Development of a Body Size Measuring Process Utilizing 2D Images

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Abstract
Body sizing of has been recognized as an important element affecting the degree of customer satisfaction in the apparel industry. Recent developments in IT technologies have enabled more studies in custom-made apparel systems that comply with the diverse demands from customers in many countries. Diverse methods to obtain personal physical size are being studied. This study estimates the accuracy by developing the system in which the data of length and girth can be calculated through changing a modeling by comparing the data with circular 3-dimensional physical configuration data. This information was computed from the process (such as the conversion to a standardize image) which utilizes the image capture of 2-dimensional three sides (front, side, and rear), contour tracing, and key-node selection and by realizing it in the real world.

Key words: 3D body shape modeling, 2D image based modeling, Body size; 3D 인체 형상 모델링, 2D 이미지 기반 모델링, 신체치수

I. Introduction
In recent fashion industry, the movement responding to the diverse demands from customers has actively made. Especially the preference of consumer oriented fashion products has gradually expanded the market of custom-made fashion products while the trend of small amount production for large kinds products and the technology intensive high added value production becomes noticeable (Park, 2006).

Also in Europe and America, the efforts to establish the virtual space innovative industry base is being made so that the whole process of design, production, order, sale, distribution and customer management can be conducted on line by using the method of 3-dimensional measurement for body size. Many countries such as Germany, Spain, England, Belgium and France have inaugurated the e-T cluster project which integrates 3-dimensional body scanner, order softwares, apparel CAD, production software and avatar technology (Jang, 2004). Nowadays the apparels produced by using the physical size measuring technology of 3-dimensional body scanner get popular.

As keeping pace with those movements in the developed countries, our country is conducting the study to construct the model of virtual dressing and
virtual fitting, which can identify the condition of how well the clothes fits to person in order to make successful the electronic commercial trade and satisfy the demand of customers (Chun & Park, 2003; Kim, 2000; Tak & Kim, 2006).

The kinds and shapes of 3-dimensional body scanner which have been commercialized worldwide are very diverse. The representative products are Whole Body Scanner WB4 from Cyberware, Vitus 3D Body Scanner of Tecmath, Body Scanner of TC2 and Tri-form Body Scan of Wicks & Wilson and there are products such as DigiSize Software of Cyberware, Scanworx and Polyworx of Tecmath, 3D Body measurement Soft system of TC2 as the 3-dimensional physical measurement software.

The previously mentioned 3D whole body scanner is required for the custom made apparel production system in which the physical size and body configuration data can be obtained. However it is expensive equipment and actually it is not yet affordable for producing custom-made apparels to the small and medium companies.

**II. Characteristics of System**

The design of system processing for physical sizing embodiment is like <Fig. 1>. First the data is obtained from the 3 pictures from front, side and back image each. the contour of front, side and back body can be produced through checking contour of pictures and thus the contour from circular 3D body data is modified and the length of each part is changed.

Simultaneously the value of each apex composing surfaces is modified. The characteristics of this system in realizing the body scan system is that the algorithm of realizing modeling can be achieved which can’t be basically produced by any other method since the original modeling can be modified based on the value of contour obtained from pictures by classifying the circular 3D body data based on the sex and physical shape, or large, intermediate and thin body. according to those processes, the new measuring system was produced and tested.

Display module made display of body modeling

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*Fig. 1. Map of entire system.*
with the use of the functions provided by Open GL and the data format provided in this system is 3DS file.

III. To Realize the System

1. Image Preprocessing

The image preprocessing includes the work process such as image standardization, tracing of contour lines and selecting key-node of contours. The calculation process of image is as follows. First the pixels of two different colors were separated by comparing color of objects of target with or to color of background in the pictured image.

In other words, it is the process that only the object is obtained as the background is removed from the picture. The two different pixels in the image are called grade. The average value of grading is calculated, the pixel consisting background is converted to black color and the pixels of object is stored in white color while they are separated each other like <Fig. 2>.

In case the two colors for grading are A (r1, g1, b1) and B (r1, g1, b1), here r, g and b is defined as red, green and blue respectively and the difference of two colors is called difColor, which is defined as the grade between two pixels.

\[
difColor = rWeight \times \text{abs}(r1, r2) + gWeight \times \text{abs}(g1, g2) + bWeight \times \text{abs}(b1, b2);
\]

\[
rWeight = 0.30;
\]

\[
gWeight = 0.59;
\]

\[
bWeight = 0.11.
\]

Although they are separated on basis of the basically designated value in the process of segregation, the output can be produced by adjusting this value when the result is not satisfying like <Fig. 3> (Barrett & Cheney, 2002).

If you want to use 2D image in order to modify original modeling, you should obtain the pixels of contour as it is. Like <Fig. 4>, you should find pixel A and subsequently the next point on the contour clockwise. If the next point meet the original starting point, it means that the tracing of contour has been completed and then the coordinate of contour is selected, listed and then store automatically.

If in the architectural configuration obtained from selection of image, the five end points of top head, both hands and both foots is chosen and ten point key-nodes from the armpit, crotch, waist are fixed, the body configuration data for head, arms, chest and legs can be obtained like <Fig. 5>.

