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**3D SCAN TO DETERMINE THE FAT CONTENT OF THE HUMAN BODY
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Abstract. This article describes the use of 3D scanners to detect body fat. Analyzed the main methods and techniques of measurement using body scanners. Identified the advantages and disadvantages of this method. Given the formulas for calculating the fat part by measuring the body scanner.

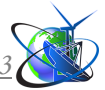
Key words: body scanner, 3D scanning, fat composition, body scan, measuring.

Introduction.

Today, the use of 3D technologies is an important part of life [1]. Such technologies help to better perceive the world. In particular, this applies to the measurement of quantities. 3D scanners are widely used in medicine. In particular, they can be used to measure and track the condition of the human body. To improve the process of self-care during fitness, it is possible to perform body measurements to calculate fat mass. such data can greatly simplify the training load program.

The main text

The constant development in the field of three-dimensional scanning has led to the emergence of 3-dimensional measurement of the human figure. Three-dimensional body scanners with an unusually short scanning process in a few seconds provide high-precision measurement. Contactless automatic registration of a set of necessary anthropometric data and display of a figure of the person is carried out. The optical scanning method is safe for vision and human health in general.



Two-dimensional photography cannot give completely correct results. One of the main factors is shadows and light, which change color. Using the wrong angle and tilt the camera also has a strong effect. Two-dimensional photos are exposed to lighting problems that can mask the shapes or even make them look different than they really are. 3D It's stern, raw and real, and the best way to actually see the result.

The quality of the obtained data objectively corresponds to the scientific standards of human spatial scanning. Immediately after scanning, you can get all the results digitally.

Depending on the scope, there are different options for work:

3D-printing: A color 3D-image of people or animals in the form of miniature models is processed by a 3D printer.

Ergonomics: development of car interiors, design of workplaces for individual needs of each user.

Tailoring: men's and women's clothing to order.

Medicine, orthopedics and sports: posture analysis, detection of spinal line, control of therapy results, anthropometric studies, diagnosis of performance, control of the training process, determination of physique.

Virtual reality: digital animation of the human body, digital transformation of art objects. Body composition is important when determining health status. 3D-scanners can capture an individual's volume and thus calculate percent body fat. 3D-scanning and editing took place in the 3D-scanner's respective software, then scans were exported to some software to calculate the volume. Participants were form-fitting clothing and stood in a standard position during scanning.

3D body scanning technology to measure waist circumference (WC), hip circumference (HC) and waist to hip ratio (WHR) precisely in an effort to improve the current health assessment for abdominal obesity.

Some "overweight" people are healthy, while others with "normal weight" are unhealthy. However, body fat percentage tells you what your weight is comprised of. Specifically, it tells you the percent of your total body weight that is fat. The lower your body fat percentage, the higher percentage of lean muscle mass you have on your frame.

The principle of 3-dimensional measurement (triangulation) is the method of light profiling [2], the profile is measured along the height along the projected light line, most often laser. The laser projects a light line on the measured object. The camera is aimed at the line at an angle and captures the projection of the line on the object as a longitudinal profile. When the light line is shifted, a three-dimensional image is formed on the object.

It is impossible to reduce the fat content in the body to zero - it threatens serious problems. Excessive thinness is dangerous: it leads to skin problems, heart failure, kidney failure and infertility in women. You need to gain weight if your fat percentage is very low and do not forget that fat is normally useful and necessary for the proper functioning of the body: fat contains energy reserves; fat maintains body temperature; protects internal organs from concussions and injuries.

With age, the amount of fat increases and muscle decreases. Therefore, everyone needs to be able to calculate the percentage of fat and control weight. By losing



weight properly with excess fat (losing mostly fat), you can avoid many problems: weakness, shortness of breath, fatigue, decreased immunity, hair loss, anemia.

Body mass index (BMI) is a measure of obesity. Body mass index is the ratio of height and weight of a person.

In order to calculate your BMI you need to measure your height and convert it into meters and square the resulting value [3]. For example, the height is 180 centimeters or 1.8 meters, which squared will be $1.8 * 1.8 = 3.24$. Next you need to divide your weight by this result. For example, at a weight of 90 kg, height is 180 cm. Accordingly, $BMI = 90 / (1.8 \times 1.8) = 27.7$.

