ENHANCING ERGONOMICS
POSTURE ALERT SYSTEM

A DESIGN PROJECT REPORT

Submitted by

MUKUNTHAN S

NAVEEN KUMAR E

SANTHOSH S

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

SAMAYAPURAM – 621 112

JUNE, 2024

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(AUTONOMOUS)

SAMAYAPURAM – 621 112

BONAFIDE CERTIFICATE

Certified that this project report titled **"ENHANCING ERGONOMICS POSTURE ALERT SYSTEM"** is the bonafide work of **MUKUNTHAN S (811721104070), NAVEEN KUMAR E (811721104072), SANTHOSH S (811721104089)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE
Dr.A.Delphin Carolina Rani M.E.,Ph.D.,
HEAD OF THE DEPARTMENT
PROFESSOR
Department of CSE
K. Ramakrishnan College of Technology
(Autonomous)
Samayapuram – 621 112

SIGNATURE
Mr.Saravanan M M.E.,
SUPERVISOR
ASSISTANT PROFESSOR
Department of CSE
K. Ramakrishnan College of Technology
(Autonomous)
Samayapuram – 621 112

Submitted for the vivavoce examination held on …………….

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on **"ENHANCING ERGONOMICS POSTURE ALERT SYSTEM "** is the result of original work done by us and best of our knowledge, similar work has not been submitted to **"ANNA UNIVERSITY CHENNAI"** for the requirement of Degree of **BACHELOR OF ENGINEERING**. This project report is submitted on the partial fulfilment of the requirement of the award of Degree of **BACHELOR OF ENGINEERING**.

Signature

MUKUNTHAN S

NAVEEN KUMAR E

SANTHOSH S

Place: Samayapuram

Date:

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ABSTRACT

The "Enhancing Ergonomics Posture Alert System" is an innovative solution designed to improve posture and prevent health issues caused by prolonged poor ergonomics. Utilizing realtime camera monitoring and machine learning, the system continuously evaluates an individual's posture and sends notifications when poor posture is detected, encouraging immediate corrections to prevent discomfort and long term health problems.This system also offers a user friendly interface with detailed posture analytics, displaying posture data over time through clear charts and graphs. Users can track their ergonomic habits and reset the posture log to monitor improvements effectively. By providing both realtime alerts and comprehensive analytical tools, the system helps individuals develop healthier posture habits, enhancing overall wellbeing and productivity in various settings.

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LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
HOG	Histogram Oriented Gradient
SVM	Support Vector Machine
IOT	Internet Of Things
IDE	Integrated Development Environment
UI	User Interface

CHAPTER 1

INTRODUCION

1.1 OVERVIEW

The "Enhancing Ergonomics Posture Alert System" addresses the prevalent issue of poor posture in modern workplaces, leveraging advanced computer vision and machine learning technologies. The system continuously monitors the user's posture via a webcam feed, providing realtime alerts when a bad posture is detected. This immediate feedback mechanism aims to mitigate the risk of discomfort and long term health problems associated with sustained poor posture, thereby fostering a healthier and more productive work environment.

Beyond realtime monitoring, the system maintains a comprehensive log of posture data, enabling users to gain valuable insights into their posture habits over time. This data is used to compute an ergonomic score, which quantifies the user's overall posture health. The ergonomic score, along with detailed visualizations such as bar graphs and pie charts, provides a clear and actionable understanding of the user's posture patterns. This feature empowers users to make informed adjustments to their posture, enhancing their long term wellbeing.

The user interface is designed with a focus on simplicity and clarity, featuring a dark grey background with white and blue highlights for optimal readability. Users can easily view their ergonomic score on the main widget and access more detailed analytics in a separate window. A reset button allows for the posture log to be cleared, enabling users to start afresh as needed. Overall, the Enhancing Ergonomics Posture Alert System is a comprehensive solution that not only promotes immediate posture correction but also supports the development of healthier habits through detailed feedback and insightful data visualization.

1.1 PROBLEM STATEMENT

In today's digital age, many individuals spend prolonged periods working at desks, often leading to poor posture habits. This sedentary behavior is linked to numerous health issues, including chronic back pain, neck discomfort, and musculoskeletal disorders. Despite widespread awareness of the importance of proper ergonomics, many people struggle to maintain good posture consistently throughout their daily activities. Traditional ergonomic interventions, such as ergonomic chairs and desk setups, offer some relief but fail to provide realtime feedback and personalized alerts to correct posture in the moment.Existing posture monitoring solutions are either overly simplistic, providing insufficient feedback, or overly complicated, making them difficult to integrate into everyday life. These systems often lack realtime alert mechanisms and fail to offer comprehensive insights into posture trends and habits over time. Consequently, there is a pressing need for a more sophisticated, user friendly system that can monitor posture continuously, alert users instantly to poor posture, and provide detailed analytics for long term improvement. This enhanced posture alert system aims to fill this gap by offering an integrated approach that combines realtime detection, immediate corrective notifications, and thorough data analysis to promote healthier posture habits and reduce the risk of posture related health issues.

1.2 OBJECTIVES

The objective of the "Enhancing Ergonomics Posture Alert System" is to create a cutting edge solution for improving workplace health and productivity by actively monitoring and correcting users' posture in realtime. By employing state of heart machine learning algorithms and computer vision technology, the system detects and categorizes users' posture from webcam video feeds. Upon identifying poor posture, the system promptly notifies users to adjust their position, thereby preventing discomfort and long term health issues associated with bad posture. Additionally, the system provides comprehensive data analytics and visualization features, allowing users to track their ergonomic habits over time. Through intuitive charts and graphs, including posture counts and ergonomic scores, users gain insights into their posture health. The ergonomic score offers a quantitative measure of overall posture health, calculated based on the ratio of good to bad posture instances. The application ensures clarity and ease of use. Furthermore, users can reset posture logs and access detailed analytics, making it a versatile tool for promoting and sustaining good ergonomic practices in various work environments.

1.3 IMPLICATION

The implications of the "Enhancing Ergonomics Posture Alert System" are multifaceted and far reaching. Firstly, on an individual level, the system can significantly improve users' physical health and wellbeing by actively promoting better posture habits. By receiving realtime alerts and feedback, users are empowered to make immediate adjustments, thereby reducing the risk of discomfort, pain, and musculoskeletal issues associated with prolonged poor posture. This can lead to increased productivity, as users are less likely to experience fatigue and discomfort, allowing them to focus more effectively on their tasks.

Moreover, on an organizational level, the implementation of this system can yield several benefits. Employers can foster a healthier and safer work environment for their employees, ultimately reducing the incidence of work related injuries and absenteeism. Additionally, by promoting good posture habits, organizations can mitigate potential healthcare costs associated with treating musculoskeletal disorders and improve overall employee morale and job satisfaction.

From a societal perspective, widespread adoption of such technology could contribute to a broader cultural shift towards prioritizing health and wellness in the workplace. By raising awareness about the importance of posture and providing practical tools for improving it, the system can help instill lifelong habits that extend beyond the workplace setting. Ultimately, the implications of the "Enhancing Ergonomics Posture Alert System" extend beyond individual users and organizations, potentially leading to broader societal benefits associated with improved public health and wellbeing.

CHAPTER 2

LITERATURE SURVEY

2.1 TITLE: A SMART SYSTEM FOR SITTING POSTURE DETECTION BASED ON FORCE SENSORS AND MOBILE APPLICATION

AUTHORS: Slavomir Matuska, Martin Paralic, Robert Hudec

YEAR: 2020

This paper presents a smart IoT system for sitting posture detection using force sensors embedded in an office chair and a mobile application. Six flexible force sensors (four on seat, two on backrest) are used to measure pressure and detect incorrect sitting positions. An Arduino board collects sensor data and sends it to a cloud server running on a QNAP NAS using MQTT protocol. The server processes the data using NodeRED and MongoDB to evaluate sitting posture correctness based on defined rules utilizing pressure distribution and deviation. A mobile app displays the sitting posture status (green/orange/red) with notifications.

