# KISTI에 있어서 한국인 인체정보의 생산과 활용

## Production and Usage of Korean Human Information in KISTI

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**요약**

한국과학기술정보연구원(KISTI)는 2000년부터 한국인의 고유한 인체 특징을 나타낼 수 있는 디지털 코리언, 비저블 코리언이라는 한국인 인체정보 구축사업을 시작하였다. 비저블 코리언 사업은 한국인 시신에 대해 CT, MRI 영상을 촬영한 다음 연속 절단하여 절단면 영상을 얻고 이 절단면 영상에서 인체 장기를 구역화하여 구역화 영상을 제작하였다. 남성 및 여성 전신과 남성 머리 및 여성 골반의 절단면 영상 제작을 마쳤으며 현재 구역화 영상을 이용한 3D 영상 제작이 진행 중이다. 디지털 코리언 사업은 약 100여명의 한국인 시신에 대해 촬영한 CT 영상으로 구성되어 있는데 CT 영상으로부터 개별 뼈를 구역화하여 3D 골격 모델을 제작하였고 피부 모델도 추가하였다. 또한 개별 뼈들의 기계적 물성값도 측정하여 제공하고 있다. 이러한 인체정보들은 2001년부터 국내외 연구자들에게 제공되어 왔는데 지금까지 국내 약 70여개 기관, 해외 약 20여개 기관들이 한국인의 인체 데이터를 제공받아 연구 활동을 진행하고 있으며 지금까지 약 160여 논문이 발표되었다. 향후에도 이러한 한국인의 인체정보는 의료 교육, 생체공학, 가상현실 등의 다양한 분야에 활용될 의료정보 인프라의 역할을 담당할 것으로 기대하고 있다.

■ 중심어 : | 디지털 코리언 | 비저블 코리언 | 인체정보 | 의료영상 | 인체모델 |

**Abstract**

The KISTI (Korea Institute of Science and Technology Information) began to produce the Korean human information called Visible Korean and Digital Korean since 2000 because there was no human information in Korea which could represent the physical characteristics of Korean human body.

The Visible Korean consists of CT, MR, sectioned and segmented images of Korean human body. We obtained the serially sectioned images by grinding the Korean cadaver in horizontal direction and segmented these images by outlining the inner organs of human. We have produced the sectioned images of Korean male whole body, male head, and female pelvis in 2008. The segmentation and 3D reconstruction of these images are now in proceeding. The Digital Korean consists of CT images of about 100 Korean cadavers. These CT images were segmented by individual bone, reconstructed to produce the 3D bone models and the skin surface model was also added. The mechanical properties of individual bones were obtained by measuring the property of individual bone sample.

We have distributed these Korean human informations to users in domestic and abroad. About 70 institutes in domestic, and 20 institutes in abroad have used our data in research use and nearly 160 proceedings and articles were published since 2001. We think these human informations have a role of medical information infrastructure that could be used in the field of medical education, biomechanics, virtual reality etc.

■ keyword : | Digital Korean | Visible Korean | Human Information | Medical Image | Human Model |

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## I. Introduction

The human information such as CT, MR, serially sectioned image, segmented image and 3D image are used as a primary image source in the field of biomechanics, medical image processing, medical education etc. However, there are no medical image data about the Korean human in domestic. So, many researchers in Korea have to use the human medical images of foreigners and it cannot represent the physical characteristics of Korean human body. By this reason, the KISTI (Korea Institute of Science and Technology Information) began to produce the Korean human information since 2000 and many kinds of Korean human data were prepared and serviced to the users in domestic and abroad. In this paper, we review the project of Korean human information called as Digital Korean and Visible Korean and we especially focus on the medical image data production and their usage.

## II. Production of Korean Human Information

### 1. Digital Korean

The Digital Korean data is produced by CT scanning of the Korean cadavers. The total number of Korean cadavers is about 100 and half of them are the males. The average age of males and females is about 50 and 54 respectively. The cadaver is CT scanned by 1 mm interval to produce the full data set of CT images about the entire body. The CT images are obtained as DICOM files and converted to BITMAP ~~Bitmap~~ file for segmentation. The segmentation is done by individual bone and total 179 bones are segmented by the specific program. The segmented images of individual bones are reconstructed to generate 3D surface models of bone and about 100 bone models of Korean entire body are created by the specific program. The file format of bone model is STL file that could be handled by commercial CAD/CAE program. The average bone models of 1 male and 1 female are made by geometric averaging technique of bone using mass center and principal direction.

