DOI:10.16016/j.1000-5404.2002.10.047
第24卷第10期 第三军医大学学报 Vol. 24, No. 10
2002年10月 ACTA ACADEMIAE MEDICINAE MILITARIS TERTIAE Oct. 2002

文章编号:1000-5404(2002)10-1231-02

论著

首例中国数字化可视人体完成

张绍祥[1],刘正津[1],谭立文[1],邱明国[1],李七渝[1],李 恺[1],崔高宇[1],郭燕丽[1],杨晓萍[1],张伟国[2],陈现红[2],陈金华[2],丁仕义[3],陈 伟[3],陆 明[3],游 箭[3],许忠信[4],王欲更[4],邓俊辉[4],唐泽圣[4] ([1]第三军医大学基础医学部人体解剖学教研室(计算医学研究室),重庆 400038;[2]第三军医大学附属大坪医院野战外科研究所影像诊断科,重庆 400042;[3]第三军医大学附属西南医院放射科,重庆 400038;[4]清华大学计算机科学与技术系,北京 100084)

提 要:目的 建立中国的数字化可视人体(Digitized visible human)。方法 选择经肉眼观察、CT和MRI检查无器质性病变的中等身材、中年男性人体标本1例,经外形测量、血管灌注后,用5%明胶包埋,置入-30℃盐水池中冰冻1周,然后在-25℃低温实验室中用TK-6350型数控铣床(铣切精度为0.001 mm)从头至足逐层铣切。逐层用高清晰度数码相机摄影,完成人体模型数据获取,得到人体结构数据集。利用连续断层图像数据,在SGI图像工作站上,利用本课题组自主开发的三维重建软件包进行人体结构的三维重建和立体显示。结果 所选用标本为男性,35岁,身高1 700 mm,体重65 kg,重庆人,非器质性疾病死亡。CT扫描层厚:头颈部为1.0 mm,其他部位为2.0 mm。MRI扫描层厚为1.5 mm。连续横断面层厚:头部和颈部为0.5 mm,其中颅底部为0.1 mm,其他部位为1.0 mm,全身共计2 518个断面。数字化摄影分辨率为6 291 456(3 072×2 048)像素,每个断面图像文件大小为36 MB,整个数据集数据量为90.648 GB。结论 ①本文报道的研究结果为首例中国可视化人体(Chinese Visible Human)的正式报道,使我国成为第三个拥有本国可视化人体数据集的国家。其研究结果同时在国际互联网站发布,网站为:http://www.chinesevisiblehuman.com/。②美国已报道的可视化人体在断面标本制作前,将人体标本裁为了4截,造成了其中的3段数据缺损,标本生前切除过右侧睾丸,因而标本不完整,断层厚度为1.0 mm和0.33 mm,断面摄影分辨率为2 048×1 216像素;韩国已报道的可视化人体为65岁的老年标本,层厚为0.2 mm。本文报道的首例中国可视化人体为无器质性病变和缺损的中等身材的中年男性,为整个标本的连续断面,无节段性数据缺损,断面图像分辨率达630万像素,断面厚度达到0.1 mm。因此,本研究在设备的先进性,数据的完整性、代表性和精确性上都超过国际上已有的报道。

关键词:可视化人体;断面解剖;计算机三维重建
中图法分类号:R319;R322 文献标识码:A

Number one of Chinese digitized visible human completed

ZHANG Shao-xiang, LIU Zheng-jin, TAN Li-wen, QIU Ming-guo, LI Qi-yu, LI Kai, CUI Gao-yu, GUO Yan-li, YANG Xiao-ping, ZHANG Wei-guo, CHEN Xian-hong, CHEN Jin-hua, DING Shi-yi, CHEN Wei, LU Ming, YOU Jian, XU Zhong-xin, WANG Yu-shu, TANG Ze-sheng, FAN Hua-quan (Department of Anatomy, Third Military Medical University, Chongqing 400038, China)