2.2 TITLE: MACHINE LEARNING ALGORITHMS APPLICATION FOR THE PROPOSED SITTING

AUTHORS: Ferdews Tlili, Rim Haddad, Ridha Bouallegue, Raed Shubair

YEAR: 2022

This paper proposes a sitting posture monitoring system based on machine learning algorithms for posture prediction. The system consists of a smart belt equipped with inertial sensors to detect posture. Seven machine learning algorithms are applied and compared for posture prediction: KNN, SVM, Decision Tree, Random Forest, Naive Bayes, Boosting, and Kmeans (unsupervised). The results show the Random Forest algorithm with 30 trees has the best accuracy (99.19%) and precision (98.70%), but higher prediction time (67.7ms) compared to other algorithms. The SVM has the shortest prediction time (0.64ms) but lower accuracy (98.56%). The Decision Tree demonstrates good accuracy (>90%) for each posture position.

2.3 TITLE: LITERATURE SURVEY ON IOTBASED SMART WEARABLE POSTURE DETECTION & ALERT SYSTEM

AUTHORS: S.Unnathi Annapurna, Adithi K.S, Meghala Murali, Saqalain Quadri

YEAR: 2022

This review examines the development of IoT based smart wearable systems for posture detection and alerting. It highlights the effects of slouching on the transverse abdominal muscle and its link to low back pain. The study discusses the design components, including a controller board with wireless connectivity and an IMU unit for angular and positional data measurement. The system uses a Node MCU as the control board and an MPU6050 IMU unit, along with a flex sensor to measure spinal movement. The review also covers the software requirements and testing platforms needed for implementing such devices. It underscores the importance of accurate posture detection to prevent discomfort and potential health issues related to poor sitting habits .

2.4 TITLE: INTELLIGENT SYSTEMS FOR SITTING POSTURE MONITORING AND ANOMALY DETECTION

AUTHORS: Patrick Vermander, Aitziber Mancisidor, Itziar , Nerea Perez

YEAR: 2024

This paper provides a comprehensive review of intelligent systems used for monitoring sitting posture and detecting anomalies, specifically for wheelchair users. The study emphasizes the importance of integrating technology into wheelchairs to assess and monitor users' postures, which is crucial for preventing musculoskeletal problems and improving the quality of life. The review is structured into two main parts: the first focuses on the devices used for collecting postural data, and the second discusses the techniques for detecting anomalies. Traditional approaches treat anomalies as incorrect postures, whereas newer individualized approaches consider changes from a user's normal sitting pattern. The paper aims to synthesize existing knowledge, identify trends, and highlight opportunities and challenges in this field.

CHAPTER 3

SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

In the current landscape, posture monitoring and correction are typically managed through passive and less sophisticated methods. Many workplaces and individuals rely on traditional ergonomic assessments, which involve periodic evaluations by ergonomic specialists. These assessments often include physical evaluations and adjustments to workstations, chairs, and other equipment to ensure ergonomic compliance. Furthermore, existing solutions such as wearable devices and posture correction braces offer some level of realtime feedback but come with limitations. Wearables, while effective in detecting posture, can be uncomfortable and intrusive for long term use. They also require continuous wear, which may not be practical for all users. Posture correction braces can help maintain proper posture but do not provide realtime feedback or adapt to dynamic movements, limiting their effectiveness. Additionally, manual tracking of posture improvements and ergonomic habits is cumbersome and often neglected, resulting in a lack of actionable insights for long term health benefits.

3.2 PROPOSED SYSTEM

The "Enhancing Ergonomics Posture Alert System" overcomes the limitations of current posture monitoring methods by using advanced machine learning and computer vision to provide realtime posture correction. By continuously analyzing webcam video feeds, the system classifies posture as good or bad and sends immediate notifications to prompt adjustments, ensuring ongoing ergonomic compliance and reducing the risk of discomfort and long term health issues. Additionally, the system offers comprehensive data analytics and visualization, logging posture data and presenting it through detailed charts and ergonomic scores. This allows users to track their progress and understand their ergonomic habits better. The user friendly interface, includes features like a reset button and detailed analytics view, making it an effective tool for maintaining good posture in both home and office settings. This approach not only enhances individual wellbeing but also promotes a healthier workplace culture, reduces healthcare costs, and improves productivity.

3.2.1 SYSTEM ARCHITECTURE

The "Enhancing Ergonomics Posture Alert System" follows a detailed system architecture to ensure effective posture monitoring and correction. It begins with data acquisition, using a webcam to capture continuous video feeds of the user. These frames undergo preprocessing, including grayscale conversion and resizing, to prepare them for feature extraction. The system uses Histogram of Oriented Gradients (HOG) features to identify key posture related information from these frames. A pretrained Support Vector Machine (SVM) model then classifies the posture as either 'good' or 'bad'. If a bad posture is detected, the system immediately sends a notification to the user, prompting an adjustment. To prevent notification overload, there is a management mechanism to avoid repeated alerts within a short period. All posture detection events are logged into a JSON file, which is then analyzed over time. The system aggregates this data and presents it through detailed charts and graphs, offering insights into the user's ergonomic habits and posture health. The user friendly interface, with a sleek dark grey background and white and blue accents, includes features for detailed analytics views and reset functionality, making it a comprehensive tool for maintaining good posture in both home and office environments.

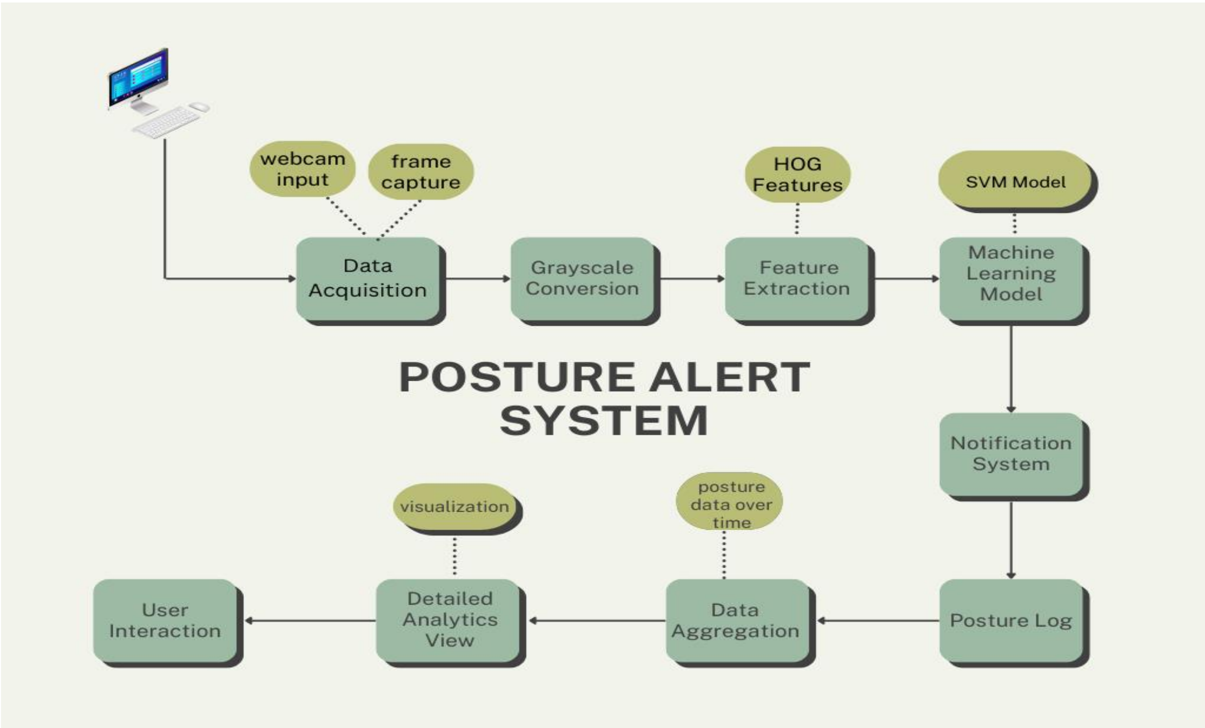

Fig 3.1 Architecture and workflow mechanism of the system

3.3 APPROACH USED

The System employs a multifaceted approach, combining advanced machine learning algorithms, computer vision techniques, and data analytics to deliver a comprehensive solution for realtime posture monitoring and correction. Using computer vision, the system captures and preprocesses images from a webcam, converting them to grayscale and resizing them for consistent feature extraction. The Histogram of Oriented Gradients (HOG) feature descriptor is then applied to extract essential posture related features. At the core of the system, a Support Vector Machine (SVM) model, trained on labeled posture images, accurately classifies postures as 'good' or 'bad'. Upon detecting a bad posture, a notification mechanism provides immediate feedback, prompting users to correct their posture. Additionally, the system logs posture data over time and employs visualization tools to present this data through intuitive charts and graphs, allowing users to track their ergonomic habits and identify patterns. The user interface, designed with a sleek dark grey background and white and blue accents, ensures ease of use and visual clarity. This holistic approach, integrating realtime feedback with comprehensive data analytics, promotes better ergonomic practices and improves overall posture health.