The bone sizes of hands, feet and teeth are so small that the geometric characteristics of them cannot be revealed enough in each bone model. So, we scanned the Micro CT (Skyscan 1076, Belgium) about them. These Micro CT images are also segmented by 54 bones of hands, 52 bones of feet and 32 teeth respectively. These segmented images are also reconstructed to produce the detailed 3D models that can represent the characteristics of small hands, feet and teeth bone. We also make the 3D skin model of fat, normal and thin human body and added these skin models to the average bone model.

We have measured the mechanical property of human bones. The 4 sample cadavers are selected from young and old male and female. The many kinds of human bone are extracted from cadavers and test bone samples are prepared by removing the other tissues from the bone. The property of cortical bone is measured by indentation test (AIS 2100, Frontics, Korea) first, and then, the specimen of trabecular bone is prepared by extracting the specimen from the bone and the property of trabecular bone is measured by compression test (Instron 5567, Instron, USA). In the mechanical property test, the value of modulus of elasticity, tensile strength and yield strength are obtained by measuring the total 1,672 points of cortical bone and 608 specimens of trabecular bone. [Table 1] shows the total amount of Digital Korean data.

Table 1. Total Amount of Digital Korean Data

| Content | Object | Amount | Format | Remark |
|---|---|---|---|---|
| CT Image | Bone (Whole Body) | M 50, F 50 Set | BMP, DCM | 1 mm interval |
| | Skin (Whole Body) | M 3, F 3 Set | BMP, DCM | 1 mm interval |
| Micro CT Image | Bone (Hand, Foot, Teeth) | M 1, F 1 Set | BMP, DCM | |
| 3D Image | Bone (Whole Body) | M 50, F 50 Set | BNS, STL | |
| | Skin (Whole Body) | M 3, F 3 Set | BNS, STL | |
| | Bone (Hand, Foot, Teeth) | M 1, F 1 Set | BNS, STL | |
| Finite Element Model | Averaged Skeletal Model (Whole Body) | M 1, F 1 Set | DAT (Text) | NASTRAN |
| | Skin (Whole Body) | M 3, F 3 Set | DAT (Text) | NASTRAN |
| | Bone (Hand, Foot, Teeth) | M 1, F 1 Set | DAT (Text) | NASTRAN |
| Mechanical Property | Head | Cortical 48 | Text | M 2, F 2 |
| | Trunk | Trabecular 30, Cortical 124 | Text | M 2, F 2 |
| | Upper Extremity | Trabecular 12, Cortical 50 | Text | M 2, F 2 |
| | Lower Extremity | Trabecular 110, Cortical 196 | Text | M 2, F 2 |

## 2. Visible Korean

The Visible Korean data are produced by sectioning the entire Korean cadaver [1-3].

Among the donated cadavers, a young adult cadavers with no pathological findings are selected for obtaining the images of good quality. Before sectioning the cadaver, the entire cadaver is CT and MR scanned by 1 mm interval to compare the CT, MR image with the corresponding sectioned image. After scanning, the cadaver is put into the embedding box, the blue embedding agent is poured into the box by many times and the cadaver with embedding agent is finally frozen at -70℃ in the freezer. To sectioning the entire body, the regular milling machine is remodeled with establishing milling table and cutting blade, and is operated by the control program. The frozen embedding box with cadaver is placed on the milling table and moved toward to the cutting blade by constant speed. As the milling table is moved, the rotating cutting blade serially sections the entire body by 0.2 mm interval. As the one slice section is ended, the sectioned surface is cleaned with ethyl alcohol and photographed by digital camera (DSC 560 Kodak, resolution 3,040×2,008) which is connected to the personal computer.

The photographed image is checked in quality and saved to the computer as the TIFF file.

This procedure is repeated and all the serially sectioned anatomic image set of entire body can be obtained as the TIFF file. We have finished sectioning the Korean male entire body, male head, female pelvis while female entire body is now in sectioning.

The segmented images are obtained by outlining the serial contours of one anatomic organ in the sectioned images. The TIFF files of anatomic image are converted to PSD file for Photoshop and the segmentations are done semi-automatically by using the Adobe Photoshop program. We extract the contours of many kinds of anatomic organs from the sectioned images and fill the specific color in the inner area of contour. All the segmented images are prepared by repeating this procedure for the specific anatomic organs that we want to segment [4].

