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ORIGINAL ARTICLE

CURRENT ISSUES RELATED TO ANTHROPOMETRY IN ENGINEERING

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Anthropos and Metrikos both mean "human" in Greek, which is where the term anthropometry comes from. Anthropometry is employed in a variety of fields, including apparel and textile design. For anthropometric evaluations, a current, thorough, and community-specific anthropometric normative-reference standard is necessary. In health care, ergonomic design is utilised to reduce pain and illness. Misalignments between humans and machines result in pain, accidents, biomechanical stress, tiredness, and musculoskeletal injuries. Designing for the anthropometrics of end users improves long-term viability. The human body comes in a wide range of sizes and shapes. Manual measurement and 3D scanning procedures, on the other hand, are inefficient and expensive, making precise body measurements difficult. This is especially true for head-worn medical devices. Manual measurement and 3D scanning are inefficient and expensive, making precise body measurements difficult. Grip strength and force were determined using hand measurements. Anthropometric parameter estimate is more precise when a 3D model is used to boost pinnae features. While numerous anatomical features have been gathered to aid in the ergonomic design of wearable devices, there is still a lot more work to be done. In three dimensions, the segment masses and torso Centre of Mass (COM) may be calculated. Researchers tracking mobility would benefit greatly from the ability to locate the body COM using a weighted sum of segment masses. Design features such as comfort and usefulness are crucial. Ergonomic characteristics like taller seats with front slopes and saddle chairs encourage good posture, movement, and alternation. In the creation of wearable technologies, using outdated anthropometric reference standards may be insufficient. This review discuses common issues related to anthropometry in engineering which includes the human body, anthropometric parameters, anthropometric measurements, the force plate method, ergonomic design, and body dimension. The goal is to give a broad overview of the subject.

Keywords: Anthropometry, human body, anthropometric parameters, anthropometric measurements, force plate, ergonomic design, body dimension

1.0 INTRODUCTION

Anthropos and Metrikos, which mean "human" and "measuring," respectively, and can be interpreted as "human measurement," are the origins of the term anthropometry. Anthropometry is widely employed in a range of sectors, including clinical nutrition research, product or workstation engineering, and apparel and textile design, to name a few. In clinical nutrition research, many anthropometric measurements are employed for a range of purposes, including body composition and form evaluation and health assessment. [1]. Anthropometry is an important part of ergonomics research since it helps to design human working and living situations. It also provides estimates of human body measurements and proportions, which can be used to design and organise an ergonomically ideal work space [2]. Anthropometry data has long been recognised as critical in product and workplace environment design. The lack of anthropometric data is likely to have a negative impact on the suitability of people, products, and workplaces in the absence of such data. A misalignment between the design of their workplace and the needs of their employers, for example, could have serious ramifications for small-scale manufacturing workers. [3]. Anthropometry is described as the science of measuring the human body in mathematics, and it is a scientific study. Human body size and form is a significant subfield of ergonomics that deals with the size and shape of the human body, as well as the strength and functionality of the body in general. Structural anthropometric metrics are used to estimate skeletal structure in a variety of applications, including user-centered design, health risk assessment, and biological maturity appraisal. It is critical to have up-to-date, thorough, and community-specific anthropometric normative-reference standards to ensure that they are applied in a given community. Economists and ergonomists use anthropometric measurements taken from typical fixed positions of the human body to create goods and surroundings that are tailored to the physical limitations of their users. Users and stakeholders may reap a variety of benefits when user-centered design concepts are used to the creation of goods and environments, including improved workplace safety and efficiency. Structured anthropometric examinations are useful in a variety of circumstances, including the prediction of health dangers and the assessment of biological maturity, in addition to assisting with ergonomic design [4] In today's society, the use of ergonomic design principles is becoming more common, and this trend can be seen throughout the design process. The field of ergonomics devotes a large amount of time and effort to the field of health care. In the field of health care, ergonomic design is utilised to solve problems related to discomfort and illness by starting with human anthropometric data and working outward. Ear measurements are becoming increasingly common as demand grows in a variety of fields, including ergonomics, clinical diagnostics, and identity identification, to name a few. In terms of safety, the relevance of considering anthropometry when designing commercial pilot chairs has been proven. When it comes to assessing cardiovascular risk, waist circumference and waist-to-hip ratio, as well as body fat percentage, are frequently used. [5]

