Project Report: BodPost (AI Based Real-Time Body Posture Detection)

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ABSTRACT

Poor posture is a major contributor to musculoskeletal disorders, back pain, and reduced productivity. Traditional posture correction relies on manual observation, which is inefficient and inconsistent. This project introduces **BodPost**, an AI-driven real-time posture detection system that combines **MediaPipe Pose Estimation** and **Machine Learning** to classify human posture as *correct* or *incorrect*.

The system extracts 33 anatomical landmarks using MediaPipe, computes posture-relevant geometric features, and trains a supervised ML classifier to distinguish posture quality. A real-time inference pipeline uses webcam input to perform continuous posture monitoring with visual feedback.

The proposed solution is lightweight, efficient, and suitable for ergonomic applications, fitness form correction, and rehabilitation support. Experimental results show high accuracy, demonstrating the effectiveness of combining pose estimation with machine learning for posture analysis.

I. INTRODUCTION

Human posture plays an essential role in physical health, workplace ergonomics, and athletic performance. With increased computer usage and sedentary lifestyles, posture-related problems have become widespread. Poor posture leads to issues such as:

- Chronic back and neck pain
- Muscular imbalance
- Fatigue and reduced productivity
- Long-term spinal complications

Manual posture correction methods—such as supervision or physical checkups—are inconsistent and impractical for continuous monitoring. Therefore, there is a growing need for **automated, real-time posture assessment systems**.

Recent advancements in **computer vision** and **pose estimation** allow accurate detection of human body posture from images and videos. Tools like **MediaPipe** provide high-quality pose landmarks with minimal computational cost. Combined with machine learning, these landmarks can be used to classify posture effectively.

This project presents **BodPost**, a complete end-to-end system that detects posture in real-time and classifies it as correct or incorrect using a trained ML model. The system is designed to be efficient, deployable on consumer hardware, and extensible for various posture-related applications.