CHAPTER 4

THEORETICAL CONSIDERATIONS

4.1 HISTORICAL INTRODUCTION

The posture monitoring and correction systems have evolved significantly. Early methods relied heavily on manual observation and intervention, where supervisors or ergonomics experts would visually monitor employees to identify poor posture. This approach was labor intensive, subjective, and lacked consistency. Additionally, it offered no realtime feedback, making it difficult to correct posture promptly.

With the advent of technology, the focus shifted towards more automated solutions. Initial attempts included the use of simple wearable devices, such as lumbar rolls, posture correcting braces, and ergonomic chairs designed to encourage proper posture. These tools provided passive support but did not offer dynamic, realtime feedback. The introduction of sensors marked a significant advancement, with early systems using pressure sensors in chairs to detect slouching or poor seating posture. These systems, however, were often limited to specific environments and could not provide comprehensive monitoring across different activities and settings.

The integration of Internet of Things (IoT) technology further expanded the capabilities of posture monitoring systems. IoT enabled devices, equipped with various sensors such as accelerometers and gyroscopes, allowed for more accurate and continuous monitoring of body movements. These devices could be worn on different parts of the body to track posture in realtime, providing immediate alerts and feedback. Despite these advancements, early IoT based solutions often faced challenges related to data accuracy, battery life, and user comfort. Over time, improvements in sensor technology and machine learning algorithms have paved the way for more sophisticated and effective posture monitoring systems.

4.2 OVERVIEW OF POSTURE ALERT SYSTEM

The "Enhancing Ergonomics Posture Alert System" is a cutting edge solution designed to revolutionize posture monitoring and correction in both home and office environments. Leveraging state of heart technology, including advanced machine learning algorithms, computer vision techniques, and Internet of Things (IoT) integration, this system offers a comprehensive approach to promoting better workplace health and productivity.

At its core, the system utilizes a webcam to capture realtime video feeds of users' posture. These video streams are processed using sophisticated machine learning models trained on extensive datasets of posture images. By analyzing key features and patterns in the video data, the system can accurately classify the user's posture as either good or bad. This realtime posture monitoring capability forms the foundation of the system's functionality, enabling it to provide immediate feedback and alerts when poor posture is detected.

In addition to realtime monitoring, the system offers robust data analytics and visualization features. It logs posture data over time, allowing users to track their ergonomic habits and identify trends or patterns in their posture behavior. This data is presented through intuitive charts and graphs, including posture counts, trend analysis, and ergonomic scores. These visualization tools provide users with valuable insights into their posture habits, empowering them to make informed decisions and take proactive steps to improve their ergonomic health.

Furthermore, the system is designed with user convenience and accessibility in mind. The user interface features a sleek and modern design, with a dark grey background and contrasting white and blue accents for visual clarity. Easy access to key features such as the posture log, detailed analytics view, and reset functionality. This user centric design ensures that individuals of all levels of technical proficiency can easily utilize the system to monitor and enhance their posture habits.

Overall, the "Enhancing Ergonomics Posture Alert System" represents a significant advancement in posture monitoring technology, offering a comprehensive solution that combines real time feedback, data analytics, and user friendly design to promote better workplace health and productivity. By empowering users to take control of their posture habits and make informed decisions, this system has the potential to transform the way individuals approach ergonomic health and wellbeing in their daily lives.

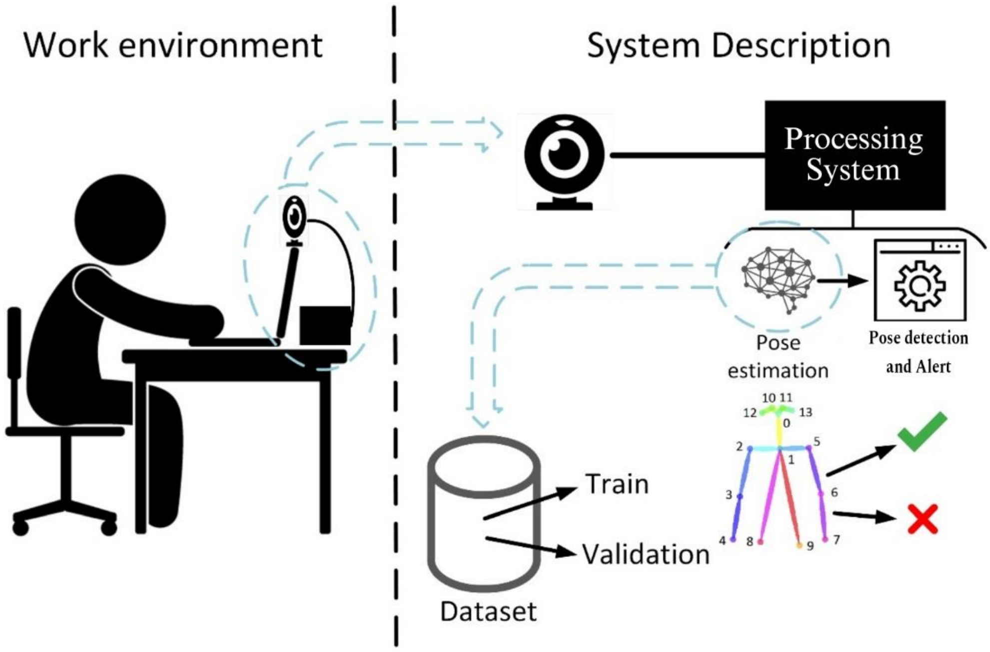

Fig.4.1 Overview of the Posture alert system

4.3 COMPONENTS

The "Enhancing Ergonomics Posture Alert System" consists of several key components that work together to provide an effective posture monitoring and correction solution. The primary component is the webcam, which captures video feeds of the user's posture. This video data is then processed by advanced machine learning algorithms and computer vision technology to detect and classify the posture as good or bad.

Another critical component is the posture detection model, which has been trained using a large dataset of posture images. This model uses features extracted from the video data to accurately predict the user's posture. The system also includes a notification mechanism that sends realtime alerts to the user when poor posture is detected. This ensures that the user receives immediate feedback and can make prompt adjustments to their posture.

The data analytics and visualization module is another essential component. It logs posture data over time and presents it in a user friendly manner through detailed charts and graphs. This module allows users to track their ergonomic habits, calculate their ergonomic score, and identify patterns in their posture behavior. The interface is designed for ease of use, with a sleek dark grey background and white and blue accents. The system also includes a reset button for the posture log and a detailed analytics view, making it a comprehensive tool for promoting and maintaining good ergonomic practices.

4.4 FEATURES

Introducing the array of features within our posture monitoring system, we embark on a journey to revolutionize workplace ergonomics. With a keen focus on user centric design and cutting edge technology, our system offers a suite of functionalities designed to enhance posture awareness, promote healthy habits, and elevate overall wellbeing.

At the core of our system lies realtime posture monitoring, enabled by advanced computer vision algorithms and intuitive alert mechanisms. Leveraging webcam technology, we provide users with instantaneous feedback on their posture, empowering them to make timely adjustments and maintain optimal alignment throughout their workday.

But our commitment to user empowerment extends beyond mere alerts. Through comprehensive data logging and analysis capabilities, users gain invaluable insights into their posture habits and trends over time. From detailed posture analytics to personalized recommendations, our system equips users with the knowledge and tools they need to proactively manage their ergonomic health.

Driven by a philosophy of customization and adaptability, our system puts users in the driver's seat. With customizable alert settings, personalized recommendations, and user friendly interface options, we strive to meet the unique needs and preferences of every individual, ensuring a tailored experience that fosters long term posture improvement and sustained wellbeing.