2.0 HUMAN BODY

Anthropometry is a discipline of science that studies the human body's size and proportions in relation to its surroundings. This method is widely used by designers and engineers, who typically use percentile anthropometric data, resulting in substantial flaws in the science of anthropometry's practical applications. However, due to the inefficiency and low cost-effectiveness of manual measurement and 3D scanning procedures, obtaining detailed body measurements is difficult. [1] Within the human body, there is a great deal of variation in terms of size and shape. The creation of complete 3D representations of the human body or biological components is a common requirement for consumer products that must have a precise fit with the human body. This is particularly true in the case of medical gadgets. Companies that design and manufacture headgear, glasses, and headphones have expressed interest in new tools and procedures that would allow them to include realistic and accurate head models into their product creation processes. The creation of complete 3D representations of the human body or biological components is a common requirement for consumer products that must have a precise fit with the human body. Accurate descriptions of the human body's shape variations are required when constructing protective gear and safety equipment, sports equipment, and medical and orthopaedic devices. [6] Ear-related wearables are being introduced, and their design forms are altering to accommodate the new functionalities. Ear-related wearable things, such as those with health-monitoring capabilities, medical robots for the ear, and wearable products that combine electronic equipment behind the ears, have piqued the curiosity of consumers, particularly youngsters and the elderly. For design purposes, categorising dimensions and products is thought to be an effective way of enhancing understanding of the features linked with human body forms and ergonomic risks. It also aids in the streamlining of the data matching process for various types of objects. [5]

3.0 ANTHROPOMETRIC PARAMETERS

The use of anthropometric data on pinnae has long been widespread in ergonomic designs; but, until recently, the use of this data for personalising Head-Related Transfer Functions (HRTFs) to improve virtual aural displays received very little attention. When assessing anthropometric parameters, it is usual practise to measure the head or take two-dimensional (2D) photographs of the pinnae; as a result, there may be measurement errors for the former and a lack of depth information for the latter. The use of a 3D model to supplement pinnae features based on contour lines allows for a higher degree of accuracy in anthropometric parameter estimate than previously feasible. When compared to manual measurements, this technology can capture a greater number of anthropometric parameters and is considerably more repeatable. The HRTFs and the comfort of a head-worn device are both influenced by the human head's structure in some way. Individual pinna anatomic data is used to personalise HRTFs, which can improve the spatial sound experience by improving spatial sound perception, in addition to being employed in the ergonomic design of wearable items to satisfy comfort requirements. Although many anatomical features have been collected to help with the ergonomic design of wearable devices, there is still much more work to be done in this area. [7] While traditional photogrammetry is still in use, low-cost alternatives, such as those that utilise the Microsoft Kinect camera, are becoming more popular. The bulk of these instruments, on the other hand, have yet to acquire adequate accuracy for consistently estimating anthropometric parameters in postural examinations requiring high precision, which is a critical limitation [8]. The length of the hand, which is one of the most important hand anthropometric factors, was found to be 3.97 percent longer in males than females when comparing the two genders. When women utilise male-designed gripping equipment, they may experience discomfort, accumulated traumas, or physical exhaustion, among other problems. According to some studies, females may be less productive because of the increased hand-grip force caused by the instrument's male-designed design. [2]

4.0 ANTHROPOMETRIC DIMENSIONS

Anthropometric measures are commonly used when developing products and workspaces for people from all walks of life, from firemen to those with impairments who need highly customised sports equipment. [9] Misalignments between a person's anthropometric proportions and the dimensions of a workstation, tools/equipment, and gadgets, among other factors, have been linked to increased pain, accidents, biomechanical stressors, fatigue, and musculoskeletal injuries. It is critical to consider end users' anthropometric dimensions when developing working places and products in order to create healthy and productive work environments. Designing for end users' anthropometric dimensions improves sustainability by reducing raw material consumption, increasing usage lifetime, and incorporating ethical human resource issues into the design [10]. Despite the considerable work made into statistically anticipating human dimensions, the various models have demonstrated limits and potential hazards when employed in the engineering and design process, as summarised below. As a result, because most research has focused on a small number of specific predictors and responses, constructing models that predict a variety of anthropometric characteristics across studies may need the development of numerous models. [1] It is recommended that anthropometric data be gathered at least once every decade to account for secular trends experienced by populations as a result of improvements or deteriorations in the quality of life. [11] To visualise and consider user anthropometrics for building tools independently for diverse populations of ethnicities, regions, or nationalities in these importing countries, an international comparison measure of anthropometric dimensions should be devised among these countries. To visualise and consider the user anthropometrics, an international comparison measure of anthropometric dimensions should be devised among different countries. Hand measurements of people of various ethnicities have been taken for anthropometric purposes, which is important in the design of hand tools and other manual equipment. [2]

