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POSTURAL ASSESSMENT BY IDENTIFYING PARTS USING ARTIFICIAL INTELLIGENCE

***[1]Viviane Sousa Ferreira, [2]Allan Kardec Duailibe Barros Filho, [3]Sally Cristina Monteiro Moutinho, [4]Christiano Eduardo Veneroso, [5]Ilka Kassandra Pereira Belfort, [6]Enrico Capone, [7]Vanessa Edilene Duarte Martins, [8]Alexssandro Guimarães Reis, [9]Thiago Silva Mendes, [10]Alisson Mota de Aguiar and [11]Arissane de Sousa Falcão**

[1]Universidade Federal do Maranhão – UFMA – Departamento de Medicina
[2]Universidade Federal do Maranhão – UFMA – Departamento de Ciencias Exatas e Tecnológicas
[3]Universidade Federal do Maranhão – UFMA – Departamento de Farmácia
[4]Universidade Federal do Maranhão – UFMA – Departamento de Educação Física
[5]Programa de Doutorado em Biotecnologia – Rede Nordeste de Biotecnologia – (RENORBIO) – Universidade Federal do Maranhão
[6]UniversitàDegli Studi de Salerno
[7]Programa de Doutorado em Biotecnologia – Rede Nordeste de Biotecnologia – (RENORBIO) – Universidade Federal do Maranhão
[8]Universidade Maurício de Nassau - Uninassau
[9]Departamento de Ciências Exatas e Tecnológicas – Universidade Federal do Maranhão - UFMA
[10]Universidade Federal do Maranhão – UFMA – Departamento de Medicina
[11]Universidade Federal do Maranhão – UFMA – Departamento de Enfermagem

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ABSTRACT

The human posture is defined by the balance of the muscular chains. This is important because throw this equilibrium a person can accomplish tasks, maintain activities with the optimal use of energy and prevent injuries. The permanent maintaining of poor posture leads to serious muscular and skeletal disorders. Many assessment methods have been created to identify imbalances and to correct postures that may lead to injury, but these methods have the disadvantage of relying on the subjectivity of the evaluator, their experience and not being able to identify minimal deviations. The objective of this research was to elaborate a tool capable of creating a new evaluation method through body scanning. To achieve the proposed objective, we collected images of previously defined healthy individuals in a common social environment with no history of injury. The results obtained with the research were: the creation of a computational tool with proven accuracy capable of identifying the pre-established joint points for postural evaluation.

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INTRODUCTION

The human posture is a combination of muscle traction and joint forms that gives the individual a balance that allows him to perform activities of daily living, physical activities and performing complex tasks. In addition to concepts related to musculoskeletal patterns, postural control of individuals involves a heterogeneous system that allows them to maintain correct body positioning, including vestibular, proprioception and visual systems. Equilibrium posture is the ability to return the center of mass within the support base in order to maintain the body's balance against disturbance (HUE *et al*., 2007; ALEXANDROV *et al*., 2005; LIPPERT, 2016). Some diseases, or conditions, alter the normal equilibrium, leading to permanent postural disturbance, and as a consequence musculoskeletal problems, one of the examples is when somebody is obese. As the volume of the abdomen increases, the center of gravity changes and there is a whole change in the balance of forces that promote posture, thus causing injury over time in the muscular and skeletal structure (SMITH, 2014 and KARIMI *et al*., 2008). In an optimal system, what is expected from a posture is that there is a skeletal alignment, muscles and joints are in a state of dynamic equilibrium generating a minimal amount of effort and overload, this minimal surcharge is not always achieved (GUYTON, 2017). Through Postural Assessment, health professionals seek ways to identify these misalignments and obtain reliable predictions about the future damage of this assessment (SACCO *et al*., 2007). Over the years, the forms of postural assessment have undergone modifications, been implemented, new equipment and technologies have been incorporated into this task. This increased exponentially with the advent of the 4th technological revolution. The inclusion of techniques such as body scan and photogrammetry has gained prominence in the scientific field. In biophotogrammetry, a software uses images of physical objects and the environment, through processes of recording, measurement and interpretation of photographic images, the method has the possibility of quantifying linear and angular measurements and with the advantage of allowing subtle recording. postural changes and to interrelate different parts of the human body, which are difficult to measure and record by other means (DUARTE *et al*., 2012).

