

Smart Yoga Mat

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Abstract: *This project presents a Smart Yoga Mat that helps users practice yoga safely without a trainer. It uses a webcam with computer vision (MediaPipe and OpenCV) to track body posture and sensors to detect pressure. An Arduino system gives real-time feedback through audio, vibration, and buzzer alerts when postures are incorrect. The system improves accuracy, reduces injury risk, and acts as an affordable, user-friendly virtual yoga guide for home and professional use*

Keywords: Arduino Uno, Flex Sensor, Buzzer, Vibrator, Mediapipe, OpenCV

I. INTRODUCTION

Yoga is widely practiced for improving physical and mental health. Many people now prefer doing yoga at home using online videos. However, lack of proper guidance can lead to incorrect postures and injuries. Without a trainer, users may not realize their mistakes. Recent technologies like AI, computer vision, and IoT help solve this problem. Tools like MediaPipe and OpenCV can track body movements in real time. Sensors can measure pressure and body alignment. A Smart Yoga Mat uses these technologies to act as a virtual instructor. It provides instant feedback, making yoga practice safer and more effective.

II. LITERATURE REVIEW

Liangqi Yuan (2025): Developed a smart pressure mat using Velostat sensors and deep learning for posture detection. It is flexible and low-cost but faces issues like noise and sensor inaccuracy.

Dan Han (2022): Designed a yoga mat for visually impaired users using tactile feedback. It improves accessibility but lacks advanced real-time correction and is complex to implement.

Sika K. (2025): Proposed an AI-based yoga mat using MediaPipe, OpenCV, and sensors with real-time feedback. It achieves high accuracy but depends on camera quality and lighting.

Wei Sun (2021): Introduced an RFID-based yoga mat system with CNN for posture detection. It ensures privacy but requires special hardware and may face signal interference.

III. PROBLEM STATEMENT

Many people practice yoga at home without an instructor, which increases the chances of doing poses incorrectly. Existing systems mostly use cameras for pose detection and they do not check important factors such as body pressure. This can lead to poor posture, reduced benefits of yoga, and even injuries. Therefore, we proposed a smart yoga mat that combines computer vision with sensors to give real-time, accurate, safe and audio based feedback mechanism to users.

IV. PROPOSED SYSTEM OVERVIEW

The proposed system is a Smart Yoga Mat that combines computer vision and sensor technology to monitor yoga postures in real time. It uses MediaPipe and OpenCV to track body movements through a webcam and sensors to detect pressure. An Arduino processes the data and provides instant feedback through audio, vibration, and buzzer alerts. The system acts as a virtual instructor, helping users correct their posture and practice yoga safely and effectively.



V. SYSTEM ARCHITECTURE

Part A)

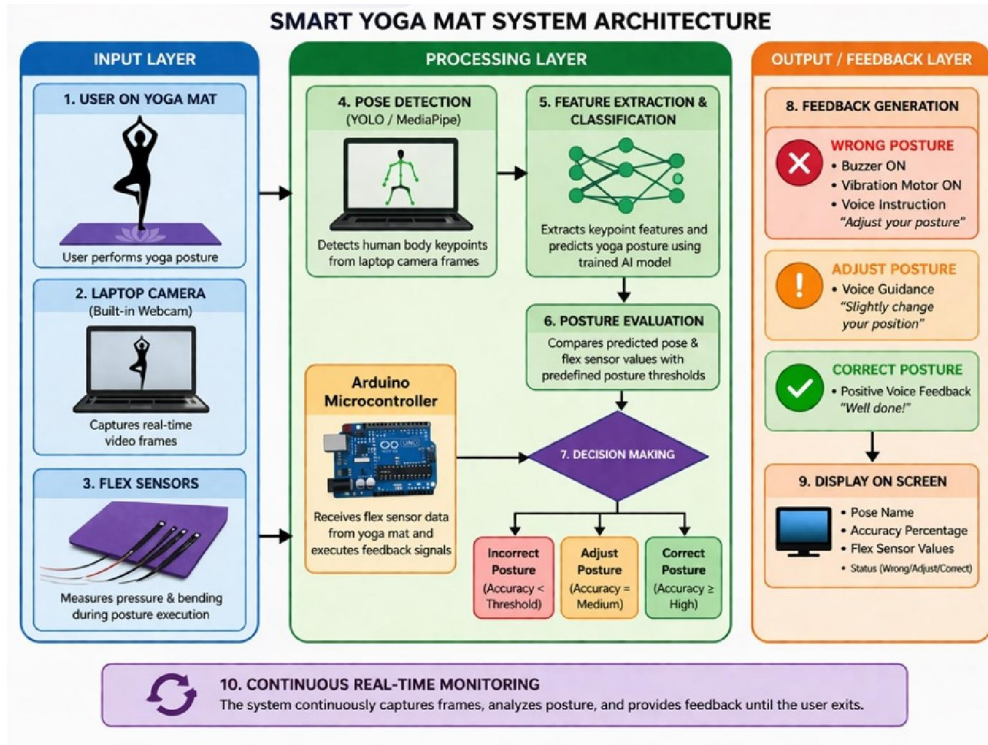


Fig. A) System Architecture Part A)

