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## INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/17694

DOI URL: <http://dx.doi.org/10.21474/IJAR01/17694>



### RESEARCH ARTICLE

#### ARTIFICIAL INTELLIGENCE IN THE COMBINATION OF TECHNOLOGY WITH ERGONOMICS FOR ESTIMATION OF CORRECT POSTURE BASED ON PYTHON

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#### Manuscript Info

##### Manuscript History

Received: 10 August 2023

Final Accepted: 14 September 2023

Published: October 2023

##### Key words:-

Ergonomics, Python, AI, RSI, Mediapipe

#### Abstract

This article outlines the main diseases caused by repetitive strain or poor posture with emphasis on the public that works in the area of information technology (IT), which for the reason that the workday is composed of 8 hours a day in a continuously seated position, has become the focus of the same. In order to improve the well-being of these professionals, a low-cost solution model will be presented to assist in the estimation of posture while performing activities during working hours, since injuries, in the work environment of the type of professional in question, are commonly due to the lack of an ergonomic approach. In order to achieve the proposed objectives, an application was developed that makes use of AI to capture posture and judge whether it is correct or incorrect in relation to the test parameters. To substantiate the ideas explained in this article, a research was carried out using the prototype to verify the classification of the posture of the group of selected people, it was noted that of the group of 15 people, 8 of them presented the correct posture representing 53% of the candidates interviewed and 7 people were with bad posture which makes up 47% of the total candidates. It is noted that a large number of people have poor posture, which can cause unwanted illnesses or injuries in the future.

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#### Introduction:-

Society is aware of the various types of jobs, based on this idea, there is a great challenge to make the person who occupies a position in a certain company have a certain stability while performing their daily activities, so that in the long term they do not acquire a repetitive strain injury (RSI), also called work-related musculoskeletal disease (WMSD).

The literature shows that RSI/WMSD has represented an important fraction of all worker-related illnesses. It affects men and women, including adolescents, in the middle of the productive phase of life [1]. Musculoskeletal disorders (MSD) are characterized by the occurrence of injuries to muscles, tendons, joints, ligaments, bones, nerves and the vascular system [2], which can harm the musculoskeletal system and cause functional imbalance. By definition, DOM involves degenerative and inflammatory phenomena in various structures, resulting in acute or chronic pain and reduced mobility and social participation, with impairment of workers' quality of life [2].

Thus, RSI and MSD are present in any workplace, since when performing repetitive activities for a long period of time, complications related to the posture adopted during the daily service time can develop.

With this, ergonomics emerged, which aims to carry out several studies on the performance of the production system, improving health and reducing consequences on the worker.

Based on this, many companies in the segment adopt workplace gymnastics to improve health and avoid employee injuries due to repetitive strain and other occupational diseases, by performing physical exercises, even if of low intensity, in the work environment, relieves stress and reduces tensions acquired during the day.

In the area of information technology, it is known that many workers in this area spend several hours a day working on computers, so it is a fact that this public runs a serious risk of being prevented from working during the workday in order to extend it to the career, since the use of it becomes mandatory for contribution in the company to which they submit to work.

Thus, with the rise of technology, they have been influencing various areas with the use of artificial intelligence (AI) seeking improvements, time and productivity gains, accuracy in pattern analysis and other applications. Taking advantage of the increasing evolution of AI, one can combine technology with ergonomic methodologies to create tools that aid in injury reduction and posture improvements.

The solution proposed in this article is the creation of a software that uses artificial intelligence to indicate the correct way to sit, it will work based on a sensor that shows and demonstrates the correct posture, the tool will use a camera where it will read from the bottom to the top of the body indicating the correct position in your workplace and will be shown the correct way of posture, This will help the environment to be more productive.

The present work aims to demonstrate how the use of artificial intelligence can be beneficial to assist in the treatment of posture during working hours and thus reduce diseases or injuries related to poor posture.