The segmented images are stacked and reconstructed to produce the 3D surface images by using the Maya and Rhino program [5-7]. At first, the segmented images of PSD file are converted to Adobe Illustrator (AI) file to prepare the isolated segmented images, so that the contours of one anatomic organ

Table 2. Total Amount of Visible Korean Data

| | Cadaver | MR Image | CT Image | Serially Sectioned Image | Segmented Image | 3D Image |
|---|---|---|---|---|---|---|
| Whole Body (Male) | - Age 33, height 164 cm, weight 55 kg<br>- Cause of death : leukemia | - Interval 1.0 mm, file size 239 MB, 1,702 images, TIFF file, RAW file | - Interval 1.0 mm, file size 239 MB, 1,702 images, TIFF file, RAW file | - Interval 0.2 mm, resolution 2,468*1,407, file size 82.5 GB, 8,505 images, TIFF file | - Interval 1.0 mm<br>- 902 human structures of 13 systems<br>- File size 578 MB, TIFF file | - Continued |
| Head (Male) | - Age 67, height 162 cm, weight 45 kg<br>- Cause of death : myasthenia gravis | - 7 Tesla, interval 0.4 mm, file size 73 MB, 312 images, BMP file, DICOM file | - None | -Interval 0.1 mm, resolution 4,368*2,912, file size 177 GB, 2,500 images, TIFF file | - Continued | - Continued |
| Pelvis (Female) | - Age 43, height 152 cm, weight 54 kg<br>- Cause of death : alcoholics | - Interval 1.0 mm, file size 98 MB, 230 images, BMP file, DICOM file | - Interval 1.0 mm, file size 98 MB, 256 images, BMP file, DICOM file | - Interval 0.1 mm, resolution 4,368*2,912, file size 47.8 GB, 2,500 images, TIFF file | - Continued | - Continued |
| Whole Body (Female) | - Age 26, height 169 cm, weight 53 kg<br>- Cause of death : gastric cancer | - None | - Interval 1.0 mm, file size 602 MB, 1,764 images, BMP file, DICOM file | - Continued | - Continued | - Continued |

could be viewed. These isolated segmented images are opened in Maya that is the commercial program to produce the polygonal 3D images. All the isolated segmented images are opened, stacked and saved as a drawing exchange format (DXF) files in Maya program. By using the Rhino program, the horizontal gaps between the contours are filled with triangular planar surfaces called polygons to produce the 3D surface images of specific organ and saved as DXF file. We are now preparing the segmented and 3D surface images of Korean male entire body, male head and female pelvis. [Table 2] shows the total amount of Visible Korean data.

## III. Usage of Korean Human Information

These Korean human informations that were produced as the information infrastructure in science and technology have been distributed to the users in domestic and foreign since the year of 2001 when the first Visible Korean project was started.

Table 3. The Distribution Status of the Digital and Visible Korean Data

| Year | Digital Korean | | Visible Korean | | Total |
|---|---|---|---|---|---|
| | Domestic | Foreign | Domestic | Foreign | |
| 2000 –2005 | 4 | 0 | 19 | 12 | 35 |
| 2006 | 5 | 0 | 8 | 3 | 16 |
| 2007 | 2 | 0 | 15 | 6 | 23 |
| 2008 | 7 | 0 | 3 | 2 | 12 |
| 2009 | 9 | 0 | 4 | 4 | 17 |
| Total | 27 | 0 | 49 | 27 | 103 |

Most of the users are professors or researchers who are studying in the university or research institute. The Digital Korean data are usually used in developing the human models in the fields of biomechanics and Visible Korean data are used in medical image processing, medical education, or medical simulator development. [Table 3] shows the distribution of Digital and Visible Korean data. It seems to be that the users are not so many that we expected because we do not have many activities to advertise our data to research users.

However, many researchers in foreign countries

Table 4. The Research Status by using of the Digital and Visible Korean Data

| Year | Digital Korean | | | | Visible Korean | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Domestic (SCI) | | Foreign (SCI) | | Domestic (SCI) | | Foreign (SCI) | | |
| | Proceeding | Article | Proceeding | Article | Proceeding | Article | Proceeding | Article | |
| 2000 -2005 | - | 2 | 5 | - | 22 | 9 | 21 | 4(2) | 63(2) |
| 2006 | 15 | - | - | 2(1) | 5 | 5(1) | 8 | 6(4) | 41(6) |
| 2007 | 6 | - | 2 | 8(4) | 7 | - | 9 | 2(1) | 34(5) |
| 2008 | - | - | - | 1(1) | 6 | 1 | 6 | 3(3) | 17(4) |
| 2009 | - | - | - | - | 1 | 2(1) | 3 | 2(2) | 8(3) |
| Total | 21 | 2 | 7 | 11(6) | 41 | 17(2) | 47 | 17(12) | 163(20) |

have requested us to receive our data because many domestic professors have published a lot of proceedings and articles about our data to the international conference and journals. Table 4 shows the number of proceedings and articles that cite our data in their study. Since 2000, nearly 150 papers and proceedings have been published in academic scholar society. The users who want to use our data for research purpose must take an agreement with us and submit the research report by every year.

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