Part B)

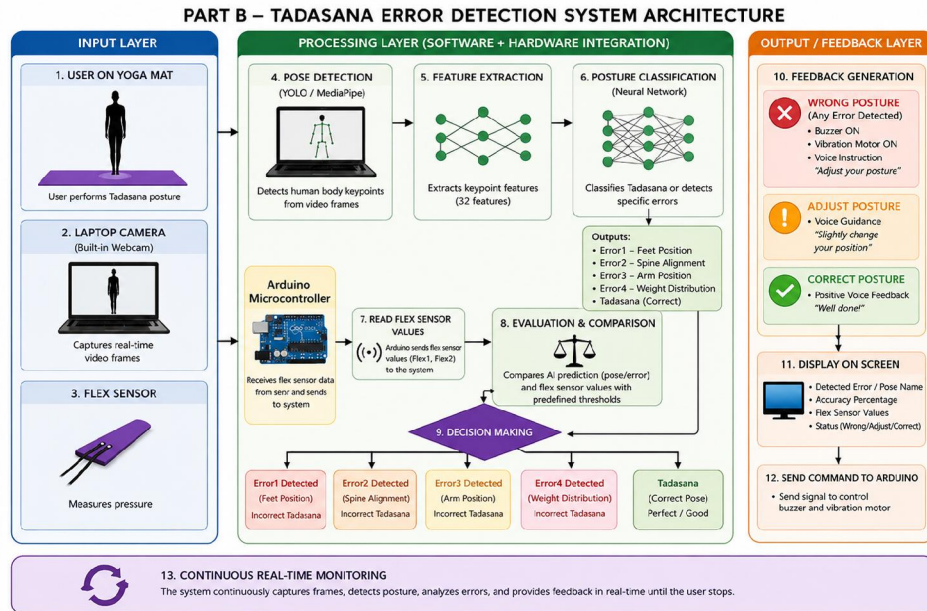


Fig. A) System Architecture Part B)



VI. SYSTEM ARCHITECTURE OVERVIEW

Part A)

The Smart Yoga Mat System is an intelligent posture monitoring solution that integrates computer vision, sensor technology, and machine learning to assist users during yoga practice. The system begins with the input layer, where a webcam captures real-time video of the user while flex sensors collect pressure and bending data. These combined inputs provide both visual and physical information about the user's posture, enabling more accurate analysis of yoga positions.

In the processing layer, pose detection algorithms such as YOLO or MediaPipe are used to identify body keypoints from the video frames. The extracted features are then passed to a trained classification model that recognizes the specific yoga pose being performed. At the same time, an Arduino microcontroller processes the flex sensor data to provide additional insights into body alignment and pressure distribution. Both visual and sensor data are compared against predefined posture thresholds to evaluate the accuracy of the pose.

Based on this evaluation, a decision-making module categorizes the posture as correct, incorrect, or needing adjustment. The output layer then delivers real-time feedback to the user through visual display, voice guidance, or haptic alerts such as vibration or buzzer signals. The system operates in a continuous loop, ensuring ongoing monitoring and immediate corrective feedback to help users improve their yoga practice effectively.

Part B)

The system starts with the input layer, where the user performs the Tadasana yoga pose on the mat. A webcam captures real-time video of the user, while flex sensors collect data about pressure and bending. These inputs provide both visual and physical information about the user's posture.

In the processing layer, the captured video is analyzed using pose detection models like YOLO or MediaPipe to identify body keypoints. These keypoints are then used to extract important features, which are passed to a neural network model to classify the posture or detect specific errors. At the same time, the Arduino microcontroller reads data from the flex sensors. Both the visual data and sensor data are compared with predefined posture standards to evaluate accuracy.

Finally, in the output layer, the system decides whether the posture is correct or if there are errors such as wrong feet position, spine alignment, arm position. Based on this, feedback is given to the user through voice instructions, buzzer or vibration alerts, and display on the screen. The system runs continuously, providing real-time monitoring and helping the user improve their posture step by step.

