Web-Based Human Body Modeling by Restricted Number of Anthropometric Data

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Abstract

The purpose of this work is to develop a system to model variations of prognostic body shapes by individual 3D scan data and to provide the modeling results to the users via the Internet. The client interface allows the users to browse the processed data in a 3D GUI, to simulate body shapes with new desired body measurements (such as weight, waist, chest circumferences, etc.), and to generate printed reports. Modeling can be controlled by a few body dimensions, or even by one measurement. Statistical ground of the modeling control method is given.

Keywords: Human body modeling, simulation, 3D Web interfaces

1. Introduction

Recent advances in the development of high-resolution and accurate 3D scanners for whole-body shape capturing make it attractive to utilize the scan data in many application fields, e.g., in individual design of car interiors, clothing, anthropometry, healthcare, social studies, body fitting, realistic 3D media content creation, aerospace and defense. Formerly *body dimensions* were widely used for apparel design, ergonomic assessment of working/operational spaces, and reverse engineering. The data are, for instance, weight, height, leg length, waist, hip or chest circumferences, etc. Body dimensions are defined as the distances between some specific points on human body surface (*landmarks*), or measured as circumferences at the level of the landmarks. The landmarks are anatomically defined features, for example, top of the head, tip of the 7th cervical vertebra, the most lateral point of acromion, etc [1]. After appearance of 3D scanning technologies, it becomes possible to automatically locate the landmarks and to retrieve body dimensions from accurately scanned range data. And, the main advantage of 3D scanning is that it provides a highly detailed individual's body *surface* shape, which can be used in further human-oriented modeling.

Human body shape modeling (HBSM) utilizing 3D scan data is a rapidly evolving multidisciplinary area [2], applicable to a wide range of practical fields, from chair and apparel design [2-4] to bio-medical applications [4]. The healthcare, beauty services and well-being applications include: anthropometric surveys; body deformity, asymmetry and obesity control; rehabilitative and training monitoring; weight control [4-5]. Now, even some visual cognition factors can quantitatively be defined with the aid of HBSM, for instance, woman body attractiveness [6], or adolescent body perception [7]. Various methods and tools are used in HBSM depending on application field and input 3D scan data, however, controls of HBSM are body dimensions mentioned above, because ergonomics designers (or, HBSM end users) clearly understand the nature of the measurements and can easily manipulate with them during modeling. It is also important to provide the end users of HBSM systems the ability to control the modeling process by a limited number of variables to avoid ambiguity and complexity of control, especially, if modeling is done though the Internet in interactive way. Moreover, in some cases, a complete set of body dimensions is not provided with 3D scan data.

Recently, Internet-based applications of the usage of 3D scan data appeared, mostly, for apparel design. In [9] a concept of server-client system for access to 3D body database as a part of UK National Sizing Survey project is presented. In the system, only point-based VRML model of torso is visualized based on input sizes. In [8] several virtual dressing systems are described (MyShape, Virtual try-on, Lands' End, My Virtual Model). These systems use "static", or pre-defined 3D models from databases, without on-line body shape modeling. OptiTex presented [10] a Web-based garment fitting system with 3D preview of a synthetic avatar, created by user's body dimensions retrieved from individual 3D scan data. It would be worthwhile to implement Web-based systems allowing the end-users to manipulate with their *personal* 3D scan data, modeling, for instance, the body shape after weight loss/gain, after physical or rehabilitative training, or displaying their virtually corrected postures.

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The users of such systems would be motivated not only in taking care on their health and physical exercises, but also in participating in 3D scanning process itself and contributing into 3D scan databases.

The purpose of this work is to develop a Web-based system to model variations of prognostic body shapes by individual 3D scan measurements and to provide the results of modeling to the users via the Internet through a 3D graphical interface. The paper is organized as follows. First, in Section 2, input data processing methods and human body shape modeling techniques, which are used in the system, are described. In Section 3, we present some statistical results allowing us to reduce the number of body dimensions to control body shape modeling. Section 4 describes the Web system's implementation details such as server-side functionality, client interface with 3D graphics, etc. Finally, conclusions are summarized in Section 5.

