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Survey on Sitting Posture Detection and Correction

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Abstract- Prolonged poor sitting posture can lead to health issues, highlighting the need for systems that encourage healthy habits. This project presents a human sitting posture detection and correction system using the Yolov5 model for real-time posture monitoring via a webcam. The system classifies user postures based on ergonomic criteria and provides corrective alerts when bad posture is detected. Preprocessing techniques, such as scaling and augmentation, are applied to the dataset to ensure model robustness. A user-defined timer is also integrated to remind users to take breaks. The trained Yolov5 model is evaluated for accuracy and implemented in a real- time detection system, with practical applications in promoting better sitting habits in home and office environments.

Keywords- Sitting posture detection, Real-time monitoring, Machine Learning, Posture correction, Deep Learning, Feature Extraction.

I. INTRODUCTION

Good posture is essential for overall well-being, especially for individuals who spend long hours sitting. Maintaining a correct sitting posture is crucial for preventing musculoskeletal disorders and promoting overall health. With increasing reliance on desk jobs and digital devices, poor posture has become a common health issue, leading to problems like back pain, neck strain, and fatigue. Traditional methods of posture correction, such as manual reminders or ergonomic chairs, do not provide real-time feedback.

Machine learning and computer vision technologies present an opportunity to address this issue by automating posture detection and correction. By using a system that monitors posture from different angles and alerts users when they adopt incorrect postures, we can ensure timely corrections. Integrating a break timer helps combat the negative effects of prolonged sitting by reminding users to take regular breaks.

This project aims to address these limitations by developing a robust and automated system for human sitting posture detection and correction. The system will leverage the power of computer vision and deep learning to accurately identify different sitting postures from multiple angles. By providing real-time feedback and alerts, the system will empower users to adopt healthier sitting habits and improve their overall well-being.

In this paper we present a literature overview on sitting posture monitoring systems with a focus on the used technologies. Indeed, we classify the posture monitoring systems according to the different models and technologies used and we discuss their corresponding characteristics and architectures.

The paper is composed of four sections. In section II, we explain the problem statement and in section III, we compare and evaluate the different sitting posture monitoring systems. section IV, we conclude the review with the prospects for future work.

II. PROBLEM STATEMENT

Spinal pain caused by the bad sitting posture can affect adults and young people. The slouching and leaning for long hours using computers and portable electronic devices is the main cause of the back problems.

Maintaining good posture is challenging, especially when sitting for extended periods. Poor posture can lead to a variety of health issues. There is a need for an automated solution that can monitor sitting posture in real-time, alert users when bad posture is detected, and remind them to take regular breaks to maintain a healthy sitting routine.

III. RELATED WORKS

In this section, we describe the different posture monitoring systems for seated people developed in literature. The systems are classified according to the different models and technologies used.

Enhancing the Classification Performance of Lower Back Pain Symptoms Using Genetic Algorithm-Based Feature Selection: This study focuses on improving the classification performance for diagnosing lower back pain (LBP) symptoms through machine learning techniques. The researchers proposed a Genetic Algorithm (GA)-based feature selection method to identify the most impactful spinal parameters from a dataset, optimizing the prediction of LBP conditions. Experiments were conducted with and without feature selection across several machine learning models, demonstrating that the GA-based approach improved accuracy, precision, recall, and other key metrics. The work addresses the complexity of chronic LBP classification and its overlap with other diseases, filling a gap in existing LBP diagnosis methods [1].

Human Posture Prediction by Deep Learning: This paper presents a deep learning- based approach for human posture prediction, which is crucial for understanding human actions in video and image data. The study highlights the challenges posed by variations in lighting, environment, and individual behaviors. Using a seven-layer neural network architecture, the model effectively analyzed human joint movements and postures, producing a reliable classification system. The approach was validated using a dataset of football matches, focusing on the posture of athletes during goal moments. The results showed high accuracy in motion detection and posture classification, particularly when background interference was minimized [2].

Human Posture Recognition and Classification: This research proposes an intelligent system for recognizing and classifying human postures in video sequences using a single static camera. The system was trained and evaluated using four different classifiers, with Multilayer Perceptron (MLP) yielding the highest recognition rate. The results showed that supervised learning methods performed better than unsupervised techniques for posture recognition. This system has applications in areas such as video surveillance, human-computer interaction, and environmental awareness, and the findings contribute to improving the robustness and accuracy of posture detection systems [3].

Human Posture Recognition Based on Multiple Features and Rule Learning: In this paper, a novel method for human posture recognition using skeleton data is introduced. The algorithm employs multiple features, including angle and distance between joints, and combines these with rule-based learning methods to enhance classification accuracy. The researchers used Bagging and random subspace techniques to diversify the training sets and improve the classifier's performance. The method outperformed traditional machine learning models and CNNs in terms of interpretability and accuracy. This approach shows promise in applications like human- computer interaction, rehabilitation, and virtual reality [4]

Human Motion Posture Detection Algorithm Using Deep Reinforcement Learning (Qi & Han, 2021): This study presents a novel algorithm for detecting human motion posture using deep reinforcement learning. It leverages deep learning to match motion feature points, normalizes motion images, and calculates the affinity between identified posture regions to detect and extract posture features. The approach improves detail capture, reduces posture recognition time, and achieves a high detection accuracy of 87%, particularly with large image datasets. The method outperforms traditional algorithms in sports and surveillance applications by enhancing motion contour clarity and capturing fine posture details with an accuracy rate of up to 98.5% [5].