### **Theoretical Framework**

The convergence between Artificial Intelligence (AI), Ergonomics and Sensors represents a significant milestone in the field of technology and occupational health. Artificial Intelligence, characterized by the ability of machines to mimic human cognitive functions, is transforming several industries, including ergonomics. Traditionally, ergonomics involved manual evaluations by professionals to improve the efficiency and safety of interactions between people and objects. However, with the integration of AI, these assessments have become more efficient, accurate, and personalized. AI, combined with sensors, makes it possible to capture detailed data from the work environment, identify patterns and trends that would go unnoticed by human observers, enabling early interventions to prevent injuries, especially in cases of RSI/WMSD. In this context, sensors play a crucial role by detecting external stimuli and providing essential data for AI, which in turn improves the process of improving sensors. This synergy between AI, ergonomics and sensors represents a remarkable evolution in the optimization of working conditions, promoting a safer, healthier and more efficient environment for workers.

### **Artificial Intelligence (AI)**

Artificial intelligence is a field of computer science that is dedicated to the study and development of machines and computer programs capable of reproducing human behavior in making decisions and performing tasks, from the simplest to the most complex. It is commonly referred to by the acronym AI or AI (artificial intelligence) [3].

It is worth noting that AI has had a greater development since the 50s, and since then it has been part of people's daily lives through voice assistants, search engines, self-driving cars and social networks. Despite bringing numerous benefits and important advances in several areas, there is much debate about the ethical limits of artificial intelligence and the role it plays in our current society [3].

In addition, it is important to mention that AI can be useful for several purposes, such as: in the elaboration of texts, creation of images, data analysis, and also to control ergonomics.

### **Ergonomics**

Ergonomics, the science of designing and organizing things people use to make people and things interact more efficiently and safely, traditionally relies on manual evaluations. These evaluations involve professionals analyzing work environments and suggesting improvements based on observations and expertise [4].

Artificial Intelligence (AI) is rapidly revolutionizing many industries, and ergonomics is no exception. The integration of AI into ergonomic assessments is paving the way for a future where the process is not only more efficient, but also more accurate and personalized [4].

AI-powered ergonomic assessments utilize machine learning algorithms to analyze data collected from a variety of sources, including sensors and cameras. These algorithms can identify patterns and trends that may go unnoticed by human observers, allowing for a more comprehensive and accurate assessment. For example, AI can detect subtle signs of tension or discomfort that a worker may not even be aware of, allowing for early intervention and prevention of potential injuries [4].

### **RSI/WMSD**

RSI (Repetitive Strain Injury) and Work-Related Musculoskeletal Disorder (WMSD) is not a disease per se. It is a syndrome consisting of a group of diseases such as tendinitis, tenosynovitis, bursitis, epicondylitis, carpal tunnel syndrome, trigger finger, thoracic outlet syndrome, pronator teres syndrome, myalgias, which affects muscles, nerves and tendons of the upper limbs mainly, and overloads the musculoskeletal system [5].

RSI is a syndrome that includes a group of diseases with symptoms such as pain in the upper limbs and fingers, difficulty moving them, tingling, muscle fatigue and reduced range of motion [5]. This disorder causes pain and inflammation and can alter the functional capacity of the affected region [5]. The problems related to the bad and excessive use of computers are one of the main focuses of the study of Ergonomics, since one of its objectives is to provide improvements in the work relationship [6].

In people's daily lives there are several possibilities to monitor the issue of ergonomics, one of them is based on sensors.

### **Sensors**

A sensor is a device capable of detecting/capturing external actions or stimuli and responding accordingly. These devices can transform physical or chemical quantities into electrical quantities [7].

With Artificial Intelligence integrated into the sensors, you can help and improve the process of perfecting the sensors. Sensors, in short, are artifacts that allow us to obtain information from the environment and interact with it. Thus, as humans use their sensory system for this task, machines and robots require sensors to interact with their environment [8].

### **Materials And Methods:-**

The text presents an innovative project that combines advanced technologies to address a common problem in the workplace: the poor posture of copywriters during their daily activities. Through the integration of Artificial Intelligence (AI), Python programming language and several specialized libraries, the developed prototype offers a solution to monitor and correct inappropriate postures in real time. The choice of the Python language was motivated by its simplicity and the familiarity of the team, allowing for efficient and intuitive development. The project utilizes powerful libraries such as NumPy for numerical operations, OpenCV for image processing, Math for advanced mathematical calculations, and MediaPipe for pose estimation and spot detection of the human body.