2. Data processing and modeling methods

2.1. Data

Several 3D whole-body scanning technologies were recently used, for example, CT/MRI, optical scanning, photogrammetry based on structured light, radio-wave scanning, laser scanning, etc. The success of CAESAR Project (see, e.g., [11]) focused attention of professionals on the industrial-type equipment providing harmless scanning with high quality output data. Among them are the scanners produced by Cyberware, Hamamatsu Photonics, Human Solutions, TC^2, and other manufacturers. The trend of the 3D body scanners' development is characterized by decreasing the cost of hardware and time of scanning (to few of seconds), easiness of installation and operation, truly 360 degree scans with low noise and data missing, and nearly millimeter range accuracy. It results in satisfactory quality of the produced data with high level of details of face and body parts of scanned subjects, ability to automatically extract dozens of body dimensions and landmarks. We mostly used data collected with the Bodyline Scanner from Hamamatsu Photonics [12].

The standard manufacturer's preprocessing software, Bodyline Manager, allows 54/55 (male/female) auto-landmarks, and about one hundred body dimensions for one data range scan. Original data are recorded as a polygonal model in OBJ graphical format with several hundred thousands vertices, accompanied by personal information (age, weight, height, BMI, gender, etc). Even Bodyline Manager has an interactive functionality to correct landmark position by a 3D editor, our processing software (see Section 2.2) was developed with the assumption that location of some landmarks may not be correct. We also considered the case, when landmarks and body measurements are not given at all. The last case was tested with the range data collected by other body scanner [13].

Several thousands subjects participated in 3D body scanning campaign managed by Nihon Unisys. The data were collected with the system "3D-Navi" from Japanese males and females aged from 20 to 75 years old. On the server side of the system, 3D scan data and measurements were sorted into ten gender-age groups: younger than 30 years old, from 30 to 40, between 40 and 50, from 50 to 60, and older than 60 years old for both, male and female subjects. The grouping reduce intra-population variations, because it is known, for instance, that on the average the younger generation is taller, older generation tends to lose muscularity, etc. For operational use, statistical analyses were conducted (Sections 2.2, 2.3, 3) separately, and overall inter-population statistics were investigated experimentally.

2.2. Homologous model creation

The data collected with 3D scanners are characterized by significant variations of body shapes, postures, number of vertices, presence of holes and noise in the data. Earlier attempts taken to convert the data to a form suitable for HBSM relied on interpolation through morphing, surface and volumetric subdivision, contour reconstruction, reconstruction in Fourier space, etc [14]. Nowadays, the most proven approach for HBSM is based on template models and reconstruction of body surfaces from eigen-spaces. Pioneered in [11], the method uses Principal Component Analysis (PCA), which captures the body shape variations from an "average", or template shape. In the method (utilizing landmarks) all the vertices of a template model are non-rigidly morphed until the best fitting to the point cloud of the input 3D scan data. The resulting fitted model is called *homologous*. Therefore, there is exact correspondence of vertices for any pair of homologous models, or a homologous model and template. This property makes it possible to apply PCA to model shape variations. The approach also resolves the hole (missed data) interpolation, and it has a variant for landmark-less fitting. If the template is accompanied by a skeleton model with body mesh skinning weights, the "bone-skin" technique (widely used in computer graphics animation) can be applied for fitting if the postures of template and scan data are significantly different. In [15,16], a correlated algorithm of body shapes' co-registration in different postures based on a deformation penalty function was introduced. Many other works (e.g.,[17-18]) propose variations or improvements of the methods given in [11,15,16]. We implemented the method similar to ones described in [11,15-18] with noticeable optimization required for request processing on the Web. The overall process of building the models is shown in Figure 1.