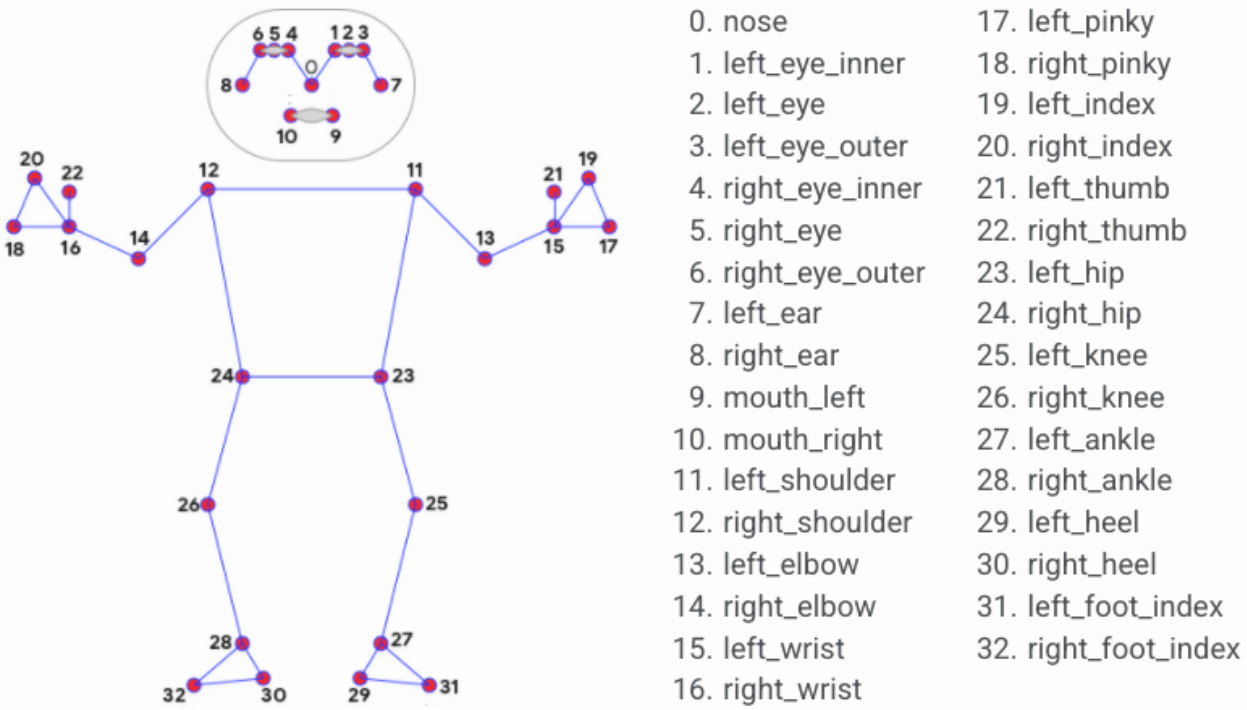

Figure 1 – Human Body Landmarks

II. MACHINE LEARNING PIPELINE

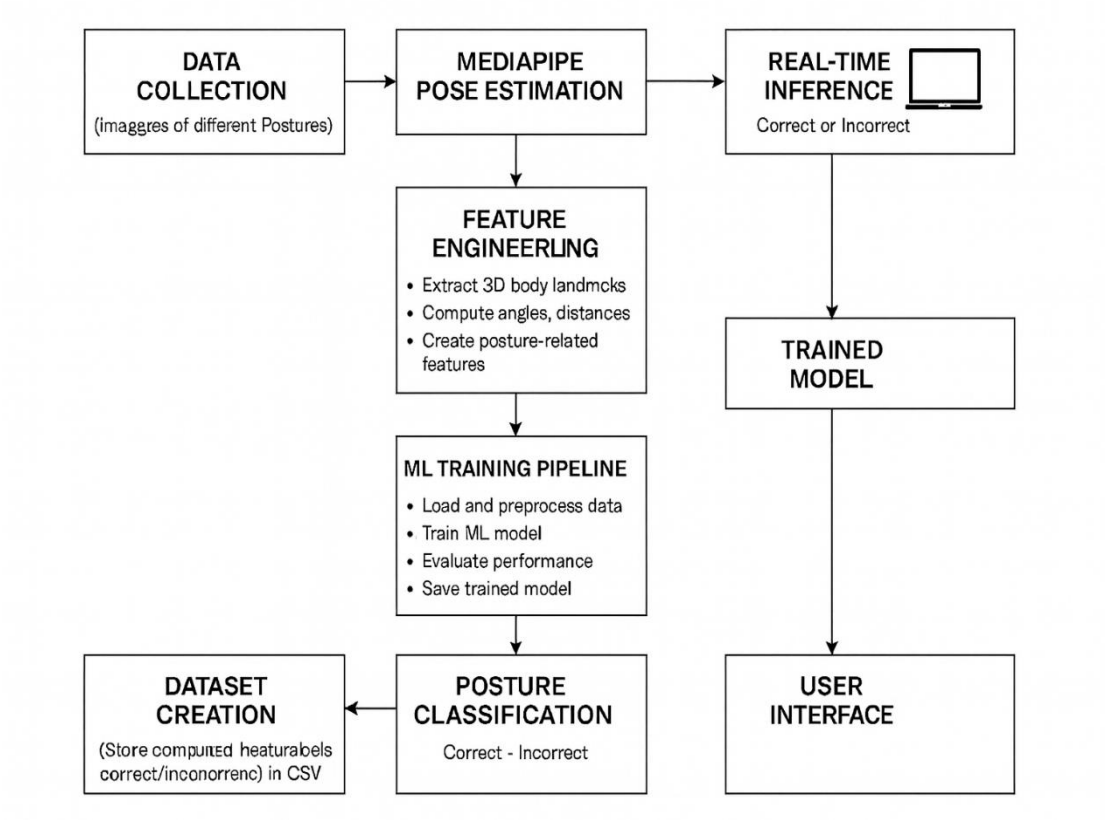

Figure 2 – Full System Architecture

III. METHODOLOGY

The methodology of the BodPost system is divided into six major components:

1. Data Collection

Images of individuals in both correct and incorrect posture positions were collected to form the dataset. These images represent variations in:

- Sitting posture
- Slouching
- Leaning forward
- Upright posture
- This dataset forms the foundation of the training pipeline.