Abstract: **Objective** To build digitized Chinese visible human. **Methods** A middle-sized, middle-aged, male cadaver without organic lesions verified by naked-eye observation, CT and MRI examinations was selected as the specimen. After measurement and vascular perfusion, the specimen was embedded with gelatin and then placed in -30 ℃ saline pool for cryopreservation for 1 w, then in laboratory at -25℃, the specimen was serially sectioned from head to foot layer by layer (sectioning accuracy: 0.001 mm) with TK-6350 Digital Sectioner. Human model data were collected by photographs of layer after another with high-definition digital camera and hence datum set for human body structures was obtained. Tridimensional reconstruction and display of human body structures were performed in SGI Imaging Workstation by using the serial cross-sectional image data and the Software for Tridimensional Reconstruction designed and developed by our research group. **Results** The selected specimen, male, 35 y, 1 700 mm in height, 65 kg in weight, born in Chongqing, died due to non-organic disease. The 1.0mm CT scans in the head, 2.0 mm in the rest parts of the cadaveric specimen and the 1.5 mm MRI scans were acquired from the cadaver and the 0.5 mm in the head and neck, 0.1 mm in the skull base, 1.0 mm in the rest part from the serial cross sections of total 2 518. The total datum set acquired was 90.648 GB with each sectioned image file of 36 MB by using the digital photograph resolution of 6 291 456(3 072×2 048) picture elements. **Conclusions** ①This is the first formally reported case of Visible Human in china, suggesting China is the third country to own her own datum set for visible human. The research results are issued simultaneously on the Internet (http://www.chinesevisiblehuman.com/). ②The reported American Visible Human with cross section thickness of 1.0 mm and 0.33mm and 2 048×1 216 picture elements is not a complete specimen because the cadaveric specimen was cut into 4 segments before the preparation of cross sectional specimen, leading to the deficiency of data from the rest 3 segments and the right testicle of the cadaver had been removed before death; the reported Visible Korean Human is a senile specimen of 65 years old with cross sectioning thickness of 0.2 mm. The first case of Chinese visible human reported in this article is a middle-sized, middle-aged male cadaveric specimen. The datum set is acquired from the serial sections of the cadaver without any loss of data. The resolution of the cross sectioning images reaches at 6.3×10^6 and thickness of each cross section at 0.1mm. Therefore, our research prevails over the reported ones in advanced equipment, complete, representative and accurate data.

Key words: visible human; sectional anatomy; computerized 3D reconstruction

基金项目:国家杰出青年基金资助项目(39925022)
作者简介:张绍祥(1957-),男,重庆市人,博士,教授,主要从事人体断层影像解剖学及计算机三维重建方面的研究,发表论文68篇。电话:(023)68752201
收稿日期:2002-08-08;修回日期:2002-09-02

?1994-2016 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

数字化可视人体(Digitized visible human)是依靠计算机技术三维显示真实人体器官结构的计算机模型。在此基础上,赋予人体器官结构相应的物理属性和生理属性等,就可建立数字化虚拟人体(Digitized virtual human),在医学、航天、汽车、体育等多个领域具有广泛的用途。2001 年 11 月 5~7 日,主题为"中国数字化虚拟人体的科技问题"的第 174 次香山科学会议在北京召开,确定要建立中国的数字化可视人体。自 1999 年开始,在国家杰出青年基金的资助下,本课题组经过 3 年的努力,完成了第一例中国数字化可视人体(Chinese Digitized Visible Human)的研究,现予报道。

1 材料和方法

选择经肉眼观察、CT 和 MRI 检查无器质性病变的中等身材、中年男性人体标本 1 例,经外形测量、20% 红色明胶动脉灌注后,用 5% 蓝色明胶包埋,置入 -30 ℃盐水池中冰冻 1 周,然后在 -25 ℃低温实验室中用 TK-6350 型数控铣床(铣切精度为 0.001 mm,数控系统为日本生产,铣刀为法国生产)从头至足逐层铣切。逐层用 Canon 高清晰度数码相机摄影,完成人体模型数据获取,得到人体结构数据集。利用连续断层图像数据,在 SGI 图像工作站上,利用本课题组自主开发的三维重建软件包进行人体结构的三维重建和立体显示。

2 结果

所选用标本为男性,35 岁,身高 1700 mm,体重 65 kg,重庆人,非器质性疾病死亡。MRI 扫描层厚为 1.5 mm,见图 1。CT 扫描层厚:头颈部为 1.0 mm,其他部位为 2.0 mm。连续横断面层厚:头部和颈部为 0.5 mm,其中颅底部为 0.1 mm,见图 2,其他部位为 1.0 mm,全身共计 2518 个断面。数字化摄影分辨率为 6 291 456(3 072×2 048)像素,每个断面图像文件大小为 36 MB,整个数据集数据量为 90.648 GB。

