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Original Article

Human Pose Detection using Machine Learning

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Abstract

This project presents a real-time human pose detection system using deep learning techniques to identify body keypoints from images and video streams. The system utilizes YOLOv8 Pose along with computer vision libraries such as OpenCV to accurately detect and track human body movements in real time. The implementation is integrated into a Streamlit-based web application, providing an interactive interface where users can perform pose estimation using a live camera or uploaded images and videos. The system processes input data efficiently and visualizes keypoints and skeletal structures for better understanding of human posture. Furthermore, the proposed solution supports posture analysis and can be applied in domains such as fitness monitoring, rehabilitation, sports analysis, and human activity recognition. The model ensures high accuracy, low latency, and ease of use, making it suitable for real-world applications and scalable for future enhancements.

Introduction

The project Human pose detection is a key area in the field of computer vision, focusing on identifying and tracking human body keypoints such as joints and limbs from images and video streams. It has gained significant importance due to its wide range of applications in fitness tracking, healthcare, sports analysis, surveillance, and human-computer interaction.

Traditional methods for motion analysis often rely on wearable sensors or manual observation, which can be expensive, time-consuming, and less efficient. With the advancement of deep learning techniques, it is now possible to detect and analyze human poses accurately using visual data alone.

In this project, a real-time human pose detection system is developed using advanced models such as YOLOv8 Pose, which can efficiently detect multiple body keypoints with high accuracy and speed. The system processes input from images, videos, or live camera feeds and visualizes the detected keypoints and skeletal structure.

The implementation is integrated into a Streamlit web application, providing a user-friendly interface that allows users to interact with the system easily. This enables real-time pose estimation and analysis without requiring complex setups or technical expertise.

The proposed system can be used for posture correction, fitness monitoring, rehabilitation support, and activity recognition. It offers a scalable and efficient solution that can be extended for real-time analytics and intelligent human behavior understanding in future applications.

Background

Human pose detection is a computer vision technique used to identify human body keypoints such as joints and limbs from images and videos. These keypoints form a skeletal structure that helps in understanding human posture and movement.

Earlier methods relied on traditional image processing techniques, which had limitations in accuracy and real-time performance. With the advancement of deep learning, modern models like YOLOv8 Pose, OpenPose, and MediaPipe can detect human poses more accurately and efficiently.

Today, human pose detection is widely used in applications such as fitness monitoring, rehabilitation, sports analysis, and activity recognition, making it an important area in intelligent systems development.

Problem Statement

There is an increasing need for real-time human activity monitoring in areas such as fitness, healthcare, and surveillance. However,

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many existing pose estimation systems struggle to provide accurate detection in dynamic real-world conditions. They often face challenges in multi-person detection and require high computational resources, which affects their efficiency in real-time applications. Therefore, it is important to develop an efficient and reliable system that can accurately detect human body keypoints in real time. Such a system should handle multiple people and perform effectively while maintaining good speed and accuracy.

Literature Survey

Human pose detection has become an important research area in computer vision, focusing on identifying and tracking human body joints such as the head, shoulders, elbows, knees, and ankles from images or video streams. It plays a crucial role in applications such as sports analysis, healthcare monitoring, surveillance systems, and human-computer interaction. However, many traditional pose detection systems face challenges related to accuracy, real-time performance, and handling multiple people in dynamic environments. Earlier approaches relied on handcrafted features and conventional machine learning methods, which often struggled with complex backgrounds, occlusion, and varying lighting conditions. To address these issues, recent research has increasingly focused on deep learning–based pose estimation techniques that improve both accuracy and efficiency.

Several studies highlight the effectiveness of deep learning models in human pose estimation. Cao et al. (2017) introduced OpenPose, a real-time multi-person pose detection framework that uses a bottom-up approach to detect keypoints and associate them with individuals in an image. Their research demonstrated how deep neural networks can accurately estimate human poses even in crowded scenes. Similarly, Sun et al. (2019) proposed High-Resolution Network (HRNet), which maintains high-resolution representations throughout the detection process, significantly improving the accuracy of keypoint localization in complex scenarios.

Another important contribution comes from Bazarevsky et al. (2020), who developed MediaPipe Pose, a lightweight and efficient pose estimation framework designed for real-time applications on mobile and edge devices. Their work showed that optimized deep learning models can perform accurate pose detection with low computational requirements, making them suitable for interactive systems and real-time monitoring applications. Furthermore, recent advancements by Jocher et al. (2023) introduced YOLOv8 Pose, an advanced deep learning model capable of performing object detection and pose estimation simultaneously. This approach improves detection speed and accuracy while maintaining real-time performance, making it highly effective for applications involving live video analysis.

In addition, researchers have explored integrating human pose detection with other intelligent technologies to enhance system capabilities. For example, some studies combine pose estimation with activity recognition algorithms to analyze human behavior and detect abnormal movements in surveillance and healthcare systems. Other research focuses on using pose detection in rehabilitation and sports training to evaluate posture alignment and movement accuracy. These advancements demonstrate that deep learning–based pose estimation systems have significant potential to improve human activity monitoring and intelligent vision-based applications.

