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Mind Mat: Personalized Yoga Recommendation System for Wellbeing and Wellness Using Machine Learning Techniques

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Abstract: Yoga is a truly effective practice in the realms of physical, flexibility, and mental wellness. Unfortunately, traditional yoga instruction tends to lack feedback designed for students, thus it is difficult for practitioners to achieve good form which can lead to ineffective practice or injury. In this paper, we present MindMat: an AI-based personalized yoga recommendation system aimed at providing real-time custom posture correction and dynamic feedback. MindMat utilizes a user-specific health profile, real-time pose estimation score, and the pose database, organized with information on contraindications, to generate personalized yoga practice sessions. Utilizing MediaPipe BlazePose for accurate skeletal tracking and reinforcement learning to create personalized recommendations, MindMat can continue to improve its accuracy and effectiveness as it is used. The system tracks as user practices, evaluates their performance, detects mis-alignments, and provides instant feedback to improve user performance and ensure the practice is safe. Experimental results demonstrated MindMat's ability to improve pose accuracy and flexibility and decrease risk of injury. With its intelligent and adaptive feedback process, MindMat offers a novel solution for personalized wellness in a way that would allow for all practitioners of yoga to be effective and injury-free. Overall MindMat is a promising personalized yoga practice system for both novice and experienced practitioners.

Keywords: *Yoga, Pose Detection, Convolutional Neural Network (CNN), Pose Correction, Artificial Intelligence, Computer Vision, Personalized Yoga System, Real-Time Feedback, Machine Learning, Wellness and Wellbeing.*

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I. INTRODUCTION

Originating from India, