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A Comprehensive Survey on the Detection and Analysis of Sitting Posture

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ABSTRACT - The COVID pandemic has led to a significant rise in the proportion of people who work from home, frequently without the infrastructure or ergonomic equipment that they require. User's well-being and health are seriously harmed by improper desk heights, a lack of suitable desktop chairs, and extensive laptop use. Bad posture while sitting is a major contributor to back pain, neck pain, headaches, and discomfort in the spine, which can result in spinal dysfunction and make it challenging to work for extended periods of time. Over time, but never proven to be diminishing, the number of patients with lower back discomfort. Additionally, this kind of illness affects about 20% of the populace, particularly those working in the software sector. The ability to better comprehend human movement and avoid musculoskeletal problems has led to an increase in the importance of posture detection and analysis in recent years. The interest in creating automated systems for posture detection and analysis has grown as high-quality, reasonably priced sensors have become more widely available. Due to their capacity to accurately and efficiently extract complex characteristics from images, deep learning-based techniques have become a promising solution to this issue. The Keras framework is used in this survey study to review the most recent techniques for detecting and analysing sitting position. The responsible people can use the knowledge created here to develop their strategies for more effectively reducing the nation's back pain challenges.

Key Words: Sitting posture Analysis, Deep learning, Keras, Health.

1. INTRODUCTION:

The maintenance or improvement of health involves preventing, diagnosing, and treating illnesses, injuries, and other physical and mental impairments in humans. Due to the COVID pandemic, more people are now working from home and using their laptops or desktops for extended periods of time. It has been observed that the employees do not set up their workspace with the ergonomic equipment or infrastructure that is required. The usage of incorrect desk heights, a lack of appropriate desk chairs, and excessive laptop use while seated incorrectly can be serious issues for employees. This could lead to spinal dysfunction, headaches, neck pain, back pain, and even back discomfort. The number of persons who experience back problems grows with time but never declines. Additionally, since 20% of the population is affected by these illnesses, workers in the software sector should be concerned.
Due to their potential to enhance our comprehension of human movement and avoid musculoskeletal problems, posture detection and analysis have grown in significance during the past several years. A growing number of people are interested in creating automated systems for posture detection and analysis due to the accessibility of high-quality, reasonably priced sensors. Since they can accurately and efficiently extract complex information from images, deep learning-based systems have become a promising alternative to traditional methods.

In this overview study, we examine the most recent approaches to sitting posture analysis and detection within the Keras framework. We give an overview of the Keras framework and discuss how it can be used to build models for posture detection that are based on deep learning. Additionally, utilising the Keras framework, we discuss the most recent cutting-edge techniques for posture identification and analysis. Finally, we discussed the challenges and applications of the development of sitting posture detection systems.

2. LITERATURE SURVEY:

SR. NO	Paper Name	Author	Description
1	Sitting Posture Recognition Based on OpenPose.[2]	Kehan Chen.	This paper proposed sitting posture recognition system based on OpenPose, which uses the monitor in the classroom to detect the sitting posture of the students, and uses OpenPose to extract the posture feature. Keras deep learning framework is used to construct the convolutional neural network, which is used to train the datasets and recognize sitting posture of students.
2	A Deep-Learning Based Posture Detection System for Preventing Telework-Related Musculoskeletal Disorders.[3]	Enrique Piñero-Fuentes, Salvador Canas-Moreno, Antonio Rios-Navarro, Manuel Domínguez-Morales, José Luis Sevillano and Alejandro Linares-Barranco.	In this work, a system based on the postural detection of the worker is designed, implemented and tested, using a specialized hardware system that processes video in real time through convolutional neural networks. This system is capable of detecting the posture of the neck, shoulders and arms, providing recommendations to the worker in order to prevent possible health problems, due to poor posture.
3	Design and Development of a Sitting Posture Recognition System.[5]	Emmanouil Fragkiadakis, Kalliopi V. Dalakleidi, and Konstantina S. Nikita.	This paper focuses on body posture monitoring, by acquiring the pressure distribution of a sitting person with thirteen piezoresistive sensors placed on a seat. The measurements from the sensors passing through a microcontroller unit fed several machine learning techniques in order to discriminate among five sitting postures (upright, leaning left, leaning right, leaning forward and leaning backward).
4	A Smart Chair Sitting Posture Recognition System Using Flex Sensors and FPGA Implemented Artificial Neural Network.[6]	Qisong Hu, Xiaochen Tang, and Wei Tang.	This paper reports a novel posture recognition system on an office chair that can categorize seven different health-related sitting postures. The system uses six flex sensors, an Analog to Digital Converter (ADC) board and a Machine Learning algorithm of a two-layer Artificial Neural Network (ANN) implemented on a Spartan-6 Field Programmable Gate Array (FPGA).