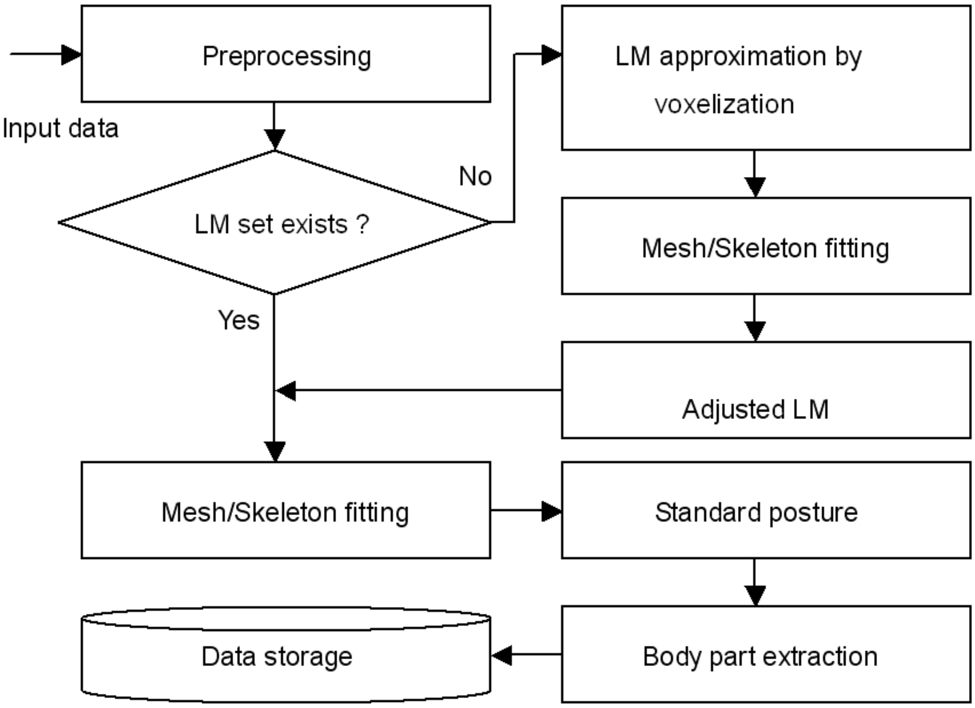

Fig. 1. Data processing pipeline.

There are several remarks on the data processing flow in order. "Preprocessing" step includes setting the vertices from the original 3D scans to proper measure units, coordinate axes orientation, and origin. In the case of absence of landmarks, special voxelization procedure first estimates approximate location of landmarks, and then "Mesh/skeleton fitting" procedure is applied to build a temporary homologous model giving more accurate location of all the landmarks. Matching itself is applied several times iteratively, altering mesh fitting and skeleton fitting. In addition to original 3D scan data, the whole homologous model is stored in original posture, and "standard" posture, which is equivalent to the posture of the template. For body shape modeling, PCA statistics are collected for the whole body (except head, hands and feet) in the standardized posture to avoid the influence of posture variations on PCs. Body parts from homologous models are also stored to fulfill final body shape model assembly by the user's request via the Internet.

Two templates, male (13379 vertices) and female (16780 vertices), are used in the processing pipeline. The templates in the form of closed polyhedra were created on the basis of "Dhaiba" models previously developed at AIST [19] by setting the template posture similar to the real "average" operational posture used in our 3D measurement campaign. The template includes a skeleton model with links and 17 rotational joints, and the mesh of the template is instrumentally connected with the links by given skinning weights to smoothly deform the mesh during posture change.

The homologous model is created first iteratively for the posture of original 3D scan data, and the joint centers and link lengths are estimated during the iterations. Finally, the user-specific skeleton is completely defined. Therefore, the homologous model can later be animated by variations of the joints. Note, that the link lengths themselves can be used as new additional "measurements" characterizing the scanned subject. For statistic collection, the homologous model is created for the standardized template posture, and the main body part is extracted. The overall process is depicted in Figure 2.

2.3. Body shape modeling

For Web-based modeling providing the customer his own prognostic body shape view in 3D, the following scenarios are possible:

- visualize the user prognostic body shape in case of weight loss/gain;
- visualize the shape in case of increase/decrease of the waist circumference;
- visualize the body model in “correct” (standard) posture without body asymmetry and deformations (which can appear, for instance, due to early stage of scoliosis);
- visualize the difference between two body state models with overlapping in 3D and 2D (contouring);
- estimate the required weight loss for the desired waist decrease.

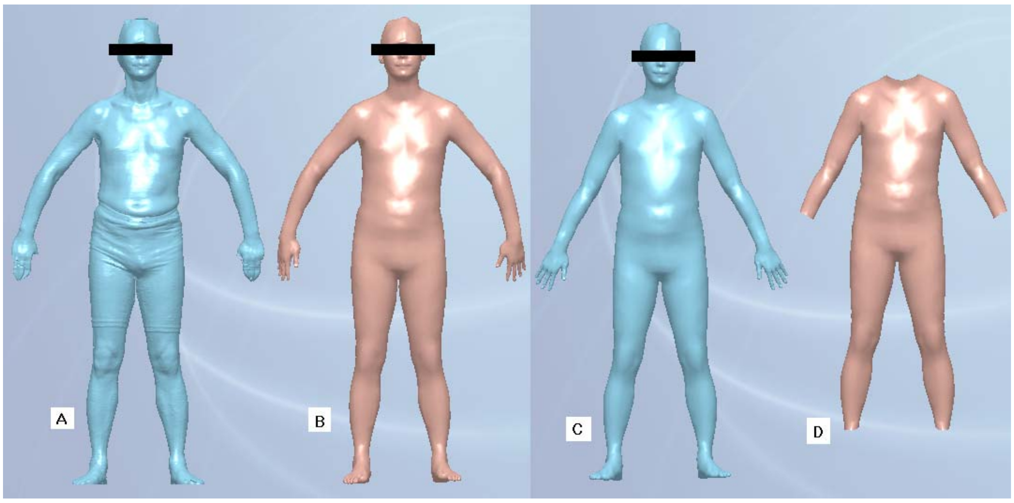

Fig. 2. Creating individual body shape models. A: Original scan data; B: Homologous model in original posture; C: Homologous model in standardized posture; D: Main body part surface.