It is possible to use various bioinformatics strategies to improve the practice of postural evaluation. In this research, we used the Artificial Neural Networks, which are computational algorithms that present a mathematical model inspired by the structure of intelligent organisms, the model copies the functioning of the nervous system (PAIVA *et al*., 2016). Due to the difficulty in the reliability of postural evaluation, a new methot is so important.The postural evaluation is considered by many authors: subjective, because it depends on factors such as past experiences and personal interpretations, with low intra and inter-examiner reliability, this difficulty causes abnormalities not always to be identified or when identified, undergo only visual inspection and do not encompass more stringent procedures with a quantitative and resolute approach to prevent future injury or even to predict injury (GANGNET *et al*. al., 2003). In this context, the area of bioinformatics emerges as an instrument to assist in the early identification of disorders, since it can be defined as: research, development and application of computational tools for the use of health data, including those for acquiring, store, organize, archive, analyze this data. One of the focuses of bioinformatics is to help the health area, regarding the collection and processing of data faster and more effectively, with greater detail and enabling the development of new solutions (PAIVA *et al*., 2016).

MATERIALS AND METHODS

This is a descriptive cross-sectional study conducted with academics from the municipality of São Luís, Maranhão, Brazil. Participants were randomly selected until sample saturation. Saturation sampling is a conceptual tool often used in qualitative research reports, widely used in health. It is used to establish or close the final size of a study sample, the method was chosen for the research, because we will capture new data until the algorithm is optimally accurate. The study population consisted of academics of both sexes, regardless of ethnicity, aged from 20 to 40 years old, duly enrolled in colleges of São Luís, Maranhão, without previous musculoskeletal disorders. Participants who met the following criteria, were included in the study: To be properly enrolled in colleges of São Luís; Be between 20 to 40 years old. Those who were not included in the survey: Pregnant women, breastfeeding or using contraception; Women who are menstruating; Physical disability that makes postural measures impossible or compromised; Mental incapacity that makes it impossible to participate in the research phases; People with chronic musculoskeletal pain not associated with postural problems such as fibromyalgia, gouty arthritis and rheumatic diseases; People who have a history of joint, ligament and orthopedic surgery injuries.The following were excluded from the research: Participants who refused to participate in some of the study phases and those who missed any days of any of the assessments. The first stage of the research comprised the capture of images, which was performed through a high resolution camera supported by a tripod and parameterized by measurements obtained prior to the execution of the photos. The images obtained were in anterior, posterior, right lateral and left lateral posture. All participants wore appropriate clothing for the evaluation that was necessary for the evidence (through images) of bone surfaces used in postural evaluations, such as:

Anterior view: lateral extremities of the clavicles, humerus heads, anterior and superior iliac spines, knees, malleoli.

Lateral view: cervical curvature, shoulder positioning, anterior and superior iliac spines, lumbar curvature, knees and ankles.

Posterior view: Scapulae - upper and lower angles, iliac ridges, popliteal regions, ankles.

For this phase of the research, we have the partnership of Mauricio de Nassau University with: own room and Sanny Anodized Aluminum Postural Portable Symmetograph. The standard image capture model used was based on a patented ProtlandStarford University model (PSU Method), validated by Althoff, Heyden and Robertson, 1988 (ALTHOFF *et al*, 1988). This study was authorized by the Ethics Commitee of University Federal of Maranhão, by the opinion of number 3.639.179, CAAE: 08529619.0.0000.5087. The coding of the algorithm depended on the participants' image and this postural evaluation was made on a frame. This assessment based on the Portland State University (PSU).Various points previously stablished by the method in the human body were included.These points, were recognized through a neural network. In addition, the algorithm will be trained based on the images obtained in the initial phases of the research.

The Python programming language was used to develop the algorithm responsible for: capturing the image, recognizing objects in the space obtained by the frame; isolation of a person's image from other objects in the world around him; recognition of different points in the human body; outline a virtual grid over the frame to. Considering an ideal human posture, detect possible postural changes in the highlighted person from angular changes with respect to the grid lines; compare divergences found in the person with the ideal model inserted in order to find more accurate results over time; store the results obtained for later consultation and to reinforce machine learning. The PostgreSQL version 10.5 database was used for information storage. The development tool for the Python language will be PyCharm Community Edition, version 2018.2.2.