1. RealTime Posture Monitoring:

Using a webcam, the system continuously captures the user's posture in realtime.Sophisticated computer vision algorithms analyze these live video streams, discerning between good and bad posture based on key factors like body alignment and limb positioning.Instant feedback is relayed to the user upon detecting poor posture, nudging them to correct their stance promptly.

2. Intelligent Alert System:

In case of poor posture detection, the system promptly sends alerts to the user, apprising them of the issue and urging corrective measures.These alerts are user friendly, ensuring swift notification of posture related concerns as they arise.Customization options are available, allowing users to tailor alert settings based on their preferences and severity thresholds.

3. Data Logging and Analysis:

The system meticulously logs posture data over time, capturing posture classifications, timestamps, and user activities.Robust analytics tools enable users to visualize and scrutinize posture data, facilitating the tracking of posture habits and the identification of trends.Graphical representations, such as posture counts and trend analyses, furnish insights into posture behavior and overall ergonomic health.Historical data access empowers users to monitor progress, set goals, and make informed decisions regarding posture improvement strategies.

4. User Friendly Interface:

Sporting a modern and intuitive user interface, the system prioritizes ease of use and accessibility.Streamlined navigation permits seamless access to vital features like the posture log, detailed analytics view, and settings menu.Visual cues and indicators enhance usability, ensuring smooth interaction with the system.

5. Customization and Personalization:

Users wield the power to customize various facets of the system, including alert preferences, visualization settings, and notification parameters.Personalized recommendations and posture tips may be dispensed based on individual user profiles and behavioral patterns.Adapting to users' preferences and habits over time, the system optimizes the posture monitoring experience to cater to their distinct needs and inclinations.

These features collectively furnish a comprehensive posture monitoring solution, empowering users to foster healthy posture habits and cultivate a more ergonomic workplace ambiance through realtime feedback, actionable insights, and adaptable options.

CHAPTER 5

MODULE DESCRIPTION

5.1 DATA ACQUISITION AND PREPROCESSING MODULE

DATA ACQUISITION

This module is responsible for capturing realtime video data from the user's webcam. It continuously streams the video feed, ensuring that the system has uptodate visual information to analyze the user's posture. The data acquisition process involves interfacing with the webcam hardware, managing the video feed, and ensuring that the system is ready for further processing at any given moment.

PREPROCESSING

Once the video feed is captured, the preprocessing component takes over. The raw video data undergoes several enhancements to improve quality and reduce noise, making it suitable for analysis. Key preprocessing steps include:

Image Resizing: Adjusting the dimensions of the video frames to a standard size, ensuring consistency in feature extraction.

Grayscale Conversion: Converting the colored frames to grayscale to simplify the analysis and focus on structural features.

Noise Reduction: Applying filters to remove any unwanted noise or artifacts in the frames, ensuring clearer and more accurate feature extraction.

5.2 FEATURE EXTRACTION MODULE

This module is dedicated to extracting relevant features from the preprocessed images, which represent the user's posture. By utilizing advanced techniques such as Histogram of Oriented Gradients (HOG), the module captures critical spatial information and shape descriptors. The process involves:

Edge Detection: Identifying the edges and contours within the image to highlight key anatomical landmarks.

HOG Features: Extracting HOG features that describe the structure and orientation of

various parts of the body, which are crucial for accurate posture analysis.
Dimensionality Reduction: Reducing the complexity of the feature set while retaining essential information to ensure efficient and effective posture classification.

5.3 POSTURE CLASSIFICATION MODULE

This module employs machine learning algorithms to classify the user's posture as "good" or "bad" based on the extracted features. The steps involved include:
Model Training: Utilizing a dataset of labeled posture images to train a classification model. The training process involves learning the patterns and correlations between the features and the posture labels.
Realtime Prediction: Applying the trained model to the real time data to predict the user's posture continuously. The system uses the extracted features from the current frame to determine if the posture is good or bad.
Algorithm Optimization: Regularly updating and optimizing the machine learning algorithms to enhance accuracy and adapt to different users' postures.

5.4 ALERT GENERATION MODULE

This module is responsible for generating alerts when poor posture is detected. It provides multiple customizable notification methods to prompt users to adjust their posture:
Visual Alerts: Displaying onscreen notifications or changing the color of the interface to indicate bad posture.
Audio Alerts: Emitting sounds or alarms to draw the user's attention.
The module ensures that the notifications are timely and effective in encouraging users to correct their posture immediately.

5. 5 DATA LOGGING AND ANALYTICS MODULE

DATA LOGGING

This component logs the posture data over time, maintaining a comprehensive database of historical posture records. Each instance of good or bad posture is recorded with a timestamp, creating a detailed log of the user's posture habits.

ANALYTICS

The analytics component performs indepth analysis on the logged data to generate insights and reports. It includes:

Trend Analysis: Identifying patterns and trends in the user's posture over time, such as recurring times of bad posture.

Ergonomic Scores: Calculating scores that represent the user's overall posture health, based on the ratio of good to bad posture instances.

Visualization: Presenting the data in user friendly charts and graphs, such as posture counts, ergonomic scores, and time series plots, to help users understand their posture habits and progress.

5.6 USER INTERFACE MODULE

This module provides an intuitive and engaging dashboard for users to interact with the system. Key features include:

Real-time Alerts: Displaying immediate posture alerts and suggestions on the screen.

Personalized Analytics: Showing detailed analytics and visualizations of the user's posture data, allowing them to track their habits and improvements.

Customizable Settings: Offering options for users to customize notification methods, adjust alert thresholds, and set personal goals for posture improvement.

By integrating these six modules, the Enhancing Ergonomics Posture Alert System offers a comprehensive solution for real time posture monitoring, timely intervention, and detailed ergonomic analysis, ultimately promoting better health and productivity in the workplace.

CHAPTER 6

SYSTEM SPECIFICATION

6.1 HARDWARE REQUIREMENTS

- Processor – Intel i5 or Higher
- RAM – 4GB or Higher
- Storage – 150GB or Higher
- External webcam (optional)

6.2 SOFTWARE REQUIREMENTS

- Operating System – Windows / Mac / linux
- Programming language – Python 3.6 or later versions
- Python Libraries – OpenCV, NumPy, scikit-image, Scikitlearn, Joblib, MediaPipe, Plyer, Matplotlib, Seaborn, Tkinter, JSON, Threading.
- IDE – VSCode , PyCharm Or Jupyter.

CHAPTER 7

MODULE IMPLEMENTATION

The posture alert system represents a sophisticated application engineered to support users in maintaining optimal posture through continuous monitoring and dynamic feedback mechanisms. Comprising six meticulously designed modules, the system ensures a seamless user experience and robust functionality. At the core of the system, the Data Acquisition and Preprocessing module captures live video frames using a webcam, meticulously preprocessing them to enhance data quality and consistency. Subsequently, the Feature Extraction module employs advanced techniques such as Histogram of Oriented Gradients (HOG) and pose estimation to extract crucial features defining various postures accurately. Leveraging a trained machine learning model, the Posture Classification module swiftly categorizes user posture in real-time, facilitating prompt identification of poor posture. The Alert Generating module complements this by triggering customizable alerts, including desktop notifications and haptic feedback, to prompt immediate corrective action. Simultaneously, the Data Logging and Analytics module meticulously records posture data over time, providing users with insightful reports and visualizations to comprehend their posture habits and track progress effectively. Finally, the User Interface module ensures a user-friendly interaction by offering real-time feedback on posture status, an intuitive analytics dashboard, and customization options for personalized settings. Through seamless integration and thoughtful design, the posture alert system empowers users to cultivate healthier habits and enhance posture awareness effortlessly.

