UDC 572.087 https://doi.org/10.33619/2414-2948/107/07

HUMAN ANTHROPOMETRIC INDICATORS FOR THE PREPARATION OF SIMULATION MODELS

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АНТРОПОМЕТРИЧЕСКИЕ ПОКАЗАТЕЛИ ЧЕЛОВЕКА ДЛЯ ПОДГОТОВКИ ИМИТАЦИОННЫХ МОДЕЛЕЙ

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Abstract. Normal human anthropometric parameters are used in the development of medical rehabilitation techniques, in the performance of surgical techniques used for normal human functioning. In order to perform these operations successfully, it is necessary to model normal human physical characteristics and, based on these models, perform the operations correctly. Normal anatomical characteristics have a positive effect on the physiological state of the person. The relevance of the research stimulates the development of the science of valeology and increases the relevance and practical significance of the topic. Prosthetics of organs lost in wars and accidents are also performed on the basis of computer models. The science of digital anthropology is modeling human anthropometrics, and practically important predictions are being made based on this modeling. Digital anthropology is based on the research of modern technology to compile a database of the most diverse anthropological indicators of people. Anthropology occupies a special place in the system of scientific knowledge about the world, because it is a field of science that studies the origin, development and role of humans in nature and society. In modern medicine, mathematical and graphic modeling of human anatomical and anthropological indicators is required in all fields. Anthropometric indicators of humans are taken as the basis in surgery, military science, sports. The structure of shoulders, diaphragm, hips, face, and the age of a human being can also be defined by these anthropometric indicators.

Аннотация. Нормальные антропометрические параметры человека используются при разработке методик медицинской реабилитации, при выполнении хирургических методик, применяемых для нормального функционирования человека. Для успешного выполнения этих операций необходимо моделировать нормальные физические характеристики человека и на основе этих моделей правильно выполнять операции. Нормальные анатомические

Т. 10. №10 2024
https://doi.org/10.33619/2414-2948/107

характеристики оказывают положительное влияние на физиологическое состояние человека. Актуальность исследования стимулирует развитие науки валеологии и повышает актуальность и практическую значимость темы. Протезирование органов, утраченных в войнах и катастрофах, также выполняется на основе компьютерных моделей. Наука цифровая антропология занимается моделированием антропометрии человека, и на основе этого моделирования делаются практически важные прогнозы. Цифровая антропология основана на исследовании современных технологий для составления базы данных самых разнообразных антропологических показателей людей. Антропология занимает особое место в системе научных знаний о мире, поскольку является областью науки, изучающей происхождение, развитие и роль человека в природе и обществе. В современной медицине математическое и графическое моделирование анатомических и антропологических показателей человека востребовано во всех областях. Антропометрические показатели человека берутся за основу в хирургии, военном деле, спорте. Строение плеч, диафрагмы, бедер, лица, а также возраст человека можно определить также по этим антропометрическим показателям.

Keywords: human anthropometric parameters, simulation modeling, three-level modeling, forensic modeling.

Ключевые слова: антропометрические параметры человека, имитационное моделирование, трехуровневое моделирование, судебно-медицинское моделирование.

Man is constantly in a process of continuous development, human development passes through several stages in the following sequence: childhood; youth; maturity; old age. The process of growth and development are related to each other and are two interdependent indicators for humans. Physical development is one of the most important indicators of improving human health and age norms, so it is necessary to constantly monitor proper physical development. Specific practical skills are required to assess correct anthropometric indicators, which should serve to raise healthy offspring. Human anatomical and anthropometric indicators are accurately defined in 3D modeling and applied in all areas of life. 3D modeling to protect human health allows to determine normal and pathological conditions of internal organs. All prospects of socio-economic development of society, including high science and standard of living, are kept at even higher level with application of 3D modeling [1].

Anthropometric indicators of a person can be different, so the first step is to prepare mathematical models of these indicators, and the next step is to make simulation models. The development of computing technology has led to the emergence of high-speed computing systems. These technologies enable simulations of cell tissue biomechanics, in which both the average continuum tissue dynamics and the behavior of each individual cell can be evaluated. The models are discrete, each tissue retaining its own scenario as it decomposes into cells that develop in their own way. In this regard, new directions have emerged that study mathematical models of all processes occurring in the human body, as well as methods of their study. It is known that mathematical modeling is a system of mathematical expressions describing properties, connections, structural and functional parameters of the modeling object. The elements of mathematical models are features that describe the objects of observation. At the same time, their totality is divided into controlled attributes, influencing the system, and attributes-reactions, characterizing the state of the system under study. There must be a known similarity between the model and the object of interest, which consists either in the similarity of physical characteristics of the model, or in the similarity of

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https://doi.org/10.33619/2414-2948/107

functions performed by the object and the model. Human anatomical and anthropometric indicators are accurately defined in 3D modeling and applied in all areas of life. 3D modeling to protect human health allows to determine normal and pathological conditions of internal organs. All prospects of socio-economic development of society, including high science and standard of living, are kept at even higher level with application of 3D modeling.