In all the above scenarios, it is quite natural to vary weight and/or body dimensions (except height and other measurements, whose variations lead to significant bone deformations). We suppose that these variations mostly result in changes of the main body part shape (Fig.2D). Note also, that head, face, hands, and feet features are very individual, and it is difficult to collect statistics for the same person to estimate the changes in the shape of these parts. The main body part surface is composed from lesser number of vertices (N=2618 in the case of our male homologous model), and statistical calculations can be done much faster for it.

As the variations of any vertex depend on adjacent vertices’ variations in a complicated manner, in [11] it was proposed to fulfill analysis and shape modeling in eigen-space. Similarly to [11], for each statistical group (collection of K main body homologous models, where each body shape is composed from N vertices), we describe the body shape of the k-th individual ($k=1,\ldots,K$) by $3N$-dimensional vector $a_k = (x_{1k}, y_{1k}, z_{1k}, x_{2k}, y_{2k}, z_{2k}, \ldots, x_{Nk}, y_{Nk}, z_{Nk})^T$. Calculating average shape a_0 and applying PCA, we can find the eigenvector decomposition (basis of vectors e_i, $i=1,..,K-1$) for variation of any shape a_k from the collection:

$$a_0 = \frac{1}{K}\sum_{i=1}^{K} a_k, \qquad a_k - a_0 = \sum_{i=1}^{K-1} PC_{ki} e_i, \qquad PC_{ki} = \frac{(a_k, e_i)}{(e_i, e_i)}.$$

The eigenvectors are sorted in ascending order of the variances associated with the eigenvectors. Similarly, any new homologous model a_h can be decomposed by the basis of the eigenvectors:

$$a_h - a_0 = \sum_{i=1}^{K-1} PC_{hi} e_i, \qquad PC_{hi} = \frac{(a_h, e_i)}{(e_i, e_i)}. \tag{1}$$

And vice versa, any new shape can be synthesized by sampling from the range of the principle components. Theoretically, it is possible to control modeling of body shape changes directly, adding variations to PC_{hi}. However, each PC cannot clearly be associated with a single anthropometric body measurement such as height, weight, or waist circumference, it is rather influenced by combination of the measurements and variations of postures. Each body shape a_k has L supplementary measurements $\{d_{k1}, d_{k2}, \ldots, d_{kL}\}$,derived from the range data and measured with scale, anthropometer, etc. Supposing that scores of the i-th PC ($i=1,..,K-1$) depend on L multiple measurements $\{d_1, d_2, \ldots, d_L\}$, we may propose control of body shape modeling through them for the case of simple linear dependency:

$$PC_i(d_1, d_2, ..., d_L) = b_{i0} + \sum_{j=1}^{L} b_{ij} d_j \ . \tag{2}$$

Then, the coefficients b_{ij} can be found by solving the task of linear regression for each principal component:

$$\sum_{k=1}^{K-1} \left(PC_{ki} - \left(b_{i0} + \sum_{j=1}^{L} b_{ij} d_{kj} \right) \right)^2 \xrightarrow{b_{i0}, b_{i1}, ..., b_{iL}} \min \quad .$$

Taken into account that PC scores can directly be reconstructed from the homologous model by formula (1), we can compare them with ones obtained from linear model (2) to clarify how accurate the assumption of linearity is. Figure 3 shows the comparison for PC_1 for one of the scanned population group. On the average, for this population the results of linear modeling are very good for lower PCs.