In order to embody the characteristics of a person on basis of selected keys, the angle between each part of body and its perpendicular direction should be computed like <Fig. 6>. Prior to modifying the original modeling, those configuration analysis information should be calculated from the image. The configuration of original modeling can be adjusted on basis of those selected configuration analysis information.
2. To Obtain 3D Configuration Data through Original Modeling Adjustment

As the original modeling of representative body of both male and female sex is basically in storage, the 3D body configuration data is formed while the original 3D body model is least modified on basis of configuration analysis data computed in the image preprocessing.

That is, the data of pre process of image is overlapped on the original body image data. And then the contour data of original modeling is modified by the contour of selected image. The one is the modified contour section of original modeling, which utilizes front and back image before it is applied to modify contour of side of original modeling. When the modifying of contour is completed, the apex of 3D circular body image data on the contour are simultaneously modified.

3. To Obtain Body Size through Images

In order to find sizes from 2D image, the white line...
installed in time of obtaining image was used as a standard. The size is computed on basis of 5×50cm white line (standard line). As the number of pixels of other section of body is counted from the specific front image or back image obtained, the number of pixels in the image of this standard line can be computed.

First by using this standard line, the scale of per pixel was found. the system can obtain the number of pixels for the width of this standard line. If you divide 50cm or the actual length of this standard line by the number of pixels, you can find the actual length of each pixel. The equation of computing image pixel is as follows.

In case of Xmm, if the number of pixel is Y,

\[ X \text{ (mm)} : Y \text{ (pixels)} = A \text{ (mm)} : 1 \text{ (pixel)} \]

The length of desired part can be computed out if it is applied to value of key and the value of each part for finding the length decided by body segregation.

4. Simulation

1) To Measure Image

The procedure of taking picture to obtain image is like <Fig. 7>. The subject is dressed in the white color shirt and pants with good tightness and the green color background was chosen so that it is contrasted to the color of subject's clothes and the process of “edge trace” can be seem clearly when obtaining data after taking picture.

The white guide line of 5×50cm was drawn over the head in order to find the fixed value for obtaining size in the background of picture. With the constant distance of 250cm between camera and subject, pictures were taken. the total of 3 pictures for front, side and back image were taken. Here the digital camera for general purpose was used.

2) System Interface

The system interface is like <Fig. 8>. It is composed of image creation and modification, area to watch pictures and modeling, identification of length data and external output.

The three images brought are disposed in the area of picture display. If icon is selected, the contour can be obtained like <Fig. 9>. And then the obtained contour creates 3D modeling via serial processing such as image preprocessing like <Fig. 10>.

3) The Part Where Data Was Selected

As the body data which can be deducted by using the developed system, the most necessary elements of upper and lower body in making clothes was chosen. The detail of them is like <Fig. 11>. The total of
12 items including the seven items such as the circumference of neck, upper chest, chest, lower chest, waist, hip and thigh and one item of the width of shoulder and 3 three length items such as length of arm, one from neck to waist, one from waist to knee and one height items were obtained.

5. Appraisal of System

The value from direct measuring of 3 persons in twenties was compared with the one from this system in order to appraise the system. The measuring and appraisal of system was conducted in the same
environment as image picturing while the subject was dressed in tight shirt and pants.

The comparison of automatic measured value by system and direct measured one is as the following table. As the <Table 1> shows, there was error of 1cm in the length and height data while 2cm error in circumference and width data. Therefore it is assumed that there will be difficulty in 3D image since the number of side image is just one.
this algorithm is to embody 3D modeling obtained from three 2D images. The result of applying the system is as follows.

1. This system is focused on the system in which size and image data for producing apparel can be obtained.
2. The three length items, seven circumference items, one Breadth item and one height body measurement data are obtained while measuring body with the use of this system.
3. It proved that the data of length and height has the error of 1cm while the data of circumference and width has the error of 1~2cm.

As there could be the difference in size depending on the clothes dressed at the time of applying this system, it is important to be dressed in tight clothes. Besides it proved that the processing is the most crucial element to decrease the error of measurement, which separates the background and object and converts the obtained values to 3D body image data by contrasting the object with white line in the separated object.

In the result of experiment of appraising clothes dressing, there is the error such as some difference from the direct measured value. Since it is a little beyond the allowable error of 4~5mm in length and maximum 9mm in circumference data in measuring 3D body data, the subsequent study should be followed continuously which is about taking picture with the more divided side image.

If the picture can be taken with the side divided more, we think the accuracy of size of each item will be improved and thus it will lead to the more correct result. By combining IT technologies with custom made apparel market, the digitalized basic technology of obtaining body size has been secured and it is expected to be a basis for technological advance toward online apparel market of customer joining.

### References


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요 약

의류산업에서의 신체치수는 소비자의 만족감에 영향을 미치는 중요한 요인으로 인식되고 있다. 최근 IT기술의 발달로 인해 소비자의 다양한 욕구에 반응하기 위한 맞춤주문형 의류시스템 연구가 국내외적으로 많이 이루어지고 있으며, 특히 개인별 신체치수를 얻기 위한 다양한 방법들이 연구되고 있다. 본 연구는 2차원적인 3장(전면, 측면, 후면)의 이미지 컨텐츠를 이용하여 이미지의 표준화를 위한 변화, 외곽선 추적, 카노드 추출 과정으로 재산된 데이터를 원형 3차원 인체 형상 데이터에 대조하여 모델링을 변화시키는 프로세스를 통해 상하길이, 둘레데이터 및 인체 형상 데이터를 간편하게 획득하는 시스템을 개발하여 시스템 구현을 통한 정확성을 평가하였다.