Proposed system

The proposed system is designed to overcome the limitations of existing human pose detection methods by integrating advanced deep learning techniques with an interactive, real-time interface. It utilizes the YOLOv8 Pose model, a state-of-the-art architecture developed by Ultralytics, for fast and accurate human keypoint detection. YOLOv8 combines object detection and pose estimation within a single unified framework, significantly improving processing speed and precision. The system is capable of identifying multiple people simultaneously in a live video stream and marking each body's keypoints — such as the head, shoulders, elbows, hips, knees, and ankles — with connecting lines to form a visual skeletal representation.

Modules Used

Authentication Module: This module manages user login, authentication, and role-based access control. It ensures system security by verifying credentials through hash-based password validation. Two roles are supported:

Admin – has access to model configuration, threshold settings, and system logs.

User – can perform pose detection and view results but cannot modify configurations.

Model Loading Module: This module is responsible for loading the YOLO model (pose.pt or yolo11m-pose.pt) with its pre-trained weights and configuration files.

Video Capture Module: The video capture module interfaces with the computer's webcam or an external camera using OpenCV.

It streams continuous video frames and passes them to the detection module. The module also supports real-time control—users can start or stop the stream through the Streamlit interface.

Pose Detection Module: This is the core module of the system. It integrates the YOLO model for real-time pose estimation by detecting human figures and predicting body keypoints such as head, shoulders, elbows, knees, and ankles. It uses confidence thresholds to filter uncertain detections and supports both CPU and GPU execution for scalability.

Data Visualization Module: The visualization module enhances system usability by providin graphical representation of detection results. It overlays skeletal keypoints on the live video feed using OpenCV drawing functions.

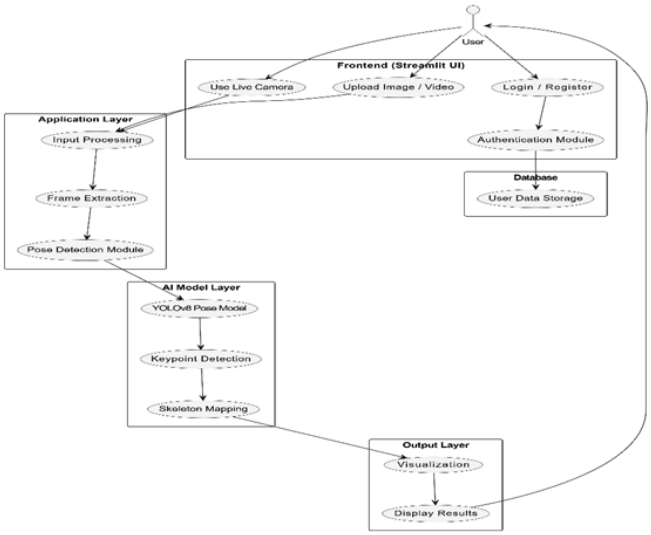
Admin Control Module: The admin control module provides extended functionalities for system administrators. Admins can configure:

- Model path and parameters
- Confidence thresholds
- Detection frame sizes
- GPU usage options

Advantages of proposed system

- Real-Time Pose Detection → Detects human body keypoints instantly from live video.
- Interactive and User-Friendly Interface → Provides an easy-to-use interface for smooth user interaction.
- Real-Time Visualization and Analytics → Displays live pose results and performance data instantly.
- Efficiency and Portability → Works quickly with low resources and can run on different devices easily.

System Architecture



Results

The Result of proposed Project performs real-time human pose detection using live webcam input, allowing continuous analysis of human movements without delay. It achieves high accuracy in detecting body keypoints such as joints and limbs by using advanced deep learning models like YOLOv8 Pose. The system supports multiple applications, including fitness monitoring, healthcare for rehabilitation, and surveillance for activity recognition. It is designed with a user-friendly web interface using Streamlit, enabling users to easily interact with the system through live camera or uploaded media. Additionally, the system ensures fast processing with low latency, providing smooth and efficient performance in real-time scenarios. Built on modern deep learning frameworks, the solution is easy to deploy and scalable, making it suitable for real-world applications and future enhancements..

Conclusion

Human pose detection using the YOLOv8 Pose model integrated with Streamlit. It demonstrates how deep learning models can be combined with web-based frameworks to create interactive and efficient monitoring systems. The model maintains an excellent balance between accuracy and processing speed, ensuring practical use in real-world scenarios such as sports analytics, healthcare, and surveillance. The Streamlit interface enhances usability by allowing users to visualize live pose detection, keypoints, and performance metrics directly in a browser. The system's portability and scalability make it adaptable to various environments and devices. Overall, this project provides a strong foundation for future research in areas such as 3D pose estimation, activity recognition, and behavioral analysis, contributing to the advancement of intelligent vision-based systems.

Future scope

The system can be further enhanced by extending it to 3D pose estimation, which enables depth-aware tracking and provides a more accurate understanding of human movements in three-dimensional space. This improvement allows better analysis of posture and spatial orientation. Additionally, integrating activity recognition and anomaly detection modules will enable the system to automatically identify specific actions and detect unusual or incorrect movements, making it useful for applications like security and health monitoring. The solution can also be deployed on cloud platforms or mobile devices, allowing scalable and efficient edge AI applications that can run in real-world environments. Furthermore, the system can be enhanced to automatically generate posture correction and movement analysis reports, helping users improve performance in fitness or rehabilitation. Finally, incorporating data logging and analytics dashboards will allow storage, visualization, and analysis of pose data over time, which is valuable for research, performance tracking, and decision-making.

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