VII. IMPLEMENTATION DETAILS

A. Hardware Implementation

The hardware part includes a webcam, flex sensors, Arduino microcontroller, and a yoga mat setup. The webcam is used to capture the user's real-time body movements during yoga poses. Flex sensors detect pressure and bending patterns of the user's body. The Arduino board collects data from the flex sensors and sends it to the system for processing.

B. Software Implementation

The software part includes Python programming, OpenCV, MediaPipe/YOLO, and a machine learning model. OpenCV is used for video processing, while MediaPipe or YOLO detects human body keypoints from the live video feed. A trained machine learning model classifies the yoga pose based on extracted features. Arduino IDE is used to program the microcontroller for reading sensor values. The system also includes a user interface that displays posture name, accuracy, and feedback messages.



C. Working

User performs yoga pose on mat → Webcam captures live video → Pose detection model identifies body keypoints → Flex sensors collect pressure data from mat → Both visual + sensor data are combined → System compares data with predefined posture standards → Posture accuracy is calculated (Correct / Incorrect / Needs Adjustment) → Feedback is generated (voice alert / vibration / screen display)

D. Outcomes

Accurate detection of yoga poses in real time, Immediate feedback for posture correction, Improved yoga practice and body alignment.

E. Challenges

Difficulty in accurate pose detection in low lighting conditions, Delay in real-time processing due to heavy computation, Limited accuracy if user is partially out of camera frame.

F. Summary

The Smart Yoga Mat System is an AI-based fitness tool that uses a camera and flex sensors to detect yoga posture and provide real-time feedback. It helps users improve their posture accuracy and enhances yoga practice in a simple and interactive way.

TABLE I: TECHNOLOGY STACK USED IN PROPOSED SYSTEM

Layer	Technology	Purpose
Input Layer	Webcam (Camera)	Captures real-time video of user performing yoga poses
Input Layer	Flex Sensors	Measures pressure and bending
Hardware Layer	Arduino Microcontroller	Collects sensor data and sends it to the system
Processing Layer	Python	Core programming for system integration and logic
Processing Layer	OpenCV	Processes video frames for pose detection
Processing Layer	MediaPipe / YOLO	Detects human body keypoints for posture analysis
Processing Layer	Machine Learning Model	Classifies yoga poses and evaluates accuracy
Processing Layer	NumPy / Pandas	Handles data processing and numerical calculations
Output Layer	Tkinter / Web UI	Displays posture status and feedback to user
Output Layer	Text-to-Speech (TTS)	Provides voice feedback for correction
Output Layer	Buzzer / Vibration Motor	Gives haptic feedback for incorrect posture

VIII. EXPERIMENTAL RESULT AND ANALYSIS

The proposed Smart Yoga Mat System was tested in a controlled environment to evaluate its performance in terms of accuracy, response time, and reliability. Different yoga poses such as Tree Pose, and Warrior Pose and Tadasan were performed during testing to analyze posture detection and feedback efficiency.

Experimental Setup

The Smart Yoga Mat System was tested in an indoor environment with controlled lighting conditions. A webcam was placed at a fixed distance to capture the full body of the user during yoga practice. Flex sensors detect pressure and



bending patterns. The system was implemented using Python with OpenCV and MediaPipe/YOLO for pose detection, while an Arduino microcontroller was used to collect and transmit sensor data. A small dataset of common yoga poses (such as Tree Pose, Warrior Pose and Tadasana) was used to train and test the classification model. Multiple users performed each pose several times to evaluate system performance.

Result

The system was able to successfully detect and classify yoga poses in real time. The combination of camera-based detection and sensor data improved overall accuracy compared to using only one method. The system provided instant feedback indicating whether the posture was correct, incorrect, or needed adjustment. In well-lit conditions, pose detection accuracy was high, and feedback was delivered with minimal delay.

Result

The overall performance of the system was satisfactory. The pose detection model showed good accuracy under proper lighting and correct camera positioning. The addition of flex sensor data increased reliability, especially in cases where the camera view was partially obstructed. However, some limitations were observed. Accuracy decreased in low-light conditions or when the user was not fully visible in the frame. There was also a slight delay in processing due to continuous video and sensor data handling. Sensor accuracy depended on correct placement and calibration. Despite these issues, the system maintained consistent performance for most standard yoga poses.

Summary

The experimental results show that the Smart Yoga Mat System is effective in detecting yoga poses and providing real-time feedback. The integration of vision and sensor data improves accuracy and user experience. Although there are minor challenges like lighting sensitivity and processing delay, the system performs well overall and has strong potential for practical applications in fitness and rehabilitation.