5	Sitting posture analysis by pressure sensors.[4]	Kazuhiro Kamiya, Mineichi Kudo, Hidetoshi Nonaka, Jun Toyama.	In this paper, a system uses pressure sensor seat on a chair for identifying sitting postures. In the experiments, a system is classified into nine postures, including leaning forward / backward / right / left and legs crossed. In this paper, "stable part" frames are only used for sitting-posture classification.
6	Sitting Posture Monitoring System using Image Classification.[7]	Ananya Ashok Naik, Krishna, Neha Kishor Mudhol, Qamrath Akthar Sheikh, Mr. Ramesh Nayak.	This system does not need additional infrastructure and can be used only via the system webcam. The proposed project helps to solve all these problems by providing a web interface solution which can detect the user's posture in real time and based on the image classification model the system gives a visual result. By making use of MediaPipe API we are able to detect the faces easily and the CNN algorithm is used for the image classification.
7	Sitting Posture Detection using Fuzzy Logic.[8]	Bruno Ribeiro , Leonardo Martins, Hugo Pereira1 , Rui Almeida, Cláudia Quaresma, Adelaide Ferreira and Pedro Vieira.	In this paper an approach is developed based on how the classification algorithm handled lateral postural changes, and identified a stability and instability zones. To differentiate between intermediate trunk flexion and extension an approach based on integrating Fuzzy logic into the existing Neural Network-based Classification Algorithm that was capable of classifying 6 standard sitting positions.
8	Machine Learning Algorithms Application For The Proposed Sitting Posture Monitoring System.[9]	Ferdews Tlili , Rim Haddad, Ridha Bouallegue , Raed Shubair.	This paper study the application of the machine learning algorithms for the prediction of the sitting posture. We implement a smart belt equipped with inertial sensors for the data collection of the sitting posture. Then seven machine learning algorithms are trained for posture prediction. The machine learning algorithms are compared based on three main metrics: Accuracy, Precision and Prediction Time.
9	Detection of sitting posture using hierarchical image composition and deep learning.[10]	Audrius Kulikajevas, Rytis Maskeliunas and Robertas Damaševičius.	In this paper, the system propose a novel deep recurrent hierarchical network (DRHN) model based on MobileNetV2 that allows for greater flexibility by reducing or eliminating posture detection problems related to a limited visibility human torso in the frame, i.e., the occlusion problem. The DRHN network accepts the RGB-Depth frame sequences and produces a representation of semantically related posture states.

10	A Proposal of Implementation of Sitting Posture Monitoring System for Wheelchair Utilizing Machine Learning Methods.[1]	Jawad Ahmad, Johan Sidén and Henrik Andersson.	This paper presents a posture recognition system aimed at detecting sitting postures of a wheelchair user. The main goals of the proposed system are to identify and inform irregular and improper posture to prevent sitting-related health issues.In the proposed monitoring system, an array of 16 screen printed pressure sensor units was employed to obtain pressure data, which are sampled and processed in real-time using read-out electronics.

3. KERAS FRAMEWORK FOR DEEP LEARNING:

A high-level deep learning framework called Keras makes it simple and rapid for programmers to create and train deep learning models. With Keras, developers may concentrate on model design as opposed to low-level implementation concerns thanks to its clear and straightforward user interface. A large variety of deep learning architectures, such as CNNs, RNNs, and hybrid models, are supported by Keras, making it a good choice for jobs requiring posture detection**.**

