AUTOMATION MEASUREMENT OF HUMAN ANTHROPOMETRY DATA FOR DIAGNOSTICS ASSESSMENT OF HEALTH LEVEL

АВТОМАТИЗАЦИЯ ИЗМЕРЕНИЕ АНТРОПОМЕТРИЧЕСКИХ ДАННЫХ ЧЕЛОВЕКА ДЛЯ ДИАГНОСТИКИ ОЦЕНКИ УРОВЕНЬ ЗДОРОВЬЯ

Abdumanonov A.A.
Central Asian Medical University
Adkhamjonov M.A.
Tashkent State Transport University
e-mail: ahror79@inbox.ru , tel: +998932708179

Abstract: *This paper presents the automation of the measurement of the main parameters of the human body using a high-level Python programming language using the MediaPipe and OpenCV libraries to study practically important issues in screening the population to determine the level of health. For medical institutions and public health authorities, anthropometric data of the population are of considerable interest, the mass character of anthropometric studies makes it possible to compare and evaluate the variability of the characteristics of different groups based on measurements of a large number of individuals, as well as to establish the features of their physical structure, which makes it possible to quantify their variability and make it possible to constantly monitor and predict the level of public health. We propose a method for automating the measurement of the human body in real time based on a unified deep learning architecture, and the architecture of the model is embedded in the structure of a neural network using artificial intelligence. The results of comparing the values of these dimensional features taken with the help of a centimeter tape with standards and calculated on the basis of non-contact measurements showed sufficient accuracy. The relative error is no more than 2% by measuring the height of a person, no more than 3.5% by weight, which is acceptable for scientific analysis and forecasting the state of human health loss according to anthropometric data with known methods to this day.*

Keywords: *pattern recognition, image processing, anthropometry, artificial intelligence, screening examination.*

Аннотация: *В данной работе представлены автоматизация измерение основных параметров тела человека с использование высокого уровня язык программирование Python с применением библиотек MediaPipe и OpenCV для исследования практически важных вопросов при скрининговое обследовании населении для определения уровень здоровья. Для медицинских учреждении и органами здравоохранении антропометрические данные население представляют значительный интерес, массовость антропометрических исследований позволяет сравнивать и оценивать вариативность признаков различных групп на основе измерений большого числа индивидуумов, а также устанавливать особенности их физического строения, что позволяет дать количественную характеристику их изменчивости и дают возможность постоянно следить и прогнозировать уровень здоровья населения. Предлагаем метод автоматизация измерения тела человека на реальном времени основан на единой архитектуре глубокого обучения, и архитектура модели всторена по структуре нейросети с использованием искусственного интеллекта. Результаты сравнения* *величин данных размерных признаков, снятых с помощью сантиметровой ленты с стандартами и рассчитанных на основе измеренных бесконтактным способом показали достаточную точность. Относительная погрешность составляет по измерению рос человека не более 2%, по весу не боле 3.5% что является допустимым для научного анализа и прогнозирование состоянии урони здравия человека по антропометрическим данным с известными методами на сей день.*

Ключевые слова: *распознавания образов, обработка изображении, антропометрия, искусственный интеллект, скрининговое обследовании.*

The volume of processed information is growing every year, which requires formalization and subsequent algorithmization of processes that were previously performed manually. One of the key concepts in automatic information processing is the “recognition” of objects of a certain class. When algorithms perform recognition at the level of a human expert, automation leads to the acceleration of data processing systems and increase their efficiency [5-6].

Of all the biometric approaches, such as recognition by fingerprints, lips, hand geometry, iris image, voice, etc., the identification of people by facial images is the most common, as it is based on the natural ability of a person to recognize others.

The problem of formalization and automation of the process of measuring human anthropometric data from the image of the body, face, etc. was touched upon at the very early stages of the development of image recognition systems (Fine's monograph - 1970). In recent years, the number of scientific studies and publications on this topic abroad has been constantly growing, which also indicates the relevance of this problem.

The very concept of "recognition" can be interpreted as "assigning the object under study, given in the form of a set of observations, to one of the mutually exclusive classes." In this sense, “pattern recognition is one of the varieties of classification,” and “in cases where each class contains only one object, classification is equivalent to identification.” From this it follows that the recognition of the faces of other people by a person is correctly called identification, which in this case means “assigning the object in question ... a unique name” [2]. The concept of verification, as applied to the case of person recognition, is even narrower - it corresponds to a particular case of identification with two classes - “this person” and “not this person” (for example, it is required to conclude that a pair of photographs being compared shows one person or different people).