RESULT AND DISCUSSION

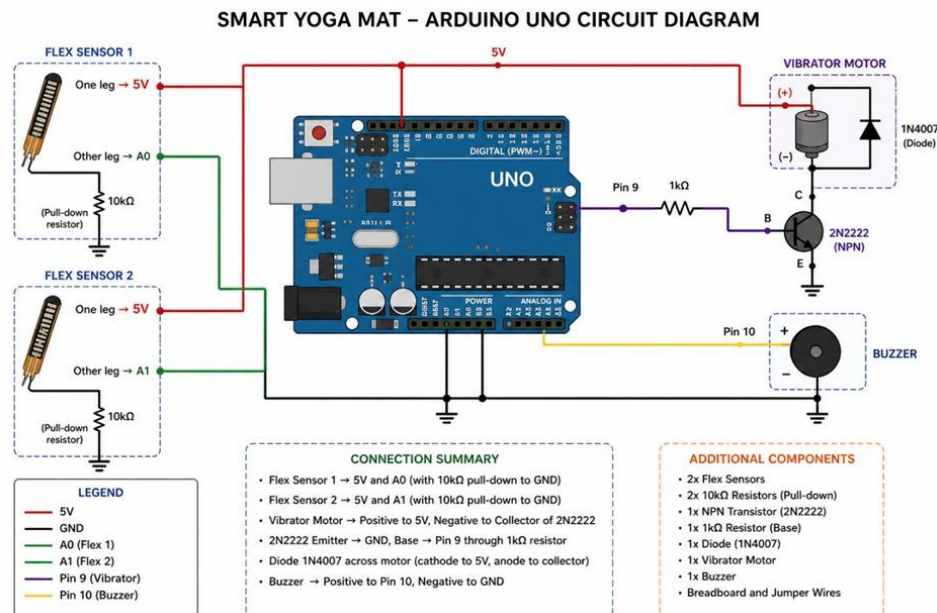


Fig.A) Circuit Diagram



Flex Sensors (2): These sensors are connected to pins A0 and A1. They detect pressure from the user's body on the mat. A 10kΩ resistor is used for stable readings.

Arduino UNO: It is the main controller. It reads sensor values and decides whether the posture is correct or not.

Vibration Motor: Connected through a 2N2222 transistor (for switching). If posture is wrong, the motor vibrates to alert the user.

Buzzer: Connected to Pin 10. It gives a sound alert when an error is detected.

Diode (1N4007): Protects the circuit from back current generated by the motor.

Working:

Sensors detect pressure → Arduino processes data → If posture is wrong → Buzzer + vibration motor alert the user.

The results demonstrate that the system can accurately detect and evaluate the **Tree Pose** in real time using AI. At lower accuracy (around 59.5%), the system identifies the posture as incorrect and provides corrective feedback to adjust the pose. When the accuracy improves to a moderate level (around 73.9%), it recognizes that the posture is partially correct and guides the user for further improvement. Finally, at high accuracy (around 99.9%), the system confirms a perfect posture and provides positive feedback, showing that the user has achieved the correct alignment successfully.