Face Tracking with Convolutional Neural Network Heat-Map (Do et al., 2018): This research applies convolutional neural networks (CNN) for heat-map-based face tracking. It introduces a shallow CNN architecture designed to enhance face/non-face classification by extracting robust features for object localization. By experimenting with various pooling sizes, the study builds a heat-map model that accurately tracks facial regions, overcoming challenges in pose changes, motion blur, and occlusion. Tested on the Visual Tracking Object dataset, the method demonstrates strong performance, contributing to improved real-time face tracking through adaptive CNN- based heat maps [6].

Sitting Posture Detection Using Adaptively Fused 3D Features (Sun et al., 2017): This paper introduces a sitting posture detection method based on 3D depth sensors, aiming to address poor posture-related health issues. The system models body joints and extracts both relative topological and local edge features for classification. The method achieves high detection accuracy (above 94%) and real-time performance (17 fps), outperforming traditional sensor-based approaches. The authors also develop a 3D sitting posture dataset and demonstrate that their joint-based feature fusion method is more effective than state-of-the-art algorithms for detecting a wide range of sitting postures [7].

Study on Deep Learning Models for Human Pose Estimation and its Real Time Application: This paper provides a comprehensive review of deep learning techniques for human pose estimation (HPE), focusing on both 2D and 3D methods. It discusses the challenges associated with accurately identifying human movements, such as running and dancing, from RGB images. The study highlights two main approaches to HPE: bottom-up and top-down models, with specific attention given to advancements in computer vision, such as OpenPose and AlphaPose. The paper also explores datasets used for training HPE models and the applications of pose estimation in fields like healthcare, video monitoring, and sports. Despite significant progress, the paper acknowledges the need for further improvements, particularly in managing occlusion and crowd scenarios [8].

Human Posture Classification from Multiple Viewpoints and Application for Fall Detection: This research investigates the classification of human postures using multi- view analysis and its application in fall detection. Using deep learning techniques like the YOLO (You Only Look Once) network, the authors achieve high accuracy in detecting and classifying postures from multiple camera angles. The study utilizes a dataset of human activities captured from six viewpoints, demonstrating a recall and precision of 99% in posture detection. The paper’s primary application focuses on fall detection, making it a valuable contribution to healthcare and safety, particularly in environments like elderly care [9].

A Vision-based Human Posture Detection Approach for Smart Home Applications: This paper proposes a YOLOv5-based vision system for posture detection, tailored for smart home applications. The system improves upon existing models by offering faster and more accurate posture identification, addressing the challenges of viewpoint changes, occlusion, and lighting variations. The research focuses on detecting common postures such as sitting, walking, and falling, and emphasizes the utility of this approach in enhancing the well-being of residents in smart homes, particularly the elderly. The paper also explores the effectiveness of data augmentation and transfer learning in improving the model’s performance [10].

The Research and Implementation of Human Posture Recognition Algorithm Via OpenPose: The paper applies the OpenPose framework to identify key body joints in both single and multi-person settings. Utilizing the VGG-19 deep neural network, it extracts feature maps and generates heatmaps for key points and joint connections to improve posture recognition accuracy, even in complex environments with occlusion. By focusing on 18 key joint points, the method enhances detection accuracy and processing speed, achieving 91.5% recognition accuracy and 9.7 frames per second. Trained on public video datasets, the system demonstrates strong performance for real- time applications such as intelligent monitoring, human-computer interaction, and motion analysis.[11]

DeepPose: Human Pose Estimation via Deep Neural Networks: The paper DeepPose: Human Pose Estimation via Deep Neural Networks introduces a deep learning approach to human pose estimation, framing it as a regression problem for localizing body joints in images. The method employs a cascade of DNN-based regressors, starting with rough joint predictions from a full image, followed by refinements using higher resolution sub-images around predicted joints. A 7-layer convolutional DNN is used to make the initial predictions, which are progressively improved. Experiments on popular datasets show that this approach outperforms previous methods, effectively handling occlusions and articulation variations, and demonstrating strong generalization across datasets to achieve state-of-the-art performance.[12]

Design and Development of a Sitting Posture Recognition System: The paper Design and Development of a Sitting Posture Recognition System introduces a system using 13 piezoresistive sensors to monitor and classify five sitting postures (upright, leaning left, right, forward, and backward) by measuring pressure distribution. The sensor data is processed by a microcontroller and analyzed with machine learning models, including SVM, KNN, Decision Trees, and Neural Networks. The system achieved a classification accuracy of over 98%, with the highest (98.33%) using the WG30NN classifier. Potential applications include monitoring the elderly or disabled, detecting driver drowsiness, and preventing musculoskeletal disorders, with future improvements possible through more sensors or specific adaptations for different environments.[13]

Posture Detection Using Deep Learning for Time Series Data: The paper Posture Detection Using Deep Learning for Time Series Data presents a hybrid deep learning approach for posture classification using data from three tri-axial accelerometers placed on participants' backs. By combining Fully Convolutional Networks (FCNs) for feature extraction and Long Short-Term Memory (LSTM) networks for capturing temporal dependencies, the system classifies nine sitting and standing postures with an accuracy of 99.91%, outperforming individual FCN (97.88%) and LSTM (88.47%) models. The paper highlights the efficiency of deep learning for time-series data in wearable posture detection systems, achieving real-time prediction in under 5 milliseconds, making it ideal for everyday posture monitoring applications.[14]

IV. CONCLUSION

We report a survey on the recent posture monitoring systems existing in the literature. These systems define the body posture using sensing technologies and provide feedback to the user in order to improve the body posture. For the patient posture correction systems and rehabilitation systems, the accuracy of the posture information remains the challenging research subject to improve the posture monitoring systems.

In the future work, we will develop and design a wearable posture monitoring system that is comfortable, easy to use and efficient in terms of the posture accuracy, the time-system treatment and feedback.

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