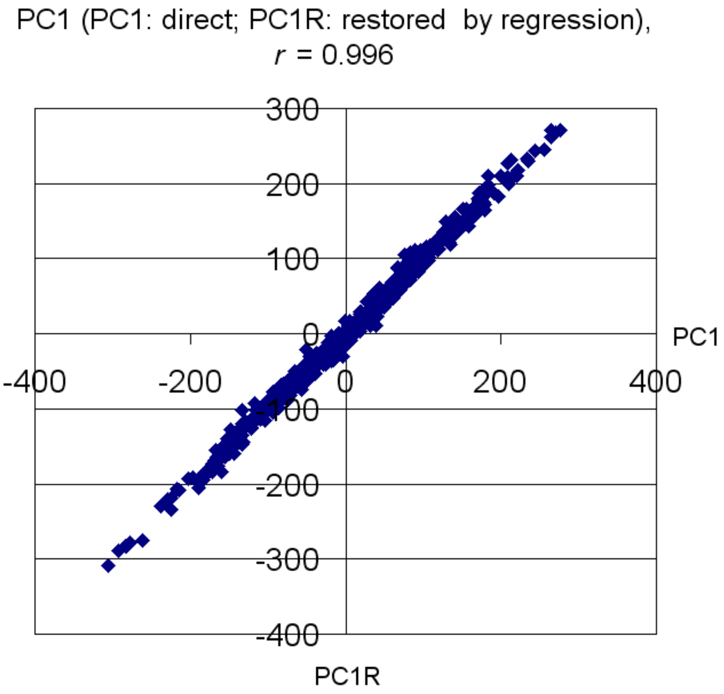

Fig. 3. Correlation of pairs of PC1, inter-population female group, 533 subjects aged from 16 to 96.

Then, any new synthetic body shape a for given set of measurements is calculated without the usage of homologous model as

$$a(d_1, d_2, ..., d_L) = a_0 + \sum_{i=1}^{K-1} PC_i(d_1, d_2, ..., d_L) e_i \quad . \tag{3}$$

For the case of individual body simulation with available homologous model a_k and measurement vector $d_k = (d_{k1}, d_{k2}, \ldots, d_{kL})^T$, it is preferable to use increments of the measurements. Then, denoting the "new" measurement set as $d = d_k + \delta d$, where $\delta d = (\delta d_1, \delta d_2, \ldots, \delta d_L)^T$ is the measurement increment, we can use our regression results to simulate new shape in terms of the increments:

$$a_{sim}(d) = a_k + \sum_{i=1}^{K-1} (PC_i(d) - PC_i(d_k)) e_i \quad . \tag{4}$$

The last formula provides more precise results of modeling than (3) in case of individual 3D scan data modeling. Note, that starting from about 20-th PC, the regression error increase (unlike good correlation shown in Figure 3). Indeed, for the high order eigenvalues with low significance, random factors in body shape variations become dominant. Limiting the value K, for instance, by 30, formulae (3) and (4) can be used for fast modeling on the client sites of the Web-based system.

3. Reduction of the number of controlling measurements

As the developed body shape modeling method was supposed to be implemented for the interactive control through the Web, it is reasonable to make such control more user-friendly and simple. If the number L of controlling measurements used in formula (4) is large enough and the user is allowed to vary them independently, the resulting simulated body shapes would be very unrealistic and the control process itself would be confusing and difficult for the users. Therefore, more simplified and robust method of modeling is needed. At first glance, it seems reasonable to reduce the number of body measurements L by configuring the scanning system's software. Once the Web-based modeling system is mostly intended for personal body weight control, the developers first reasonably decided to use weight, height, BMI, and 3D scanner's measurements obviously dependent from weight gain/loss. They are listed in Table 1. The body dimensions are mostly the circumferences of body parts (neck, torso, arms, and legs) measured in horizontal cross sections.

Table 1. Basic modeling measurement list: weight, BMI and body dimensions, female group, 65 subjects, aged from 30 to 39.

Measurement	*Name [unit]*	*Mean*	*S.D.*
d1	Height [mm]	1587.0	49.4
d2	Weight [kg]	53.5	8.6
d3	BMI [kg/m^2]	21.2	3.2
d4	Neck circumference [mm]	319.5	16.9
d5	Chest circumference [mm]	867.7	65.7
d6	Waist circumference [mm]	706.6	80.6
d7	Abdominal circumference at omphalion level [mm]	776.4	87.8
d8	Hip circumference [mm]	919.7	60.1
d9	Left max thigh circumference [mm]	537.1	39.3
d10	Right max thigh circumference [mm]	545.0	40.2
d11	Left mid thigh circumference [mm]	488.5	39.3
d12	Right mid thigh circumference [mm]	492.4	42.3
d13	Left calf circumference [mm]	347.9	27.0
d14	Right calf circumference [mm]	349.8	26.1
d15	Left upper arm circumference [mm]	246.7	25.6
d16	Right upper arm circumference [mm]	250.1	25.8