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The 3D scanner is used in the imaging of muscles, nerves, cardiovascular and other systems. It applies special marks that are scanned into a single coordinate system, which gives a three-dimensional image on and around the prepared material. An example of how these programs work is the "Pirogov" hardware and software system. This is a collection of comprehensive medical literature and textbooks. It facilitates the training of students in "Anatomy", "Topographical Anatomy and Operative Surgery", "Pathological Anatomy" and many other subjects. This complex operates in four modes: Review, Comparison, Diagnostics Knowledge Check. Review mode: life-size 3D model of the human body, structure with Russian and Latin names of internal organ systems and cues with object description. Comparison mode: three-dimensional model of paired organs, norms and various pathologies. This mode is accompanied by a written description, demonstration of macro and micro preparations. Diagnostic mode: designed for training doctors specializing in functional diagnosis. Allows to study the diagnostic information in the interactive mode: CT, MRI-axial, frontal and transverse slices; ultrasound — up to 8 positions of probe for each organ. The study of individual diagnostic data is provided.

When working in the knowledge check mode, students have the right to create and download tests based on the lecture material. Questions can be linked to a specific 3D model. An anatomically

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accurate, realistic 3D model of the human internal organs and skeleton is the best textured, expanded, and animated model for any presentation or video. In this model, all organs are movable. The animation includes: anatomically accurate movement of the thorax; respiratory organs-lungs; movable diaphragm; beating heart; peristaltic movements of the large and small intestine; Depending on the movement of the diaphragm all organs move realistically; bipedal and unreal motor skeleton system. The model has high-quality textures. Materials with subsurface dispersion effect. All models unfold accurately with non-overlapping facets. Animation, lighting setup, ss-materials and rendering settings are provided in 3ds max 2014 format. The scene uses Vray rendering and the free colorrect plugin. Other formats do not require plugins. Available formats: 3ds max 2014 with vray renderer; 3ds max 2014 scanline renderer; 3DS; FBI; EDM; Cinema 4D; Light Wave. Creating objects: The panel on the right side of the page is used to create any three-dimensional shape. After selecting any object, click in the appropriate place in the editing area to place it. When the model is displayed in the main editor window, there are additional tools you can use to move or change the shape. In the "Shape" block, you can set the. Service models are very simple, set the parameters with just a few parameters: Height — height; Weight; Chest circumference; Waist circumference; Hip circumference; Inner seam — groin level. Three-dimensional photogrammetry is the process of recreating a physical object to create an accurate three-dimensional model. This method can be used to capture everything from people and historical artifacts to airplanes, buildings and even larger objects. The possibilities of digital photogrammetry and 3D modeling are endless - the technique is used in industrial production, engineering projects, as well as in design, entertainment and health care. Creating a 3D model of a person can help in diagnosing and monitoring the course of treatment. In the industrial sector, the ability to create a 3D model avoids the additional costs of prototyping [2, 3].

Medical simulators are increasingly being used to train medical professionals in treatment and diagnostic procedures as well as medical concepts and decision-making. Simulators are designed to teach procedures ranging from the basics, such as blood draws, to laparoscopic surgery and trauma treatment. They are also important for prototyping new devices to solve biomedical engineering problems. Simulators are now being used in medicine to research and develop tools for new treatments, cures, and early diagnosis. Many medical simulators, including computer-assisted simulations of plastic anatomy, are available. These types of sophisticated simulations use a realistic mannequin that can be programmed to respond to injectable drugs and create simulations of life-threatening emergencies. Other simulations present visual components using computer graphics techniques and present haptic components using haptic feedback devices as part of a physical simulation procedure computed in response to user actions. Such medical simulations often use 3D CT or MRI scans of the patient to augment reality. Some medical templates are designed to be widely distributed (e.g., Web protocols and simulation procedures that can be viewed through standard Web browsers). Interaction can also be established using standard computer interfaces such as the keyboard and mouse. Another important medical application of simulation is the use of a drug placebo, which simulates the active drug in drug efficacy trials, although the simulator has a slightly different meaning [4].

There are free programs for creating photorealistic 3D human models for use in computer graphics. It was developed by programmers, artists and scientists interested in 3D character modeling. The technology was developed using MakeHuman 3D morphing technology. It works with a standard (unique) androgynous human, which can be transformed into different characters (male and female) by blending with linear interpolation. For example, using the four basic morphing targets (child, teenager, young, old), all intermediate shapes can be obtained. Modern plastic surgery MakeHuman 3D works with this modeling. Using this technology with a large

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database of morphing targets, almost any character can be reproduced. Hundreds of morphs use a very simple graphical interface for easy access and control of the target. MakeHuman's approach is to use architecture with common parameters such as height, weight, gender, ethnicity and musculature (Figure 1).