4. STATE-OF-THE-ART METHODS FOR POSTURE DETECTION AND ANALYSIS:

1. Multi-scale deep neural networks: Deep neural networks with numerous scales can capture both global and local characteristics by employing different scales of the input image. When compared to single-scale models, this strategy has been found to increase the accuracy of posture identification.
2. Transfer learning: Transfer learning is using deep learning models that have already been trained, including VGG, ResNet, Xception, Densenet and Inception, and honing them for a particular posture detection task. It has been demonstrated that this technique produces good performance even with little training data.
3. Convolutional Neural Networks (CNNs): Convolutional neural networks (CNNs) are deep learning models that are frequently employed for picture classification tasks, such as posture detection. Multiple layers of convolutional and pooling procedures make up CNNs, which use them to extract hierarchical characteristics from input images. The CNN's last layers, which do the classification, are normally fully connected layers.
4. Recurrent neural networks (RNNs): RNNs excel in posture detection applications requiring temporal data. This technique has been used to examine the changes in posture throughout time.
5. Hybrid models: These models, which integrate both conventional and deep learning methods for computer vision, have also yielded encouraging results.

5. MODELS BASED ON KERAS FRAMEWORK:

1. Xception
   Xception is a deep convolutional neural network architecture that uses depthwise separable convolutions to accurately and quickly extract characteristics from photos. It was first presented in 2016 by Google researchers as a replacement for conventional Inception models, and it has since demonstrated cutting-edge performance on numerous benchmarks for picture categorization and object recognition. Due to its effective design, it can be used in contexts with limited resources, such as mobile devices. The strong and adaptable deep learning model Xception may be utilised for a variety of computer vision tasks, including the detection and analysis of sitting posture.

2. VGG
   Researchers at the University of Oxford created the deep convolutional neural network architecture known as VGG (Visual Geometry Group). It has demonstrated cutting-edge performance on image classification tasks and has 16–19

layers. The simplicity and consistency of the VGG design, which consists of a series of convolutional layers, pooling layers, and fully linked layers, are its distinguishing features.

3. ResNet
ResNet, short for "Residual Network," is a deep convolutional neural network architecture that Microsoft researchers unveiled in 2015. Instead of directly learning the underlying mapping, it makes use of residual blocks that enable the network to learn residual functions. This strategy helps to solve the vanishing gradient issue and allows for deeper networks without performance deterioration.

4. MobileNet
MobileNet is made for embedded and mobile applications with constrained computational resources. It reduces the amount of parameters and computations while retaining excellent accuracy by using depthwise separable convolutions.

5. EfficientNet
A family of models known as EfficientNet uses fewer parameters and requires less computation to attain state-of-the-art performance. To obtain the best performance, it balances the model's depth, width, and resolution using a compound scaling technique.

6. DenseNet
DenseNet is characterised by its densely connected layers, where each layer is coupled to every other layer in a feedforward manner. This architecture has fewer parameters and better accuracy than previous architectures because it allows for better feature propagation and reuse.

7. Inception
Inception is a network design that consists of numerous parallel convolutional layer routes with various filter sizes, enabling the extraction of information at various scales. It has been demonstrated that this architecture can achieve great accuracy while using fewer parameters.

6. APPLICATIONS:

Systems for automatically detecting and analysing posture have many uses in ergonomics, sports, and healthcare. Medical professionals can monitor patients with musculoskeletal diseases and offer early intervention to stop further difficulties by using posture detection devices. By observing how players move, posture detection devices in sports might help athletes perform better and avoid injuries. The risk of musculoskeletal problems can be decreased by designing workstations that are specific to each worker's needs using posture detection technologies in ergonomics.

In addition to these uses, posture detection systems can be used to examine how people walk around in real-world settings including homes, schools, and public areas. The architecture of buildings and public areas can be improved using this knowledge to make them more accessible and accommodating to people with mobility issues.

7. CHALLENGES:

Due to a variety of circumstances, including changes in body shape and size, clothes, illumination, and camera angle, posture identification is a difficult process. Additionally, analysis of both static and dynamic postures, as well as the capacity to recognise posture changes, are prerequisites for posture detection. Finally, since inaccurate posture detection might result in wrong diagnoses and treatments, posture detection systems must be precise and dependable.

8. CONCLUSION:

In conclusion, the creation of automated systems for posture detection and analysis is a crucial area of study that has the potential to advance our knowledge of how people move and shield them from musculoskeletal problems. The Keras framework-based deep learning-based methods, in particular, have demonstrated outstanding performance on posture detection tasks. However, issues including differences in body shape and size, attire, lighting, and camera position continue to be major obstacles. Future studies should concentrate on creating dependable posture detection systems that can handle these difficulties and enhance our capacity to examine and comprehend human movement.

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