Fig 7.1 DFD Level 0

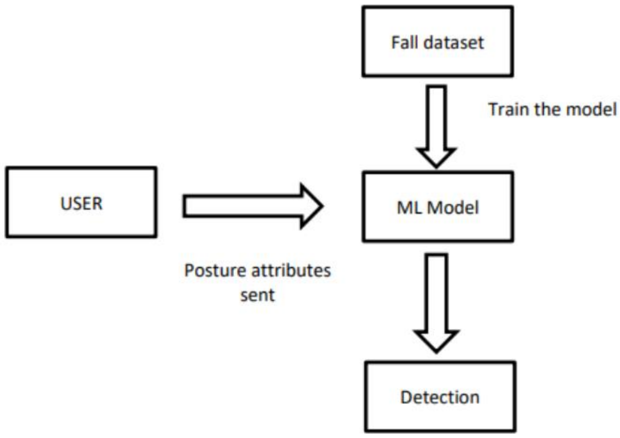

Fig 7.2 DFD Level 1

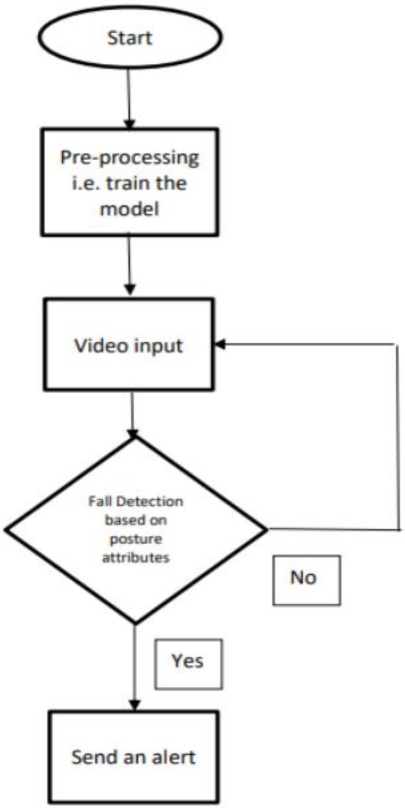

Fig 7.3 DFD Level 2

7.1 IMPLEMENTATION DETAILS

7.1.1 DATA ACQUISITION AND PREPROCESSING MODULE

In the Data Acquisition and Preprocessing module, the system initiates the posture monitoring process by utilizing a webcam to capture live video frames of the user's posture. This module is crucial as it sets the stage for subsequent analysis steps. Upon capturing the frames, the preprocessing steps ensure that the data is prepared optimally for analysis. Grayscale conversion reduces the complexity of the data while retaining vital structural information, making it easier for subsequent processing. Resizing the frames to a standard dimension ensures uniformity, facilitating consistent analysis across different frames. Normalization of pixel values enhances the performance of machine learning algorithms by standardizing the data range, thus improving the system's ability to accurately classify posture regardless of variations in lighting or camera settings. The efficiency of this module is paramount as it directly influences the accuracy and reliability of posture classification in the system.

Fig 7.4 Data acquisition and preprocess

7.1.2 FEATURE EXTRACTION MODULE

The Feature Extraction module is responsible for transforming preprocessed images into meaningful representations that are essential for posture analysis. By employing advanced techniques such as the Histogram of Oriented Gradients (HOG) method, the module detects edges and gradients within the images, thereby highlighting critical contours and shapes that define different postures. Additionally, sophisticated pose estimation techniques like MediaPipe are utilized to identify and map key body points such as shoulders, spine, and hips. These key points provide a detailed skeletal model of the user's posture, allowing for precise analysis. By accurately extracting and representing these features, this module significantly enhances the system's ability to differentiate between various postures, thus ensuring accurate posture classification.

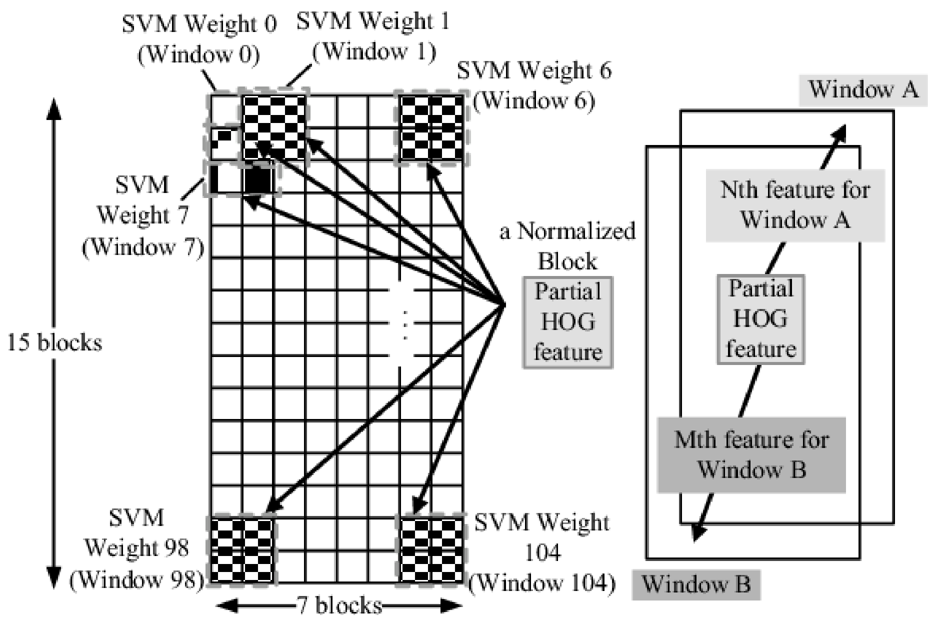

Fig 7.5 Feature Extraction – HOG Features

7.1.3 POSTURE CLASSIFICATION MODULE

The Posture Classification module is the core component responsible for determining whether the user's posture is good or bad based on the extracted features. This module employs a trained machine learning model that has been developed using a dataset of labeled posture images. During the training phase, the model learns to recognize patterns associated with different postures by analyzing the correlations between the extracted features and the corresponding posture labels. Once trained, the model is integrated into the system for real-time inference. As the system processes the live video feed, it continuously classifies the user's posture by comparing the extracted features against the learned patterns. This real-time classification enables the system to promptly identify poor posture and trigger corrective actions, thereby assisting the user in maintaining proper posture consistently.

7.1.4 ALERT GENERATING MODULE

Upon detecting poor posture, the Alert Generating module serves the critical function of notifying the user to make immediate corrections. This module employs a variety of alert mechanisms to ensure timely notification. Desktop notifications are a primary method, providing visual and auditory cues to attract the user's attention. Additionally, the system can integrate haptic feedback through vibration motors or buzzers for users who may not notice visual or auditory alerts. This flexibility in alert mechanisms and settings ensures that users are promptly notified of poor posture, encouraging them to make necessary adjustments to maintain good posture consistently.

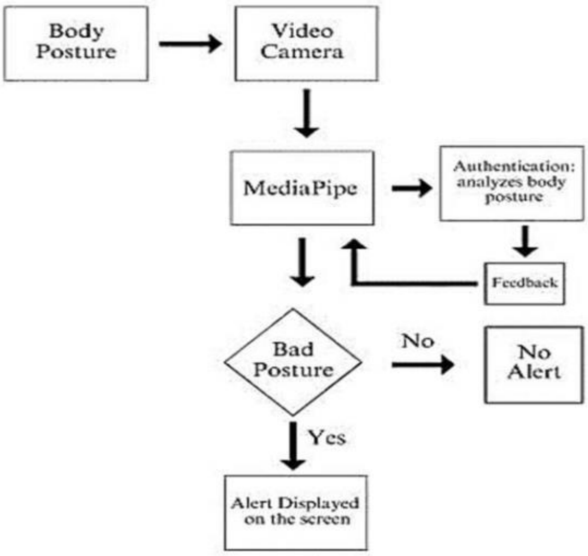

Fig 7.6 Work Flow of Alert Generation

7.1.5 DATA LOGGING AND ANALYTICS MODULE

The Data Logging and Analytics module play a crucial role in recording and analyzing the user's posture data over time, providing valuable insights into their posture habits. This module logs each posture classification along with timestamps, creating a detailed record of the user's posture history. The logged data is then analyzed to generate comprehensive reports, including posture frequency analysis, duration analysis, and trend analysis. These analytics help users understand their posture patterns, identify problematic habits, and track their progress over time. Visualizations such as graphs and charts make it easy for users to interpret the data, thereby empowering them to make informed decisions to improve their posture effectively.

7.1.6 USER INTERFACE MODULE

The User Interface module ensures that the system is user-friendly and accessible, providing a seamless experience for the user. This module includes a real-time feedback display, showing the current posture status on the screen so users can see immediate feedback and make necessary adjustments. The interface also features an analytics dashboard that presents detailed posture data and analytics in an easy-to-understand format. Users can access graphs, charts, and summaries that help them track their posture habits and progress. Customization options allow users to configure system settings, such as alert preferences and sensitivity levels, to suit their individual needs. Designed for ease of use, the interface ensures that users can easily engage with the system and benefit from its features.

CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENT

8.1 CONCLUSION

In conclusion, the posture alert system stands as a sophisticated and indispensable solution in combating the pervasive issue of poor posture prevalent in modern society. Through its amalgamation of cutting-edge technologies such as computer vision and machine learning, the system offers users a robust framework for maintaining optimal posture with ease. The modular design ensures seamless functionality across all components, from the initial data acquisition to the intuitive user interface. By harnessing modules like Data Acquisition and Preprocessing, Feature Extraction, Posture Classification, Alert Generation, Data Logging and Analytics, and the User Interface, the system provides users with a comprehensive toolkit for posture management. It empowers individuals with accurate posture analysis, timely alerts, insightful analytics, and an intuitive interface to foster awareness and encourage positive behavioral changes.

8.2 FUTURE ENHANCEMENT

Enhancing the features of the posture alert system presents an opportunity to further elevate its effectiveness and user engagement. One avenue for improvement lies in enhancing accuracy through continual refinement of machine learning algorithms and feature extraction techniques. By fine-tuning these algorithms, the system can achieve higher levels of precision in posture classification, ensuring more reliable feedback to users. Moreover, expanding the repertoire of recognized postures beyond basic classifications like "good" and "bad" posture can offer users more nuanced insights into their posture habits. Introducing specific classifications for different types of slouching or leaning, for instance, can provide more targeted feedback, fostering greater awareness and facilitating corrective action.

Adaptive alerting mechanisms represent another avenue for feature enhancement. By incorporating factors such as user fatigue, work intensity, and individual posture habits, the system can tailor alert notifications to each user's unique circumstances. This personalized approach not only increases the relevance of alerts but also enhances user engagement by acknowledging and accommodating individual needs and preferences.Integrating the system with wearable devices represents a significant enhancement that can enhance the user experience. By leveraging data from devices such as smartwatches or posture correction devices, the system can provide real-time feedback and encouragement throughout the day. This seamless integration offers users a more holistic approach to posture management, integrating into their daily routines and promoting continuous awareness and improvement.

Furthermore, offering customizable analytics dashboards empowers users to personalize their posture tracking experience according to their preferences and goals. By allowing users to customize metrics, charts, and insights, the system can provide a more tailored and relevant analysis of their posture habits. This customization enhances user understanding and facilitates informed decision-making, empowering individuals to take proactive steps towards improving their posture and overall well-being.Incorporating integration with existing health platforms represents a final enhancement that can further enhance the system's utility and value. By seamlessly integrating with platforms and applications focused on health and wellness, the posture alert system can become an integral part of users' overall health management strategy. This integration enables users to leverage the system's posture management capabilities in conjunction with other health-related activities, fostering holistic well-being and promoting sustainable lifestyle changes.

APPENDIX A (SOURCE CODE)

Sample code

train.py

```
import os
import cv2
import numpy as np
from skimage.feature import hog
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import classification_report, accuracy_score,
confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
import joblib
import warnings

warnings.filterwarnings('ignore')

# Function to preprocess images
def preprocess_image(img_path):
    image = cv2.imread(img_path)
    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    resized = cv2.resize(gray, (128, 128))
    return resized

# Function to display images
def display_images(images, labels, categories, title, num_images=10):
    plt.figure(figsize=(10, 10))
    for i in range(min(num_images, len(images))):
        plt.subplot(5, 5, i + 1)
        plt.imshow(images[i], cmap='gray')
        plt.title(categories[labels[i]])
        plt.axis('off')
    plt.suptitle(title)
    plt.show()

# Directory paths
data_dir = 'A:/code/Dp2/Posture-Detector/postures'
categories = ['bad', 'good']
images = []
labels = []
```

```
# Load images and labels
for category in categories:
    path = os.path.join(data_dir, category)
    label = categories.index(category)
    for img_name in os.listdir(path):
        img_path = os.path.join(path, img_name)
        image = preprocess_image(img_path)
        images.append(image)
        labels.append(label)

# Convert lists to numpy arrays
X = np.array(images)
y = np.array(labels)

# Extract HOG features
hog_features = []
for img in X:
    fd = hog(img, orientations=8, pixels_per_cell=(16, 16),
cells_per_block=(1, 1), visualize=False)
    hog_features.append(fd)

X_features = np.array(hog_features)

# Split the data into training and validation sets
X_train, X_valid, y_train, y_valid = train_test_split(X_features, y,
test_size=0.2, random_state=42)

# Display sample training images (original images)
display_images(X[np.isin(y, y_train)][:25], y[np.isin(y, y_train)][:25],
categories, "Sample Training Images")

# Display sample validation images (original images)
display_images(X[np.isin(y, y_valid)][:25], y[np.isin(y, y_valid)][:25],
categories, "Sample Validation Images")

# Train the SVM model
svm_model = SVC(kernel='linear')
svm_model.fit(X_train, y_train)

# Evaluate the model
y_pred = svm_model.predict(X_valid)
accuracy = accuracy_score(y_valid, y_pred)
print("SVM Model Accuracy:", accuracy)
print("Classification Report:")
print(classification_report(y_valid, y_pred))
```

```
# Plot Confusion Matrix
cm = confusion_matrix(y_valid, y_pred)
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=categories,
yticklabels=categories)
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()

# Save the model
model_filename = 'posture_detector_model.pkl'
joblib.dump(svm_model, model_filename)
print(f"Model saved as '{model_filename}'")
```

detector.py

```
import cv2
import numpy as np
from plyer import notification
import threading
from joblib import load
import mediapipe as mp
from skimage.feature import hog
import time
import json

# Load the MediaPipe Pose model
mp_pose = mp.solutions.pose
mp_drawing = mp.solutions.drawing_utils

# Load posture detection model
posture_model = load('posture_detector_model.pkl')

# Function to preprocess image
def preprocess_image(image):
    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    resized = cv2.resize(gray, (128, 128))
    return resized

# Function to send notification for bad posture
def notify():
    notification.notify(
        title='Posture Notification',
        message='Your current posture is BAD, Please Fix!',
```

```
        app_icon=None,
        timeout=10
    )

# Function to reset the notification flag after a timeout
def reset_notification_flag():
    global send_notification
    send_notification = False

# Initialize notification flag and time tracker
send_notification = False
bad_posture_start_time = None
bad_posture_duration_threshold = 5  # seconds

# Log file path
log_file_path = 'posture_log.json'

# Initialize posture log
posture_log = []

# Function to log posture data
def log_posture(posture_value):
    global posture_log
    timestamp = time.time()
    posture_log.append({'timestamp': timestamp, 'posture': posture_value})
    # Save the log to a file
    with open(log_file_path, 'w') as log_file:
        json.dump(posture_log, log_file)

# Function to start posture detection
def startPostureDetection():
    global send_notification, bad_posture_start_time

    # Initialize camera
    cap = cv2.VideoCapture(0)

    with mp_pose.Pose(min_detection_confidence=0.5, min_tracking_confidence=0.5)
as pose:
        while cap.isOpened():
            ret, frame = cap.read()
            if not ret:
                print("Cannot receive frame (stream end?). Exiting ...")
                break

            # Preprocess frame
            preprocessed_frame = preprocess_image(frame)
```

```
        # Extract HOG features
        fd = hog(preprocessed_frame, orientations=8, pixels_per_cell=(16, 16),
cells_per_block=(1, 1), visualize=False)

        # Predict posture
        prediction = posture_model.predict(fd.reshape(1, -1))
        posture_value = "bad" if prediction == 0 else "good"

        # Log posture data
        log_posture(posture_value)

        # Set font and text properties
        font = cv2.FONT_HERSHEY_SIMPLEX
        font_scale = 1
        font_color = (0, 0, 255) if posture_value == "bad" else (0, 255, 0)

        # Check for bad posture and send notification if detected
        current_time = time.time()
        if posture_value == 'bad':
            if bad_posture_start_time is None:
                bad_posture_start_time = current_time
            elif (current_time - bad_posture_start_time >=
bad_posture_duration_threshold) and not send_notification:
                notify()
                send_notification = True
                threading.Timer(bad_posture_duration_threshold,
reset_notification_flag).start()
        else:
            bad_posture_start_time = None

        # Overlay the predicted posture text on the frame
        cv2.putText(frame, f"Posture: {posture_value}", (10, 30), font, font_scale,
font_color, 2)

        # Convert the frame to RGB for landmark detection
        rgb_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)

        # Detect landmarks
        results = pose.process(rgb_frame)

        # Draw Pose landmarks on the frame
        if results.pose_landmarks:
            mp_drawing.draw_landmarks(image=frame,
landmark_list=results.pose_landmarks,
connections=mp_pose.POSE_CONNECTIONS)
```

```
        # Display the frame with the predicted posture and landmarks
        cv2.imshow('Posture Detection', frame)

        # Check for user input to quit the loop
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    # Release the camera
    cap.release()
    cv2.destroyAllWindows()

# Start posture detection
startPostureDetection()
```