### **Language**

To develop this prototype, a research was carried out in order to select the language. In this scenario, some languages were listed, such as: C, C++, C# and python, so the choice of the python language was due to the familiarity of the team and the ease of working with it.

The most obvious advantage of programming in Python is the intuitive and easy way in which the developer can learn the language. As it is quite simple, a few notions of pseudocode are already enough to provide an extremely fast learning curve [8], as well as its variety of diverse application libraries.

### Libraries

To start the development of this project, the following libraries were used to develop this prototype: Numpy (Numerical Python), Opencv (Open Source Computer Vision Library), Math and Mediapipe.

Numpy is a python library that provides a multidimensional object array, various derived objects (such as masked arrays and arrays), and a variety of routines for quick array operations, including mathematics, logic, shape manipulation, basic linear algebra, basic statistical operations, random simulation, and more, making it indispensable for numerical and scientific tasks [9].

OpenCV is an open-source computer vision library that allows developers to create applications that can process images and videos. Intel developed OpenCV in 1999 and currently applications of robotics, artificial vision, artificial intelligence, image analysis and pattern recognition use this library [10].

Math is a Python library that has several functions that are essential for performing advanced mathematical calculations. These functions range from basic operations to trigonometric and exponential calculations [11].

MediaPipe is an open-source platform maintained by Google, which offers a comprehensive set of tools, APIs, and pre-trained models that make it easier than ever to build applications for tasks such as pose estimation, object detection, facial recognition, and more [12]. Note that figure 1 shows the points of the body and their connections.

**Figure 1:-** Introduction to MediaPipe and Pose Estimation.



Source: Sigmoidal, 2023.

### Artificial Intelligence

The core tenet of AI is to replicate, and then exceed, the way humans perceive and react to the world. It is quickly becoming the cornerstone of innovation. Powered by various forms of Machine Learning that recognize patterns in data to enable predictions, AI adds a lot to project accomplishment [13].

In the application, AI plays an important role as it is used to read the points to identify the correct posture. With the help of the camera capturing images and python libraries, points of the human body are detected to estimate the correct posture from the calculation of the angle of the ear in relation to the shoulder.

### Prototype

In the creation of this prototype, a nuisance that is present in the daily life of the writers in question during the working day was evaluated. Soon after using the tools mentioned above, the implemented logic accesses the device's camera, in this case a notebook was used, displays the video capture in a window with markings on the trunk and ear line along with a message informing if the posture captured in real time is correct (displays the message in green) or not (displays the message in red).

### Materials Used:-

The code editor used to develop this prototype was visual studio code, an editor created and maintained by Microsoft, the programming language was python version 3.11.5 along with some installed libraries and the used Lenovo Legion 5 model AMD Ryzen 7 notebook with 16 RAM.

**Figure 2:-** Notebook used to develop the prototype.



Source: Miranda, 2023.