First we tried simulation in accordance with (4) based only on this measurement set, but found that body shape deformations due to weight increase tend to be unrealistic in case of large values of weight change, exhibiting effect of "inflated bubble" and significant bone length changes. Then we re-used additional 28 skeleton measurements (bone lengths and distances between joints) calculated during building the homologous model. These measurements are included into the regression and PC calculation (2). The skeleton measurements, when being kept constant in individual shape modeling, result in constraining effect and prevent bone deformations, and as a consequence, the modeled shapes look much more realistic, and regression errors (example shown in Figure 3) becomes smaller. Basic software for the 3D scanner can provide up to 72 body dimensions. We tried the complete set of the measurements in the regression. Even correlation between actual PCs restored from the homologous models and reconstructed by the regression model became higher, the final composition of body shapes from PCs calculated with the basic measurement set (Table 1) and the complete set appeared very similar for the task of weight variations.

In order to reduce the number of user controls from the list of body dimensions (d4-d16), the measurement correlations were studied. It is natural to expect that correlations of the symmetric pairs of arm and leg circumferences are high. Indeed, cross-correlations of the pairs (d9-d10), (d11-d12), (d13-d14), (d15-d16) appeared as 0.951, 0.944, 0.953, and 0.958, respectively. Then, the dependency of the neck and calf circumferences from weight appeared the lowest, showing cross-correlations 0.561 and 0.642 for the pairs (d2-d4) and (d2-d13). This is in accordance with our intuitive understanding of the fact that, for example, calf circumference much less increases when weight gains. Pairs (d9-d11) and (d6-d7) are also highly correlated. As for the last pair, it is better to exclude the measurement d7, because the term "waist" is more understandable for people. Also, BMI measurement is redundant, because it can explicitly be calculated through weight and height. Finally, height should not be varied by the users, when they model their body shapes. Based on the above speculations, we checked the reduced body dimensions' set with our regression and modeled several shapes to compare them with the shapes, reconstructed with the usage of all 16 measurements. The compared shapes were very similar visually and in terms of a shape matching function, and, in principle, the reduced set can be applied for modeling, even some personal features may not be captured, e.g., highly muscular calves. In any case, the aim of the "reduced" set is not in the usage of it in the modeling functions (3) and (4), but rather in the use of weight and body dimensions as customer controls through an interactive GUI.

In GUI, the measurements can be changed individually, one-by-one, every time applying simulation (4) and displaying the result of simulation in a 3D window. However, change in one measurement requires adjustment of all others simultaneously for realistic body shape view. Intuitively clear, that d4-d16 depend on d3, and cross-correlation calculations proves it: all the measurements are highly correlated with weight (except height, which correlation with weight is just 0.16). Based on this fact, we can approximately model the changes of the measurements by weight change in accordance with the following scheme. Suppose, all the measurements depend on weight w linearly:

$$d_i(w) = d_i + c_i(w - d_2), \quad i = 1..16, \tag{5}$$

where d_2 is weight measured on the day of 3D body scanning together with all other measurements d_i. We can also define $c_1 = 0$ (height does not depend on weight) and $c_2 = 1$ (weight is weight!). There are two cases of control by one measurement.

CASE 1: If input control is weight w, then formula (5) is applied directly to all measurements.

CASE 2: If input control is not weight (i-th measurement is varied by increment δd_i, $i \neq 2$), then the increments of all other measurements, δ_j, $j = 1,\dots,16$, are balanced as follows:

$$\delta d_j = \begin{cases} \frac{c_j}{c_i}\delta d_i, & i \neq 1 \\ 0, & i = 1 \end{cases}.$$

Thus, it is possible to predict the change of waist circumference by change of weight, and vice versa. Coefficients c_i are defined by linear regression through all the data for each statistical group. The standard deviations estimated from the regression are small enough to reconstruct all the measurements even at high gain or loss of weight. There are two remarks on the method. First, it is better to calculate new BMI directly by known weight and height. Also, in [11] it was proposed to use the cubic root of weight for PCA, rather than weight, appealing to the fact that weight has volumetric measure. We checked the regressions (3), (4), and (5) with the usage of the cubic root of weight and did not find improvements of regressions' accuracies. It can probably be due to non-uniform distribution of the gained fat in the body.