2. Pose Estimation using MediaPipe

The collected images are processed using **MediaPipe BlazePose**, which extracts **33 body landmarks**, including:

- Shoulders
- Hips
- Knees
- Neck
- Spine base
- Head position

Each landmark provides (x, y, visibility) coordinates. MediaPipe is selected because:

- It is extremely fast (real-time on CPU)
- It provides accurate anatomical keypoints

- It is open-source and easy to integrate

3. Feature Engineering

Raw landmark coordinates alone are insufficient for posture classification. Therefore, several engineered features were computed:

- **Joint angles** (neck angle, back angle, shoulder slant)
- **Distances** between key landmarks (shoulder–neck, hip–spine)
- **Ratios** indicating symmetry / alignment
- **Posture deviation features**
- **Body alignment metrics**

These features transform pose landmarks into meaningful posture descriptors.

A labeled dataset is generated and stored as:

posture_features_mediapipe.csv

4. Machine Learning Model Training

The dataset is used to train a classification model using **Scikit-Learn**. Steps include:

Data Preprocessing

- Handle missing values
- Normalize features
- Split into training/testing sets

Model Selection

Models explored include:

- **Random Forest Classifier**
- **Support Vector Machine (SVM)**

The Random Forest produced strong performance due to:

- Resistance to overfitting
- Ability to handle nonlinear relationships
- Interpretability of feature importance

Training & Evaluation

Metrics evaluated:

- Accuracy
- Precision / Recall / F1-score
- Confusion Matrix

The trained model is stored as **posture_model.pkl** for deployment.

5. Real-Time Inference Pipeline

The deployment pipeline includes:

- Capturing frames from webcam using OpenCV
- Running MediaPipe Pose to extract landmarks
- Computing the same engineered features as during training
- Feeding features into the trained ML model
- Displaying: Pose skeleton, Predicted posture label, Real-time feedback

The system operates at near real-time speed on standard hardware.

6. User Interface

The real-time output includes:

- Live webcam video feed
- Pose skeleton overlay
- Dynamic posture classification (Correct / Incorrect)

IV. FUTURE WORK

Potential enhancements include:

- Multi-class posture classification
- Posture scoring mechanism (0–100 posture score)
- Time-based alerts for continuous poor posture
- Deep learning classifier using LSTM or GNN for temporal posture analysis
- Mobile app deployment
- Integration with health dashboards for long-term analytics

V. RESULTS

1. The ML classifier achieves high accuracy ($\approx$ 98%) on test data.
2. The system can detect posture errors such as:
    - Forward head posture
    - Rounded shoulders
    - Slouching
    - Upright alignment
3. Real-time performance is smooth and responsive.

These results validate that combining pose estimation with feature-based ML classification is an effective approach for posture detection.

VI. CONCLUSION

This project successfully demonstrates BodPost, a real-time AI system for posture classification. Using MediaPipe Pose for landmark extraction and machine learning for classification ensures high accuracy with minimal computational requirements.

The modular architecture (data → features → ML → inference) allows the system to be easily extended, adapted, and deployed in various domains such as ergonomics, fitness coaching, and rehabilitation monitoring.

The results show significant potential for improving posture awareness and helping users correct unhealthy habits through automated feedback.

GITHUB REPOSITORY

https://github.com/devsachink22/BodPost

ACKNOWLEDGE

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