The software is specifically designed to simulate virtual humans with a simple and complete posture system that includes muscle movement simulation. The interface is easy to use with quick and intuitive access to many of the parameters needed when simulating the human body. The development of MakeHuman is related to a detailed technical and artistic study of the morphological characteristics of the human body. Morphing is done by linear interpolation, movement and rotation. With these two methods, combined with a simple form factor calculation, it is possible to obtain results such as simulations of muscle movement accompanied by limb rotation [5].

The movement toward modeling human functions and abilities can also be observed today in various technical sciences. Thus, in relation to artificial intelligence it is noted: "An important feature of artificial intelligence is that it deals only with mechanisms of verbal competence. Accordingly, the most important direction in the theory and practice of artificial intelligence is the transfer of the system knowledge base of human competence. It is clear that the effectiveness of the systems surrounding the human depends on the level and direction of the human. It should be noted that the most important rule of conducting three-dimensional modeling is that the characteristic features of anatomical proportions must be determined in advance, and the model must be prepared according to this rule. To use the services of modeling a person in 3D selected as much as possible quality photos. It is desirable to work on the photo from different sides (side, front, back), then the 3D model of the human figure will be more accurate and the 3D modeling process will take less time (Figure 2).

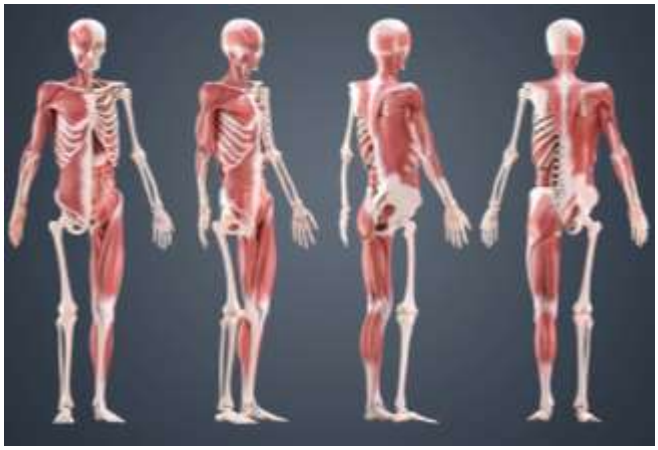

Figure 1. Views of 3D human model: a) from the front, b) from the side, c) from the side, c) from the back

Figure 2. 3D model of a human face

Simulation of anthropometric indicators of a person — the method of photobooths - is widely used in modern criminalistics. The most common and accessible tool for "creating" signs of a person's appearance is a description. The description is guided by specific rules included in the verbal portrait method; forensic registration, search and identification [6].

The rules of description in the verbal portrait method are based on the interrelated principles of sequence (order) and completeness (details). First, signs that characterize the general physical elements of appearance are noted: sex, age, nationality (anthropological type), height, body

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https://doi.org/10.33619/2414-2948/107

structure, and then the anatomical signs of individual body parts. The description of the signs of appearance is carried out according to the scheme "from the general to the particular" and "from top to bottom". In this case in the first place the figure in general, the head in general, the face in general, its separate elements, the neck, shoulders are described. Each of the anatomical elements is characterized by shape, size and position, and some by color. Geometric shapes (round, oval, rectangle, triangle, etc.) or geometric lines (straight, convex, curved, etc.) are used to describe the shape. Description of the size of the element is given in relation to other elements of the appearance, not necessarily. At the same time its height, length, width, number, etc. It is characterized. The price gradation is basically three-dimensional: large, medium, small. If there is any doubt about the size characteristic, it is indicated in two values: medium-small, large-medium [7].

The position of the element is determined relative to the vertical and horizontal planes of the body (horizontal, inclined, concave inward, etc.), including the mutual position (connected, separate). Characterized by hair color (black, dark brown, light brown, russet, red, gray); eyes (black, brown, gray, etc.) and sometimes skin color (heavily red, yellow, blue-red nose, color of birthmark, etc.). Anatomical features are illustrated from two perspectives: front view and side view (in full-face and right profile). The head must be in a "normal" position, when the horizontal line passes through the bridge of the nose, the outer corner of the eye and the upper third of the auricle (called the French anthropological horizon). Facial muscles should be relaxed (no smiling, facial expressions, frowning), no makeup, hair removed from forehead and ears, glasses and headgear removed (Figure 3).