RESULTS AND DISCUSSION

We include in the algorithm the default model predetermined by the method proposed by Althouff *et al*, 1998, then we include the images obtained from the participants to be compared to the model previously inserted in the algorithm, we identify the points explained by the algorithm in the postures. Anterior, posterior and lateral. Finally, we obtained the result of the evaluation of each of the cross images and the algorithm ready for postural evaluation based on the PSU method. Figure 1 describes the processing performed by capturing the individual's image in the environment in which he is located (1). The individual's image is sent to a module (2) that identifies body parts through an iteration with a Neural Network (3); Once the body parts were recognized, comparisons were made with the ideal model (4) to verify the divergence of angulation between two parts of the same nature, such as the angle of inclination between right shoulder and left shoulder for example. With the angulation information between parts of the same nature, module (6) eliminates the body part that does not correspond to a critical point by comparing the angulation data with the obtained data (7). Finally, module (8) reports the most dysmetric points.

nature through the edges. These edges denote the distance and slope between the parts. The table demonstrates that the algorithm is able to identify with an average of 60% accuracy the body parts (represented in detail in the probability column), and then defines at which X-axis and Y-axis pixel scaling the component is found. This result corroborates the hypothesis that it is possible through an Artificial Neural Network based algorithm to create a simple and accurate model for postural evaluation. Below is Table 1. In Table 2, after the algorithm trained by all the images for refinement of the algorithm, we tested the model created in a random patient just to perform the control of what we obtained. We used 5 items: Comparison of the parallel line drawn between the shoulders (right and left), comparison of the parallel line between the hips and knees, we did not use ankle measurements or profile posture for the test, because the objective of the test It was: with just a few items, if we would result in an optimal algorithm response. Considering that: in some dimly lit environments or because of the lack of contrast between light and dark we will not be able to identify all parts, the objectification of this test was valid. The result was satisfactory within what we proposed, we obtained the identification of the inclination degree of: -5.8560 between the shoulders, we have the identification of the

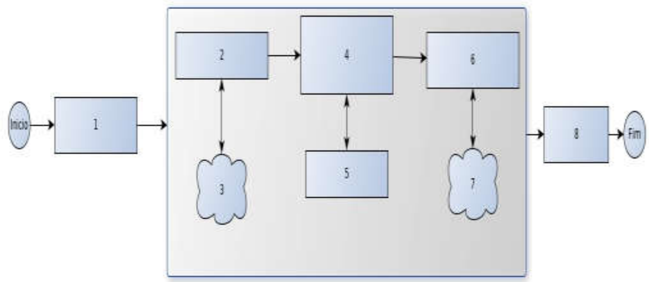

Figure 1. Flowchart of algorithm operation

Table 1. Parts Matrix

Partsidentifier	Nameoftheparts	Probability	Xaxis (Pixel scale)	Yaxis (Pixel scale)
1	Neck	0,79	70	15
2	Rightshoulder	0,65	31	15
3	Right Elbow	0,71	31	86
4	Right Wrist	0,83	15	157
5	Left Shoulder	0.63	109	7
6	Left Elbow	0,78	125	78
7	Leftwrist	0,69	140	149
8	Rightrip	0.43	54	142
9	Right Knee	0.55	54	244
10	Rightankle	Notidentifeid	-	-
11	Left Rip	0,42	109	134
12	Left Knee	0,47	109	236

Class Matrix

Classdescription	Tilt in degrees	Distancebetweenthe points
Shoulderscomparison	-5,8560	0,10
Hip comparison	-8,2758	0,14
Kneecomparioson	-8,2758	0,14

Table 1 is the result of processing performed by the algorithm to identify the body parts of the individual. Using the PSU (Portland State University) method, the algorithm classified the items to be identified into 12 parts that comprised: Identification of neck posture, shoulders (right and left), elbows (right and left), wrist (right and left), hip (right and left), ankle (right and left), used the postures in: right and left, anterior and posterior profile and, establishing parallel lines and connecting the parts that represent the point of the same

inclination degrees between the hips of: -8.2758 and between the knees of -8, 2758 Which represents as a result the competence of the computational model to be a useful tool and that can be used as an evaluative method. The literature already uses computational models for postural evaluation, such as the SAPO / PAS method. This model is software that uses images to assist the examiner in postural evaluation (SACCO et al., 2007). One of the disadvantages of the SAPO method is that the patient needs to be pre-prepared with the identification of all points to be scanned by the software, making it restricted to previous training, more time for evaluation and the need for a larger technological apparatus (SOUZA et al., 2011). In the present model, no previous preparation is necessary, because with the training already performed and tested by the algorithm this step becomes unnecessary.

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