-girth, hip-girth, etc.) by using principal component analysis and inverse regression. However, this way cannot show the variation of human body with same semantic parameters.

In this study, we propose a statistical method which takes dispersion of human body shapes into account using principal component analysis and regression model.

2 Interval prediction of 3D body shapes

Assume that we have obtained 3D scanned data of whole human bodies which are expressed by coordinates of the surface. We shall provide a way to generate coordinates on surface of human body from semantic values such as height, chest-girth, waist-girth, hip-girth.

For dimensionality reduction, Wang et al. (2003) proposed a method to extract the adequate amount of lattice-shaped points to generate human body shape. Assume there are n scanned data and we extract m lattice-shaped points. Then we have a (3m, n) matrix

\[ Z = \begin{bmatrix} z_1 & z_2 & \cdots & z_n \end{bmatrix} \]

According to the following procedure, Chu et al. (2010) proposed a way to generate coordinate on surface of human body from semantic values. First, they applied principal component analysis for Z, and we can have the principal component vectors \( h_i (j = 1, 2, \cdots, 3m) \) and the principal component scores

\[ Y_{3m \times n} = \begin{bmatrix} y_1 & y_2 & \cdots & y_n \end{bmatrix} \]

where

\[ y_i = \begin{bmatrix} h_{1i}^T \\ h_{2i}^T \\ \vdots \\ h_{3mi}^T \end{bmatrix} (z_i - \bar{z}) \]

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*Graduate School of Science and Engineering, Chuo University

†Faculty of Science and Engineering, Chuo University
and $\bar{z}$ is the average of $z$. Incidentally, given the principal component score $y_0$, we may obtain coordinates of $m$ lattice-shaped points $z_0$ as

$$
z_0 = \begin{bmatrix}
h_1^T \\
h_2^T \\
\vdots \\
h_k^T \\
y_0 + \bar{z}
\end{bmatrix}
$$

(2.1)

Next, they applied a regression model where the principal component scores $Y$ are explanatory variables, and the semantic values $x$ are objective variables. Using inverse regression method, we can estimate $Y$ from $x$.

Typically, there may be several body shapes for the same semantic values. However, in the way of Chu et al. (2010), we can only know a standard body shape corresponding to the semantic values. So we provide a method to obtain predictive interval of 3D body shape. In our approach, we consider a regression model where $x$ are the explanatory variables and $Y$ are the objective variables:

$$Y = \beta x + c.$$  

(2.2)

Using this model, we may obtain confidence interval or tolerance interval of $Y$: the interval $[y_{0j}^\text{min}, y_{0j}^\text{max}](j = 1, 2, \cdots, 3m)$ expresses variation of principal component score for the same semantic values $x_0$. Let

$$y_{0j}^\text{min} = (y_{01}^\text{min}, \cdots, y_{03m}^\text{min})^T, y_{0j}^\text{max} = (y_{01}^\text{max}, \cdots, y_{03m}^\text{max})^T,$$

(2.3)

then we can predict an interval of coordinate on lattice-shaped points $[z_0^\text{min}, z_0^\text{max}]$ as

$$
\begin{bmatrix}
h_1^T \\
h_2^T \\
\vdots \\
h_k^T \\
y_0^\text{min} + \bar{z} \\
y_0^\text{max} + \bar{z}
\end{bmatrix}
$$

(2.4)

then we can generate 3D body shapes with variation from the coordinate.

We will show the detailed results and conclusions at the presentation.

References