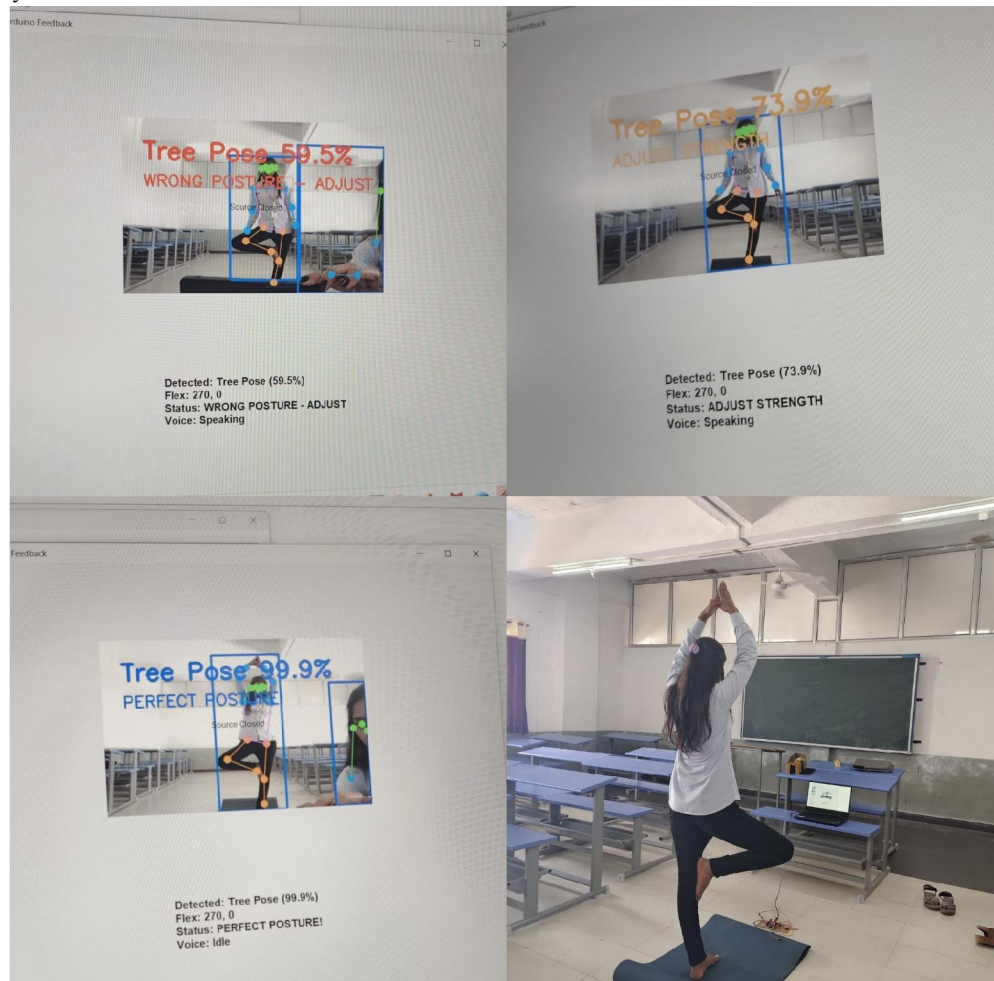


Figure B) Tree Pose



The results show that the system successfully detects and evaluates the **Warrior II pose** in real time using AI. At lower accuracy (around 57.7%), the system identifies the posture as incorrect and provides adjustment guidance to improve alignment. As the accuracy increases to a moderate level (around 65.3%), it indicates that the posture needs improvement and suggests strengthening and better positioning. Finally, at high accuracy (around 99.9%), the system confirms a perfect posture and provides positive feedback, demonstrating that the user has achieved the correct form successfully.



Fig. D) Extended Triangle Pose

The results show that the system accurately detects and evaluates the **Extended Triangle Pose** in real time using AI. At lower accuracy (around 54%), the system identifies the posture as incorrect and provides corrective guidance. When the accuracy improves to a moderate level (around 67.7%), it indicates that the posture needs adjustment and suggests better alignment. Finally, at high accuracy (100%), the system confirms a perfect posture and provides positive feedback, showing that the pose is performed correctly.





Fig. E) Goddess Pose

The results show that the system effectively detects and evaluates the **Goddess Pose** in real time using AI. At lower accuracy (around 44.4%), the system identifies the posture as incorrect and provides guidance to correct the pose. When the accuracy improves to a moderate level (around 65.5%), it indicates that the posture needs adjustment and suggests improvements in alignment and stability. Finally, at higher accuracy (around 81.1%), the system recognizes a correct posture and provides positive feedback, confirming that the user is performing the pose properly.

IX. DISCUSSION

The Smart Yoga Mat System shows that combining a camera (computer vision) with sensors (flex sensors) can improve how accurately yoga postures are detected. Unlike systems that use only a camera, this system uses both video and physical data from the mat. This makes posture detection more reliable, even when the camera view is not perfect or the body is not fully visible.

One of the main advantages of this system is real-time feedback. It continuously checks the user's posture and immediately tells whether it is correct or not. This helps users learn and correct themselves while practicing. It is



especially helpful for beginners who do not have a yoga trainer. The system also gives feedback in different ways like screen display, sound, or vibration, making it easy and engaging to use.

The system uses models like YOLO or MediaPipe to detect body points from the video. These help in identifying the yoga pose. However, their performance can be affected by factors like low lighting, messy background, or wrong camera position. Similarly, flex sensors may give less accurate results if they are not placed properly or get damaged over time. So, proper setup and calibration are important.

Another issue is processing speed. Since the system handles video and sensor data at the same time, it may become slow on low-performance devices. To solve this, faster models or better hardware can be used.

Even with these challenges, the system has many useful applications. It can be used at home for fitness, in therapy for rehabilitation, and also by visually impaired users. In the future, the system can be improved by using better AI models, more advanced sensors, and mobile or cloud-based features.

Overall, the Smart Yoga Mat System is a useful and modern solution that helps users improve their yoga practice with the help of technology

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