Since there are many tasks associated with image analysis (for example, searching for faces in a group photo, tracking lip / head movements in a video sequence, determining the emotional state and other characteristics of a person from his image, diagnosing diseases, recognizing by face profile, etc.) it is necessary to determine the type of data coming to the input of identification algorithms.

From the studied literature [12-17] it became clear that in the 19th and 20th centuries anthropometry manifested itself in the measurement of weight, circumference, height and thickness of the skin fold, which were used to identify environmental factors that affect human growth. Since ancient anthropometric studies were a relatively modern concept, the relevant medical literature relating to nutrition and physical growth served as a valuable theoretical source.

The great artists of the Renaissance Leonardo da Vinci created many works related to the human body, which were designed according to rules that were considered to represent classical anthropometric methods of measuring proportion. Leonardo da Vinci was interested in both art and science. He recorded his measurements, notes and drawings with the attention to detail of a scientific researcher, for the first time in history he examined the human face, head, neck and other related parts in detail, he was interested in the proportions of the human body part which was called the "golden section", from 1509 years were called in Europe "divine proportion" (lat. "Divina Proportione", Italian. "Proporzione Divina") [18].

The biomedical literature of the World Health Organization (WHO) was considered one of the best sources that represented general health conditions in society. Due to its use as a measurement of physiological and developmental human growth, anthropometry has appeared in several clinical practices in which instruments such as manometer, sphygmograph, hemoglobinometer, spirometer, etc. have been used. The need for these measurements has arisen due to the interaction between several inextricably linked concepts, including nutrition, psychosocial stress, dietary risk factors for health and ecology. Factors mainly related to socioeconomic status and poverty indicated that body size was a signal for quality of life. Thus, anthropometric methods can be used as a public welfare tool.

Modern anthropometry (from the Greek Ανθρωπος - man and μετρεω - to measure) is one of the main methods of anthropological research, which consists in measuring the human body and its parts in order to establish age, gender, racial and other features of the physical structure, allowing to give a quantitative description of their variability. Depending on the object of study, there are somatometry (measurement of a living person), craniometry (measurement of the skull), osteometry (measurement of the bones of the skeleton). Anthroposcopy also includes anthropometry - a qualitative (descriptive) description of the shapes of body parts, the shape of the head, facial features, pigmentation of the skin, hair, iris, etc.

In medicine, anthropometry is one of the fundamental methods of anthropological research, which consists in measuring the main parameters of the human body (height, weight, percentage of fat, hips, waist, chest, etc.) and its parts [1].

Recently, anthropometric studies have become widely used to solve practically important issues in the screening of the population to determine the level of health. For medical institutions and health authorities, anthropometric population data are of considerable interest, as they make it possible to constantly monitor and predict the level of health of the population, compare and evaluate the variability of the characteristics of different groups (racial, age, sex, etc.) based on measurements of a large number of individuals, and also to establish the features of their physical structure, which allows us to give a quantitative description of their variability.

Analyzing the trends in the development and application of biometric technologies, it can be concluded that the search for solutions to such little-studied problems as verifying a person from a photo from an identity card and identifying a person by his photo portrait by searching a database, automating the measurement of human anthropometric data for early medical diagnosis of pathological diseases very relevant at the moment. This work [1-4, 7-11] is devoted to the study of algorithms for constructing systems that solve these problems.

The goal is to develop automated systems for measuring human biometric data, weight, height, iris pattern, face images, measurement of individual parts of the human body. This is due to the fact that at the moment the main obstacle to the further development of information environments, various kinds of virtual services, etc. is the problem of mass screening of the population. It is expected that the use of such systems will significantly reduce the time of a mass survey of the population and make it possible to quickly extract a group of risks associated with the deviation of anthropometric data from the norm, the technology for identifying the state of human health based on images is recognized as the most acceptable for mass use, since it does not require physical contact with the device, unobtrusive, natural and, potentially, can have a high speed.