analytics.py

```
import json
import time
import threading
import tkinter as tk
from tkinter import ttk, messagebox
import matplotlib.pyplot as plt
import seaborn as sns
from matplotlib.backends.backend_tkagg import FigureCanvasTkAgg
import pandas as pd
from matplotlib import animation

log_file_path = 'posture_log.json'

# Function to calculate ergonomic score
def calculate_ergonomic_score(posture_log, window_size=86400):  # 24 hours
window
    current_time = time.time()
    window_start_time = current_time - window_size
    windowed_log = [entry for entry in posture_log if entry['timestamp'] >=
window_start_time]
    if not windowed_log:
        return 100  # No data means no bad posture detected
    bad_posture_count = sum(1 for entry in windowed_log if entry['posture'] == 'bad')
    good_posture_count = len(windowed_log) - bad_posture_count
    score = (good_posture_count / len(windowed_log)) * 100
    return score

# Function to update the plot
def update_plot(frame, fig, ax1, ax2):
```

```
    try:
        with open(log_file_path, 'r') as log_file:
            posture_log = json.load(log_file)
    except (FileNotFoundError, json.JSONDecodeError):
        posture_log = []

    timestamps = [entry['timestamp'] for entry in posture_log]
    postures = [entry['posture'] for entry in posture_log]
    ergonomic_score = calculate_ergonomic_score(posture_log)

    # Update the small widget score display
    score_label.config(text=f"Ergonomic Score: {ergonomic_score:.2f}%")

    # Clear the axes
    ax1.clear()
    ax2.clear()

    # Plot the posture counts
    df = pd.DataFrame({'Timestamp': timestamps, 'Posture': postures})
    sns.countplot(x='Posture', data=df, order=['good', 'bad'], palette={'good': '#1E90FF',
'bad': '#FFFFFF'}, ax=ax1)
    ax1.set_title('Posture Counts', fontsize=14, color='white')
    ax1.set_xlabel('Posture', fontsize=12, color='white')
    ax1.set_ylabel('Count', fontsize=12, color='white')
    ax1.set_facecolor('#333333')  # Dark grey background for ax1
    ax1.tick_params(colors='white')

    # Plot the ergonomic score
    labels = ['Good Posture', 'Bad Posture']
    sizes = [ergonomic_score, 100 - ergonomic_score]
    colors = ['#1E90FF', '#FFFFFF']  # Darker blue for good, white for bad
    ax2.pie(sizes, labels=labels, colors=colors, autopct='%1.1f%%', startangle=140,
textprops={'color': 'white', 'fontsize': 12},
            wedgeprops={'edgecolor': 'black'})  # Add black border to pie chart
    ax2.set_title('Ergonomic Score', fontsize=14, color='white')
    ax2.set_facecolor('#333333')  # Dark grey background for ax2

# Function to reset the posture log
def reset_posture_log():
    with open(log_file_path, 'w') as log_file:
        json.dump([], log_file)
    update_plot(None, fig, ax1, ax2)
    messagebox.showinfo("Reset Score", "Ergonomic score has been reset for the
current session.")

# Function to show detailed analytics
```

```
def show_analytics():
    analytics_window = tk.Toplevel(root)
    analytics_window.title("Posture Analytics")
    analytics_window.configure(bg='#333333')  # Dark grey background

    # Create a figure and axes for plotting
    global fig, ax1, ax2
    fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 6))  # ax1 for bar chart on the left,
ax2 for pie chart on the right
    fig.patch.set_facecolor('#333333')  # Match background color
    fig.tight_layout(pad=4.0)
    canvas = FigureCanvasTkAgg(fig, master=analytics_window)
    canvas.get_tk_widget().pack(side=tk.TOP, fill=tk.BOTH, expand=1)
    reset_button = ttk.Button(analytics_window, text="Reset Score",
command=reset_posture_log, style='TButton')
    reset_button.pack(side=tk.BOTTOM, pady=10)
    ani = animation.FuncAnimation(fig, update_plot, fargs=(fig, ax1, ax2),
interval=1000, cache_frame_data=False)
    analytics_window.mainloop()

# Initialize the main application window
root = tk.Tk()
root.title("Posture Score Widget")

# Set up the style
style = ttk.Style()
style.configure('TButton', font=('Helvetica', 12, 'bold'), foreground='#1E90FF',
background='#2196F3', borderwidth=0)  # Blue buttons
style.map('TButton', background=[('active', '#1976D2')])
style.configure('TLabel', font=('Helvetica', 16, 'bold'), background='#333333',
foreground='white')

# Create a frame for the top bar with dark grey background
top_frame = tk.Frame(root, bg='#333333', height=30)
top_frame.pack(fill=tk.X, side=tk.TOP)

# Create a frame for the main content with dark grey background
main_frame = tk.Frame(root, bg='#333333')
main_frame.pack(fill=tk.BOTH, expand=True)

# Small widget to display ergonomic score
score_label = ttk.Label(main_frame, text="Ergonomic Score: Calculating...",
style='TLabel')
score_label.pack(pady=20)
detail_button = ttk.Button(main_frame, text="Show Details",
command=show_analytics, style='TButton')
```

```
detail_button.pack(pady=10)

# Configure the window size and appearance
root.geometry('300x150')
root.resizable(False, False)

# Run the application
root.mainloop()
```

APPENDIX B (SCREENSHOTS)

OUTPUT:

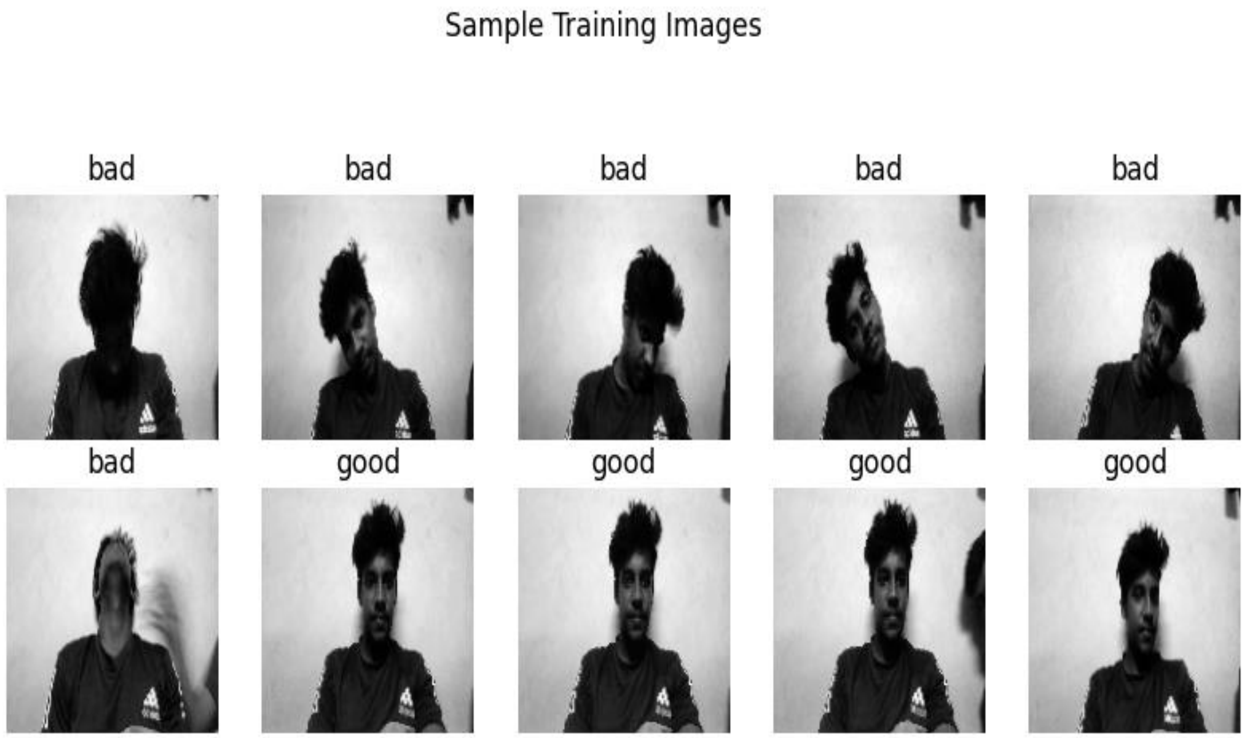

Fig B.1 Sample Training Images

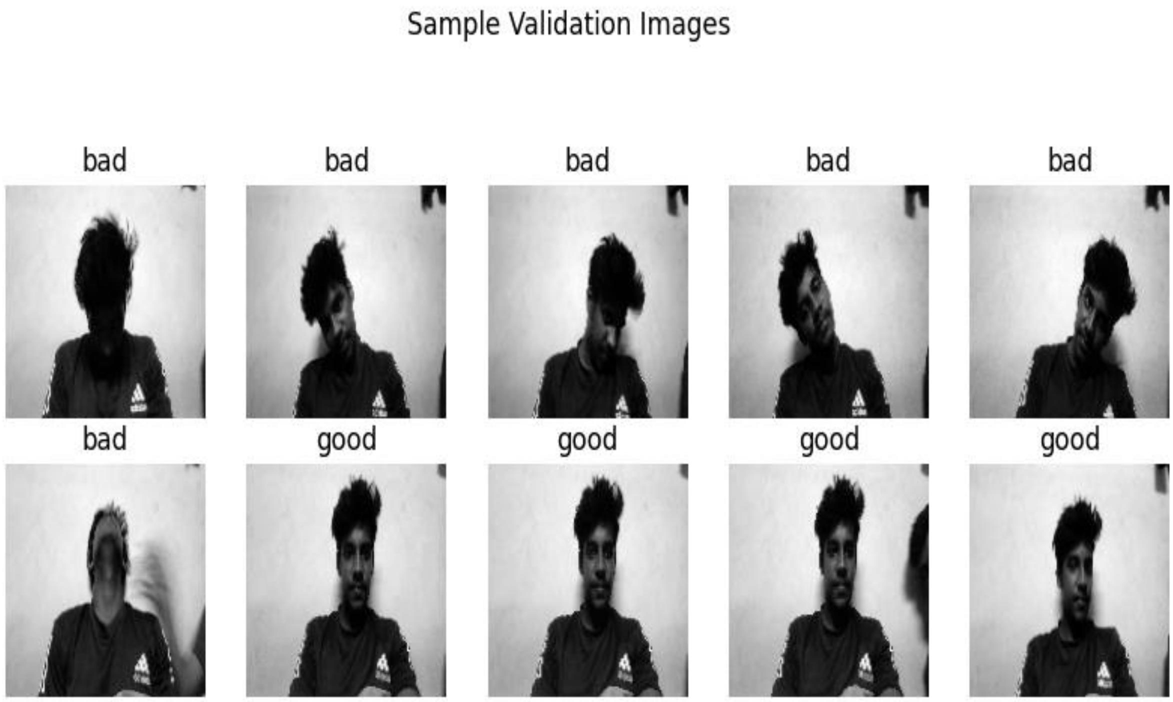

Fig B.2 Sample Validation Images

Fig B.3 Detecting Good Posture

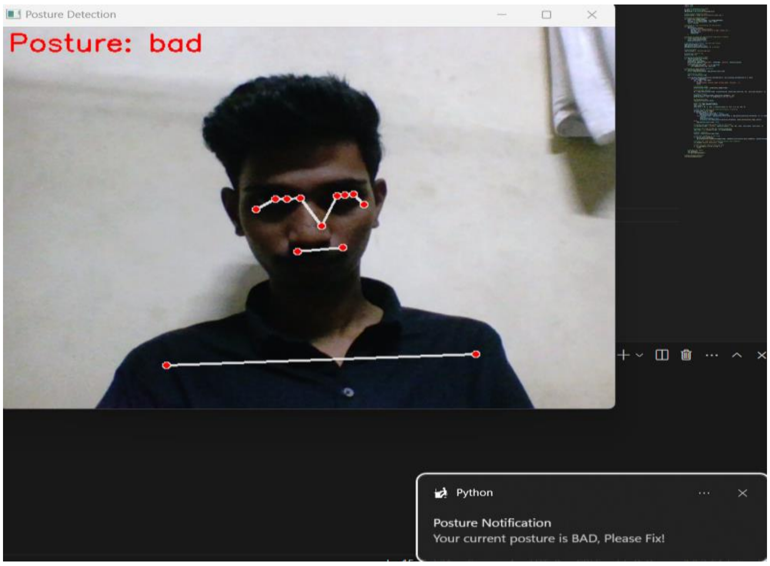

Fig B.4 Detecting Bad Posture with Notification

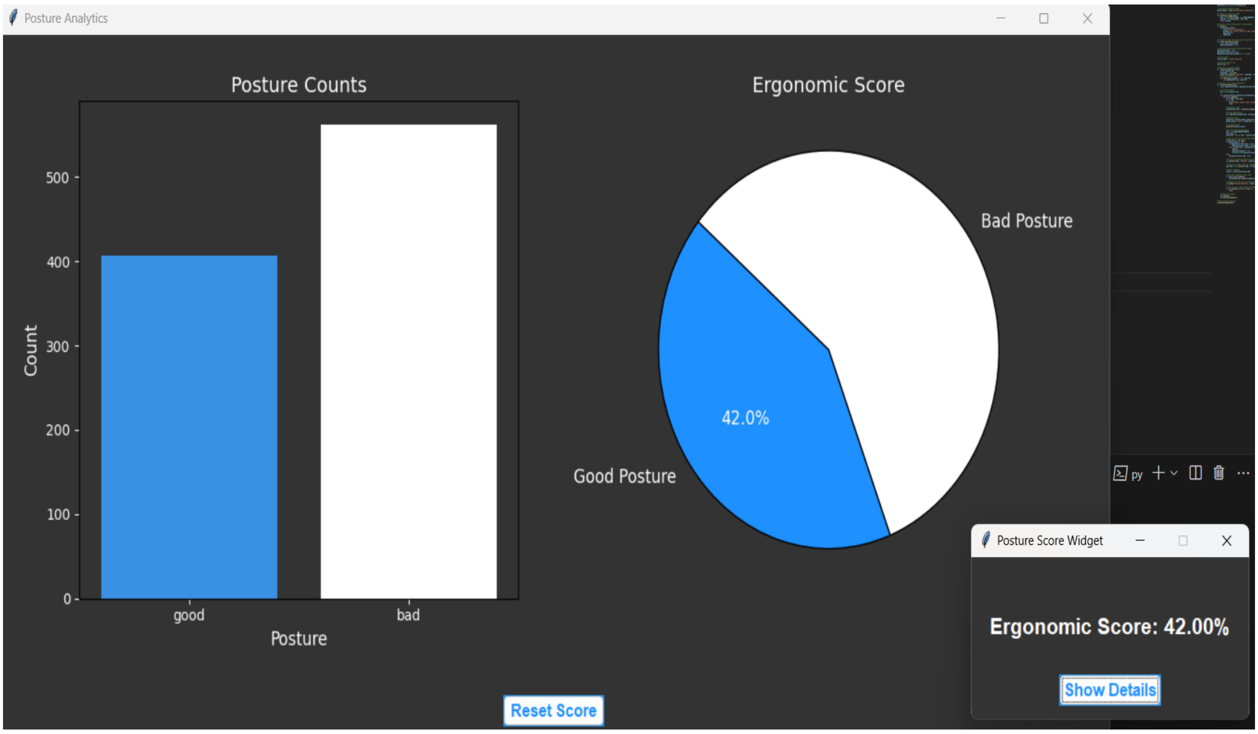

Fig B.5 Data Analytics – Ergonomic score

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