Waist-to-Height Ratio - a waist-to-height ratio of 0.5 or greater indicates an increased amount of abdominal fat for both men and women. Abdominal fat increases the risk of cardiovascular disease.

The resulting number is body mass index [4]. There are 6 groups of body mass index: low weight - up to 18; normal weight - from 18 to 25; overweight (before obesity) - from 25 to 30; 1st degree obesity - from 30 to 35; 2nd degree obesity - from 35 to 40; obesity 3 degrees - from 40 and above.

Formulas are used to determine BMI, and specialized calculators can also be used, but such measurement data will not be accurate enough. To obtain highly accurate information about the condition of your body, use a 3D fitness body scan.

Using a fitness scan provides the following benefits: exact dimensions of the human body; percentage of fat in the body; dry body weight; rate of basal metabolism; the ratio of waist to hips; body shape rating; the ratio of torso to legs; posture and balance.

This technology is very useful for those who train and for coaches.

Waist-to-Height Ratio - a waist-to-height ratio of 0.5 or greater indicates an increased amount of abdominal fat for both men and women. Abdominal fat increases the risk of cardiovascular disease.

3D-scanners can calculate using formulas for body circumference method developed by Hodgdon and Beckett [4]. Men and women require different measurement methods because men tend to store belly fat (apple figures) and women accumulate belly and hips fat (pear figures).

Formula for men:

$$Fat = \frac{495}{(1,0324 - 0,19077)(\log(Waist - Neck)) + 0,15456 (\log(Height))} - 450$$

Formula for women:

$$Fat = \frac{495}{(1,29579 - 0,35004)(\log(Waist + Hips - Neck)) + 0,221 (\log(Height))} - 450$$

The scanner instantly provides complete information about the parameters of the current person. Based on the information received, the training plan is built as efficiently as possible. And for the athlete himself, this is a wonderful, vivid illustration of the condition in which he came to the gym, and the result he achieved. The technology allows you to track all the parameters of your body. You can learn



everything that is important to you to work on a specific area and understand the general condition of the body.

3D-body scanners use infrared sensors to get a detailed look at the shape of your body, as shown on the image 1 [5]. The sensors generate a 3D-model of your body. For some devices, you stand on a rotating platform for several minutes while the sensors detect your body shape. Other devices use sensors that rotate around your body. The scanner's equations then estimate your body fat percentage based on your body shape. In this way, 3D-body scanners are similar to circumference measurements. However, a greater amount of information is provided by a 3D-scanner.



Image 1. – 3D scanning and measuring

Advantages: A 3D-body scan is relatively quick and easy. **Disadvantages:** 3D-body scanners are not commonly available but gaining popularity. **Availability:** Several consumer-grade devices are available, but they're not as affordable as simple circumference-measurement methods like skinfold calipers. **Accuracy:** Limited information is available, but some 3D-scanners may be fairly accurate with errors of around 4% body fat [6].

3D-scanning is perfectly safe for health. It does not use an x-ray or MRI. It is simply a camera of smartphone that reads the surface of body to create an image based on the images it takes. It is non-invasive. In fact, no part of the equipment even touches body, save for the rotating disc that person stand while the scanning is taking place. It is fast, easy, and poses no health risks whatsoever.

That way, you make a starting point of the body. It makes possible to watch progress and see what you achieve have done.

The use of 3D-body scan provides number of incredible benefits. Some will be very personal to just one, but some of the more common benefits include: 3D model of body; measures body fat percentage, BMI, body volume; assesses your waist to hip ratio to help determine certain health risks; measurements at more than 20 points all over the body; appropriate for all fitness levels; assesses posture; track your fitness level.



Once the 3D model of body is made, special program software in feature recognition to identify specific base point such as waist, hips, and bust of the body. It helps to analyze the information to create measurements including volume, circumferences, and surface areas so that you get a more accurate, detailed picture of the size and shape body are – not the distorted, usually larger version that our minds often trick us into believing.

Conclusion.

The issue of using 3D-scanners to perform measurements of the human body was considered. In particular, the advantages of this method were analyzed. Possibilities for application in practice are given. That is, applications in the field of medicine and fitness. Formulas for calculating the relative mass of body fat are also given. There are ways to apply different scanning approaches.

Information was obtained on how to calculate body fat. The scope of 3D scanning is listed. Formulas for calculation based on 3D-model data are also provided.

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