4. Web-based implementation: "3D-Navi"

The methods described in Sections 2 and 3 were implemented in our Web-based system "3D-Navi" managed by Nihon Unisys. In principle, the methods could be realized as a standalone application, but there are many disadvantages of this approach, because the collected 3D scan data are commercially sensitive and should not arbitrary be accessed or updated by the users. Also, there are serious ethic reasons (e.g., the requirement of non-disclose of almost undressed personal body shapes) restricting a stand-alone implementation. Therefore, it was decided to implement a centralized control of data access from Web clients with a secure authorization mechanism.

In order to motivate humans in participating in 3D scanning, the main scenario of the usage of the "3D-Navi" Web-based system was supposed to provide the subjects with ability to observe their current personal body shapes, model body shapes in cases of weight loss or gain, visualize their virtually regal carriage, and, therefore, to stimulate them in physical training, exercises, and dieting. To realize the above scenario, "3D-Navi" was designed to provide user-friendly and secure access to personal data, to quickly react on the users' requests from the client side, to intuitively convenient 3D browse the whole body shape and selected body parts, to generate reports with 3D views of current and modeled body shapes and body dimensions in textual form. Real-time rendering of 3D contents on the client side (not only homologous models, but also original 3D scans with up to one million vertices) implies high requirements on the implementation performance and the network bandwidth bottleneck overcome.

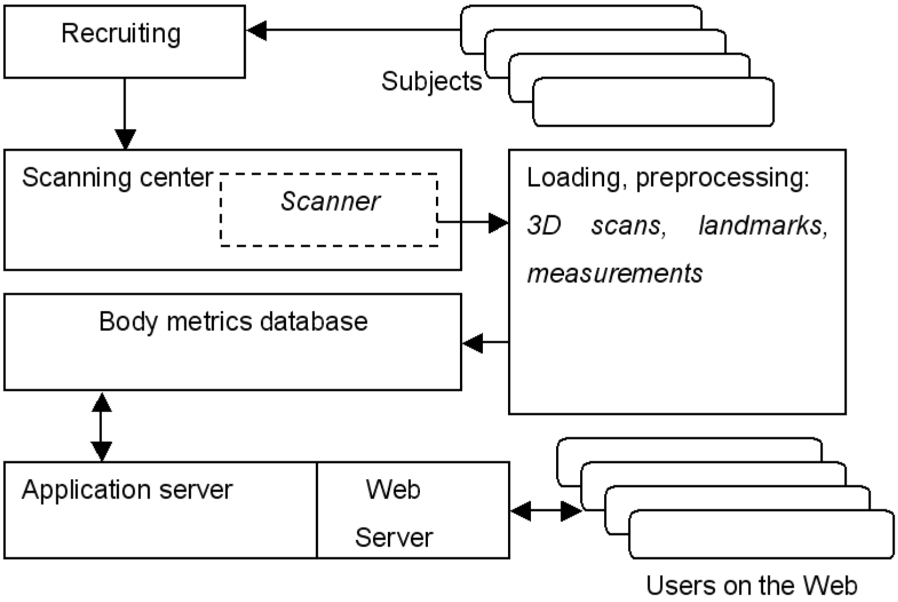

Fig. 4. Web-based system.

Our methods were algorithmically and programmatically optimized to obey the requirements, especially for the server-side tasks of preprocessing and building homologous model (which can start just after 3D scan data loading) and body modeling by the users, e.g., by formula (4). In case of gradual increase of collected 3D scans in the database, the data required for one body shape modeling, namely, eigenvectors and PCs, can be much more bulky than the size of file with modeled 3D body shape. Thus, it was decided to implement modeling as an optimized server-side application without cutting of higher order eigenvectors. (The last simplification usually applied, see, e.g. [11, 17,18].) PCA analysis is periodically updated on the server by administrator's request. Modeled body shapes are transferred to the client side in a compressed form of the Wavefront graphical format (OBJ). The overall server-client system is depicted in Figure 4.

To support variety of browsers and platforms, the client side is implemented as an HTML form-based GUI with JavaScript control calling Java applet for 3D visualization in a panel inside the main frame of the client window (Figure 5). 3D graphics and navigation in 3D is implemented in Java3D on top of OpenGL, which provide real-time rendering of modeled shapes. The applet also provides a variety of service functions, such as model loading, high quality off-screen image rendering for modeling session report generation, modeling measurement settings, etc.

Modeling measurement selection is performed via buttons, popup windows, and editable fields. As described in Section 3, modeling can be done in several modes: with measurement masking, independent, and setting by one measurement.