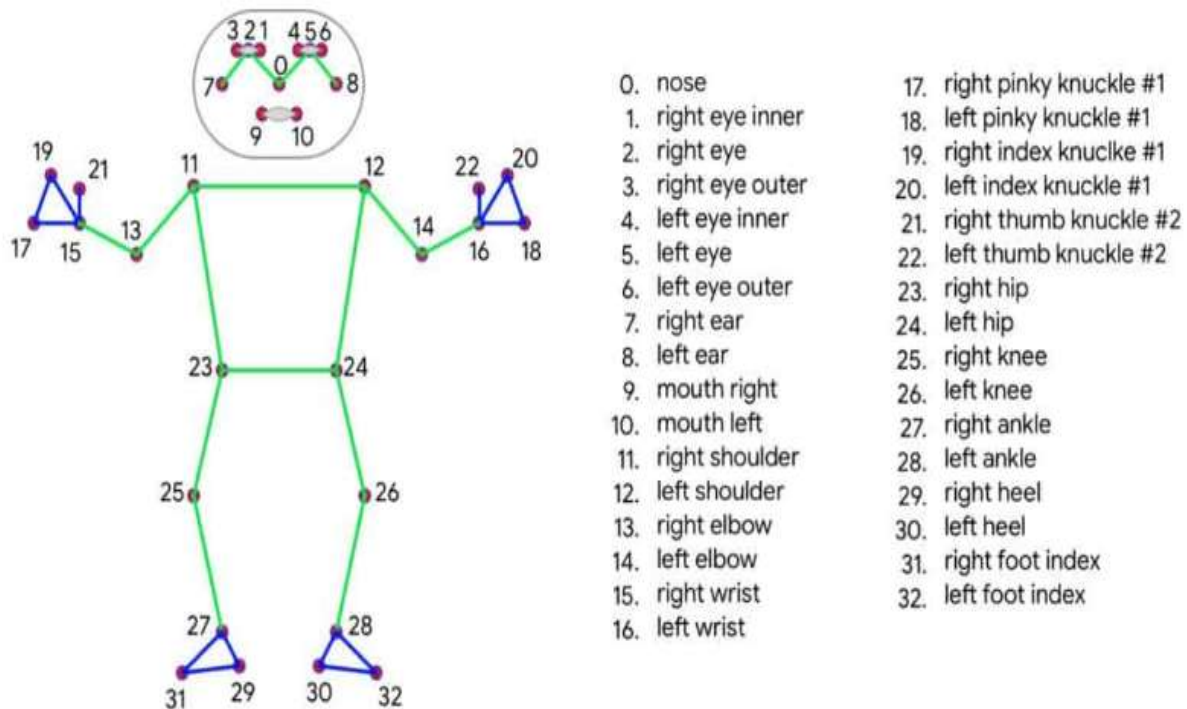
### Results And Discussions:-

As a result, after tests and improvements, it is noticed that there is a marking along the image captured by the camera that is indicating the posture condition of the person, which after a certain time may bend, causing him to find himself with an ergonomically unpleasant posture and that can cause disorders in the long term.

Below are attachments showing the prototype working according to the proposal, to display the image captured by the notebook's webcam, making use of the opencv library, with its marking made by the mediapipe library estimating whether the posture is correct or incorrect according to values defined for the points considered.

Figure 3 shows the pose of a human body in red, green and blue (RGB) dots used by the mediapipe library to detect Body posture, the parts of the body that are recognized by the software are numbered from 0 to 32.

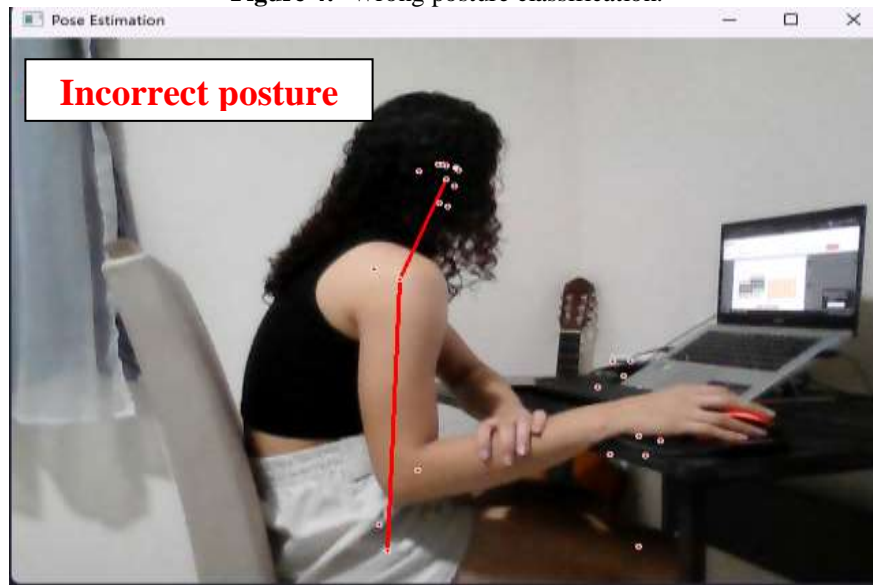
**Figure 3:-** Body points.



Source: Learnopencv, 2022

We can notice that the points detected by the colors of the RGB human body are used as a basis in the design to verify the points of our application.