Research methods were based on digital image processing, pattern recognition, discrete transformations and system analysis. The experimental part of the study was based on the processing and analysis of digital images and visual evaluation of the results. For the software implementation of the developed algorithms, methods for creating software systems and programming in high-level languages Python, modeling with the help of specialized libraries OpenCV and MediaPipe were used. OpenCV is one of the most popular computer vision libraries. It was written in C and C++ and also supports Python besides Java and MATLAB. While not the fastest library, it is easy to work with and provides a high-level interface that allows developers to write stable code. The Python OpenCV library is mainly for real-time computer vision. MediaPipe is an open-source cross-platform machine learning platform used to build complex and multi-modal applied machine learning pipelines. It can be used to build advanced machine learning models such as face recognition, multi-hand tracking, object detection and tracking, and more. The MediaPipe basically acts as an intermediary to handle the implementation of models for systems running on any platform, which helps the developer to focus more on experimenting with the models than on the system. The mediapipe Pose, Hand, Face Landmarks is one of the pipelines that contains optimized face, hand, and pose components, allowing for holistic tracking that allows the model to simultaneously detect hand and body poses along with face landmarks. One of the main uses of MediaPipe holistic is to detect faces and hands and extract key points to feed into a computer vision model.

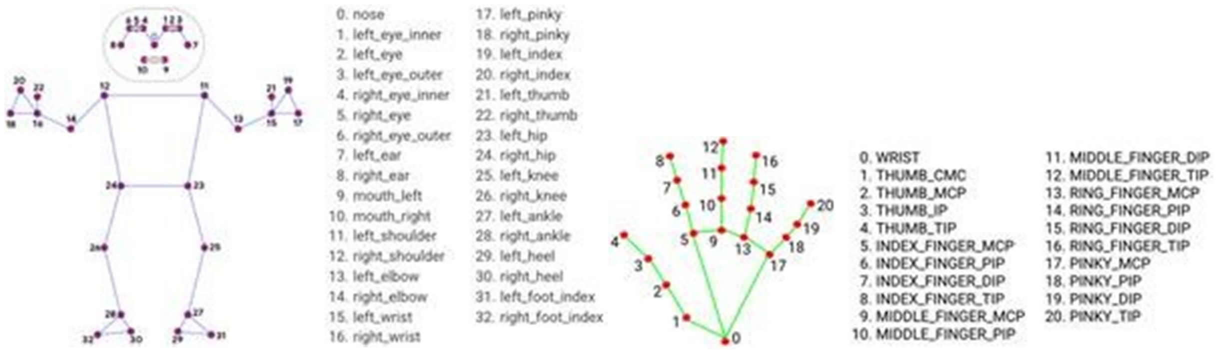

Fig.1- Mediapipe pipelines to define hand and body poses along with facial landmarks.

The data collected in the process is subjected to variational-statistical processing and presented in the form of tables, graphs and diagrams. The mass nature of anthropometric studies makes it possible to compare and evaluate the variability of the characteristics of different groups (racial, age, sex, etc.) based on measurements of a large number of individuals, as well as to establish the features of their physical structure, which makes it possible to give a quantitative description of their variability.

We propose a new method for estimating body size from real-time 2D human body data. The method is based on a unified deep learning architecture that takes a single grid-structured point as input and regresses the values for a set of predefined anthropometric measurements. The architecture of the model is built according to the structure of the Google Net neural network. As part of the evaluation of our method, we report three indicators:

- 1 - mean absolute error (MAE) denotes the average error between ground truth and predicted measurements in millimeters;
- 2-mean accuracy (MT) per measurement denotes the percentage of samples in which a particular measurement was estimated to be within a specified threshold from the measurement's true;
- 3- mean Deviation (SD) denotes the percentage of samples evaluated by CAO (over all measurements).

For an experimental study of the developed automation technology for measuring anthropometric data of a person, 500 students (of which 187 were women and 313 men) of various physiques were formed and their anthropometric parameters were measured. According to the results of contact and non-contact measurements of anthropometric data, an assessment of the relative error of calculations was made when measuring various dimensional features. The results of comparing the values of these dimensional features taken with the help of a centimeter tape with standards and calculated on the basis of non-contact measurements showed sufficient accuracy. The relative error is no more than 2% by measuring the height of a person, no more than 3.5% by weight, which is acceptable for scientific analysis and forecasting the state of human health loss according to anthropometric data with known methods to this day.

The created system makes it possible to automate the mass measurement of the main anthropometric data of respondents in real time and diagnose healthy levels using well-known methods such as the Brock Index, Mohammed's Formula, Potton's Index, Cooper's Formula, Harris' Formula, Muffin's Formula, Sample. Automation of anthropometric research with intellectual filling makes it possible to identify a risk group for further in-depth study of the state of health and saves time for a mass survey of the population, focusing the attention of specialists on specific respondents who require a thorough examination and clarification of the diagnosis of the disease.

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