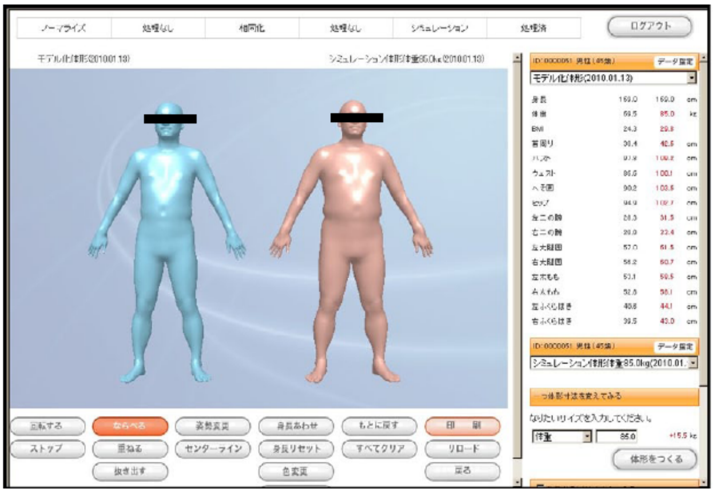

Fig. 5. Client's user interface.

In the 3D window the user can visualize up to two models (for example, original homologous and prognostic with over-weight of 20kg is shown in Fig 5), rotate, scale, align them, or start auto-rotation mode. Different body parts can be colored with specially assigned colors for displaying the body part surface difference. Important feature is overlapping the shapes in a semi-transparent mode, which obviously displays the difference of the overall shapes or body parts (Figure 6.)

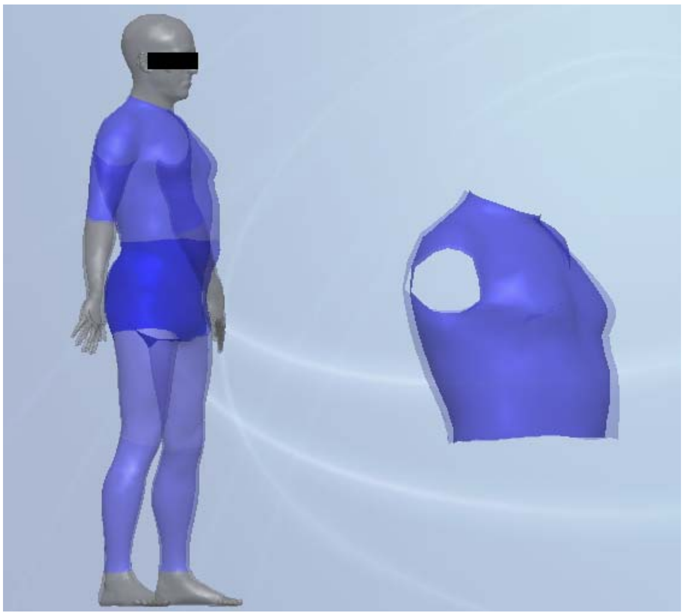
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Fig. 6. 3D view of full body (left) and zoomed torso (right) overlays for normal state and 10kg overweight.

During design of interface layouts, colors, reactions on mouse operations, and scaling, the developers followed the end-users' recommendations.

5. Conclusion and future works

Web-based "3D-Navi" system design and implementation is described in this paper. The system is intended for remote access to individual 3D scan data and personalized body shape modeling by interactive variations of limited number of body dimensions (or, even one such measurement). Typical scenarios are, for instance, visualization of the user's desired body shape after weight loss, or prognostic shape after wished waist decrease. The system is supposed to motivate the people in physical exercises, training and follow to unloading diets. The system is supported by real-time graphical rendering and browsing the body shapes and/or body parts in a 3D window on the Web. Simple, intuitive and user-friendly 3D navigation allow easy comparison of current and prognostic body (or, body part) shapes. Also, the system allows to generate printed reports of the results of scanning, measurements, and body shape modeling.

For the Web-based system, special rapid methods of 3D range data preprocessing, canonical model creation with corrected posture, and statistical analysis were implemented. The methods are based on templates (body meshes with associated skeleton) with high level of details for face, hands, and feet. The individual features of face are well transferred to the modeled shapes. To simplify modeling by user's control through a limited set of anthropometric data, an original method of measurement settings was proposed and implemented in the system.

The authors hope that the system will be attractive for the users, and they will use it periodically during the course of their weight-loss exercises and unloading dieting, that will result in not only contribution to 3D scan data bases, but mainly in collecting statistics for individuals. The last feedback from users would improve human body shape modeling significantly.

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