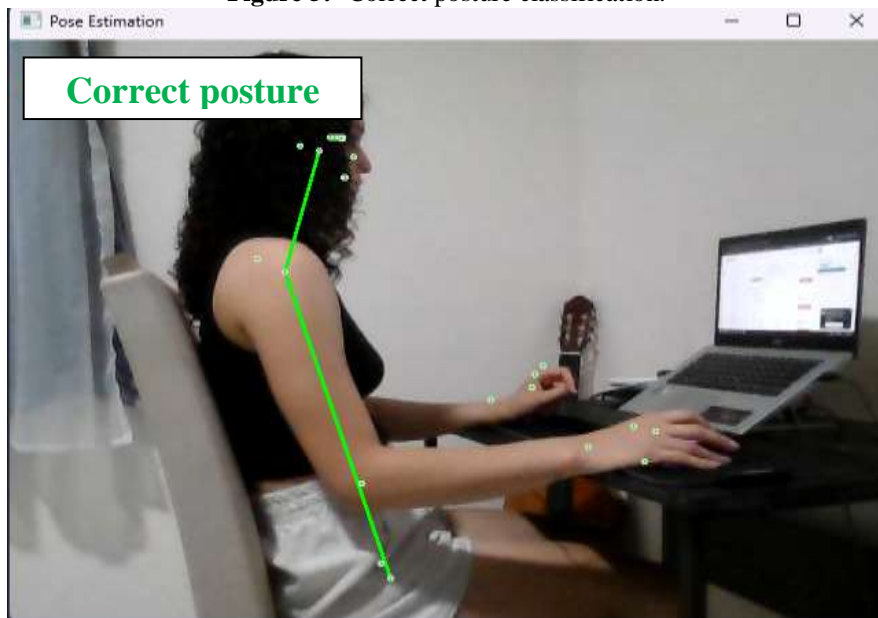
**Figure 4:-** Wrong posture classification.



**Source:** Authored by the authors, 2023

Above, in figure 4, the posture classified as wrong is shown due to the inclination of the trunk in relation to the hip being outside the value defined in the code, note that the marking on the hip is defined as the central point.

**Figure 5:-** Correct posture classification.



**Source:** Authored by the authors, 2023.

Figure 5 shows the posture classified as correct due to the inclination of the trunk in relation to the hip being within the limit defined in the code, in this case the value is 90 degrees, so the connection of the points is displayed in green estimating that the posture is within the defined value.

As a way to validate the functioning of the prototype on screen, the postural position of 15 people, aged between 20 and 40 years, all from the IT area, were evaluated, and the following result was obtained, as shown in figure 6, graph.

**Figure 6:-** Research on posture.



**Source:** Authored by the authors, 2023.

The graph above shows that of the 15 people selected, 53% of the interviewees had correct posture when using the prototype and another 47% had incorrect posture. This prototype represents a way to search for solutions using technology with the aim of demonstrating how to combine two distinct branches to achieve a significant improvement.

### **Final Considerations**

This article presented an innovative proposal that combines the principles of ergonomics with artificial intelligence to improve the posture of workers during working hours. The growing concern about work-related injuries such as RSI/WMSD has highlighted the need for innovative solutions to mitigate these issues. The use of sensors, cameras, and AI algorithms allowed the development of a prototype capable of assessing users' posture in real time. The practical application of this solution was evidenced through tests with IT workers, where more than half of the participants improved their posture with the help of the prototype. This demonstrates the potential of this technology to positively impact the health and well-being of workers by reducing complications related to poor posture.

The integration of artificial intelligence in ergonomic assessments, as presented in this paper, represents a significant advance. By identifying subtle patterns and discomforts that may go unnoticed by human observers, AI enables early interventions and injury prevention, contributing to healthier work environments. In addition, the development of this prototype in Python, using libraries such as Numpy, OpenCV, Math and Mediapipe, provided a practical and accessible approach. Choosing the Python language made the development process easier, allowing for the creation of an effective and easy-to-understand solution for end users.

This work not only highlights the importance of ergonomics and artificial intelligence in occupational health, but also offers a tangible solution to a real problem faced by workers in a variety of fields. The combination of these disciplines opens doors for future research and innovation, providing a safer and healthier work environment for all.



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