5.0 FORCE PLATE

With the help of a series of anthropometric measurements collected while silently standing on a force plate, it is possible to estimate the necessary components, which are the segment masses and the torso centre of mass location (COM), in three dimensions. This approach has also been proven to be more adaptable than other approaches because it can be easily changed to different marker sets utilised by different researchers. It is advisable to perform a silent standing experiment on a force plate while recording torso COM in the anterior and lateral directions while using the centre of pressure. If a researcher needed to track the movement of the body COM, the ability to determine its location using a weighted sum of segment masses would be incredibly valuable. The identification of segment COMs in relation to joint centres, in addition to the identification of discrete pelvic, lower torso, and upper torso segments, allows this method to be used to motion capture data for the goal of calculating the body COM, according to the authors. In addition to force plates, force plates can be used to determine the location of the COM in the body. It will be used to calculate the average location of the body's centre of gravity, which is a two-dimensional projection of the COM in the transverse plane and in two-dimensional space. When looking in the front direction, it is not necessary to have correct COMs and masses of other segments because the other segments are generally inline when the person is standing, and thus the force plate approach is unaffected. [12] Despite the fact that static positioning on force plates can be used to estimate segment parameters in a non-invasive manner, their use is limited to predefined anthropometric sets due to the placement of visual markers and assumptions made about their locations in relation to anatomical axes and rotation centres. [13]

6.0 ERGONOMIC DESIGN

In the field of health care, ergonomic design is utilised to solve problems related to discomfort and illness by starting with human anthropometric data and working outward. The number of persons who take ear measurements is growing to match the growing need for them in fields including ergonomics, clinical diagnostics, and identity recognition. [5] Comfort and simplicity of use are two crucial factors to consider when designing. The gathering of anthropometric data at the province level, rather than at the national level, may result in increased workplace safety and productivity, as well as more accurate prediction and assessment of health risk and biological maturity. A longitudinal comparison of anthropometric data is also conceivable. Extrapolating trends from longitudinal comparisons can be used for forecasting in a variety of applications, including risk assessment for population health and climate change. [4] Despite the fact that a large amount of data has been collected and used in ergonomic designs, the use of anthropometric data about pinnae for personalising head-related transfer functions (HRTFs) to improve virtual auditory presentation has gotten little attention. The HRTFs and the comfort of a head-worn device are both influenced by the human head's structure in some way. Individual pinna anatomic data is used to personalise HRTFs, which can improve the spatial sound experience by improving spatial sound perception, in addition to being employed in the ergonomic design of wearable items to satisfy comfort requirements. It has taken a long time and a lot of money to collect a large number of anatomical features that can be used to aid in the ergonomic design of wearable devices. Higher seats with forward slopes, saddle chairs, and adjustable height workstations are examples of ergonomic designs that encourage appropriate postures, as well as alternation and mobility. In the construction of ergonomic designs, the use of outdated anthropometric reference standards has the potential to be insufficient [14].

7.0 BODY DIMENSION

Anthropometry is a discipline of science that studies the human body's size and proportions in relation to its surroundings. This method is widely used by designers and engineers, who typically use percentile anthropometric data, resulting in substantial flaws in the science of anthropometry's practical applications. However, due to the inefficiency and low cost-effectiveness of manual measurement and 3D scanning procedures, obtaining detailed body measurements is difficult. It is possible to mitigate this issue by using non-statistical body metrics, although this is not advised. [1] The relative relevance of these characteristics varies from one group to the next, but a population's body size can rise over time due to a variety of factors, including dietary and nutritional changes, socioeconomic level, and other factors. [4] Qualified staff conducted the training, which included the use of approved methodologies for measuring human body proportions. A digital scale was used to determine body weight; a manual anthrometer was used to determine body dimensions in standing and sitting postures; a sliding calibre was used to determine the width and depth of small body segments such as the hands and feet; and a measuring tape was used to determine body circumferences. Aside from that, the importance of hand anthropometric measures was emphasised in the context of a number of other factors, including the construction of predictive models for other body dimensions and hand strength. Hand measurements have been used to determine grip strength or force, manual dexterity and performance, estimate optimal grasp span, and predict stature [2]. When it comes to garment size systems, a population is classified into a number of unique but generally homogeneous subgroups based on certain main body dimensions, each with its own set of measurements. People who belong to the same subgroup are presumed to have the same body type and, as a result, to wear the same clothing size. A clothing sizing system must select a collection of sizes from which a limited number of sizes can be selected to ensure that a ready-made garment that best fits the persons in the population is chosen. [3]

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