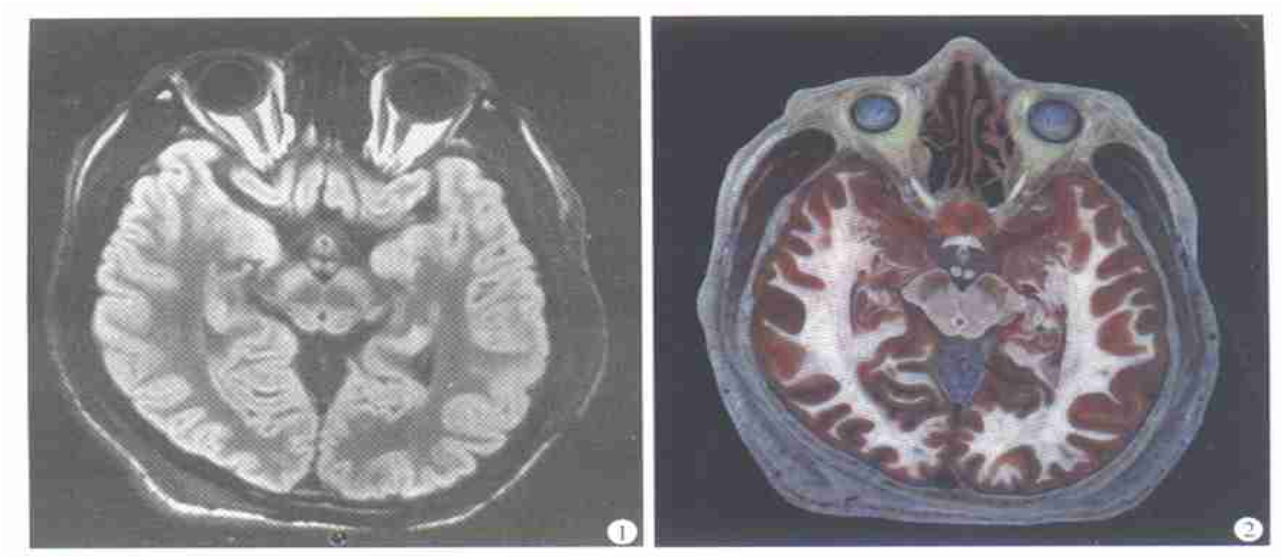


图 1 头部 MR 扫描图像(层厚 1.5 mm)

Fig 1 MRI of the head (The thickness of the layer is 1.5 mm)

图 2 头部断面图像(层厚 0.1 mm)

Fig 2 Section image of the head (The thickness of the layer is 0.1 mm)

3 讨论

在美国国立医学图书馆(NIM)的资助下,1994 年 11 月,美国 Colorado 大学健康科学中心(Health Sciences Center)完成了世界第一个"可视人体计划(Visible Human Project)",并向世界作了公布[1]。韩国可视人体("Visible Korean Human")5 年计划于 2000 年 3 月开始,预计 2005 年 2 月完成,现在已经公布了 1 例人体的实验结果[2]。本文报道的研究结果为首例中国可视化人体(Chinese Visible Human)的正式报道,使我国成为第三个拥有本国可视化人体数据集的国家。其研究结果同时在国际互联网站发布,网站为:http://www.chinesevisiblehuman.com/。

美国已报道的可视化人体在断面标本制作前,将人体标本裁为了 4 截,造成了胸部、股部和小腿部有 3 段数据缺损,标本生前切除过右侧睾丸,因而标本不完整,断层厚度为 1.0 mm 和 0.33 mm,断面摄影分辨率为 2 048×1 216 像素,每个断面未压缩数据为 7.5 MB,整个数据集为 15 GB;韩国已报道的可视化人体为 65 岁的老年标本,形体异常消瘦,层厚为 0.2 mm。这些研究结果如果作为标准数据集,都具有明显的缺陷。本文报道的首例中国可视化人体为无器质性病变和缺损的中等身材的中年男性,为整个标本的连续断面,无节段性数据缺损,断面图像数字化摄影分辨率为 6 291 456(3 072×2 048)像素,每个断面图像文件大小为 36 MB,整个数据集数据量为 90.648 GB。断面厚度达到 0.1 mm。因此,本研究在设备的先进性,数据的完整性、代表性和精确性上都超过国际上已有的报道。

参考文献:

[1] Ackerman M J. The visible human project: a resource for education[J]. Acad Med, 1999, 74(6): 667-670.

[2] Chung M S, Kim S Y. Three-dimensional image and virtual dissection program of the brain made of Korean cadaver[J]. Yonsei Med J, 2000, 41: 299-303.

(编辑 张 宁)

?1994-2016 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net