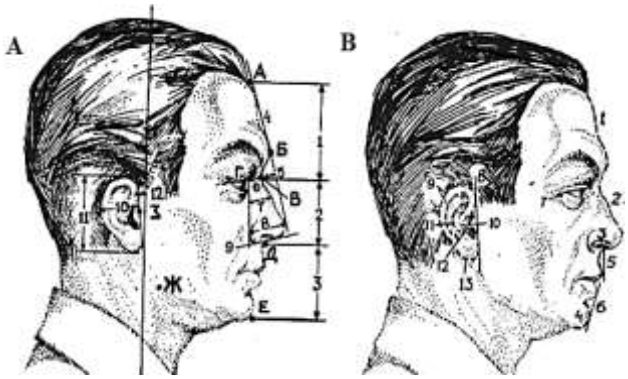

Figure 3. Forensic model of the human face, elements and features of the face

Results

For a long time, skull reconstructions were rarely performed for research purposes. This was due to the fact that such work is labor-intensive and that anthropologists also need to know the sculpture. Nowadays, a simpler technique has been developed. Using a set of images of facial features, which can be determined from the skull with sufficient reliability, by studying the anthropometric characteristics of the skull, it is possible to select from sets of images appropriate images and make a subjective portrait from them. A cross-sectional image of the skull can be used for control. Further improvement of skull appearance modeling technique is connected with application of computer technologies in this area, in particular the volumetric-planar computer method of images reproduction.

References:

1. Faigman, D. L. (2007). Anecdotal forensics, phrenology, and other abject lessons from the history of science. *Hastings LJ*, *59*, 979.

2. Mokwena, R. J. (2012). *The Value of Photography in the Investigation of Crime Scenes* (University of South Africa).

3. Bell, A. (2018). Crime scene photography in England, 1895–1960. *Journal of British Studies*, *57*(1), 53-78. https://doi.org/10.1017/jbr.2017.182

4. Lindegaard, M. R., & Bernasco, W. (2018). Lessons learned from crime caught on camera. *Journal of Research in Crime and Delinquency*, *55*(1), 155-186. https://doi.org/10.1177/00224278177278

5. Norris, C., McCahill, M., & Wood, D. (2004). The growth of CCTV: a global perspective on the international diffusion of video surveillance in publicly accessible space. *Surveillance & Society*, *2*(2/3). https://doi.org/10.24908/ss.v2i2/3.3369

6. Piza, E. L., Welsh, B. C., Farrington, D. P., & Thomas, A. L. (2019). CCTV surveillance for crime prevention: A 40-year systematic review with meta-analysis. *Criminology & public policy*, *18*(1), 135-159. https://doi.org/10.1111/1745-9133.12419

7. Duncan, J. (2018). How CCTV surveillance poses a threat to privacy in South Africa. *The Conversation.*

Список литературы:

1. Faigman D. L. Anecdotal forensics, phrenology, and other abject lessons from the history of science // Hastings LJ. 2007. V. 59. P. 979.

2. Mokwena R. J. The Value of Photography in the Investigation of Crime Scenes. University of South Africa, 2012.

3. Bell A. Crime scene photography in England, 1895–1960 // Journal of British Studies. 2018. V. 57. №1. P. 53-78. https://doi.org/10.1017/jbr.2017.182

4. Lindegaard M. R., Bernasco W. Lessons learned from crime caught on camera // Journal of Research in Crime and Delinquency. 2018. V. 55. №1. P. 155-186. https://doi.org/10.1177/00224278177278

5. Norris C., McCahill M., Wood D. The growth of CCTV: a global perspective on the international diffusion of video surveillance in publicly accessible space // Surveillance & Society. 2004. V. 2. №2/3. https://doi.org/10.24908/ss.v2i2/3.3369

6. Piza E. L., Welsh B. C., Farrington D. P., Thomas A. L. CCTV surveillance for crime prevention: A 40-year systematic review with meta-analysis // Criminology & public policy. 2019. V. 18. №1. P. 135-159. https://doi.org/10.1111/1745-9133.12419

7. Duncan J. How CCTV surveillance poses a threat to privacy in South Africa // The Conversation. 2018.

Работа поступила
в редакцию 11.09.2024 г.

Принята к публикации
17.09.2024 г.

Ссылка для цитирования:

Mammadov R., Abdullayeva S., Zeynalova A., Abdullayeva S. Human Anthropometric Indicators for the Preparation of Simulation Models // Бюллетень науки и практики. 2024. Т. 10. №10. С. 55-61. https://doi.org/10.33619/2414-2948/107/07

Cite as (APA):

Mammadov, R., Abdullayeva, S., Zeynalova, A. & Abdullayeva, S. (2024). Human Anthropometric Indicators for the Preparation of Simulation Models. *Bulletin of Science and Practice, 10*(10), 55-61. https://doi.org/10.33619/2414-2948/107/07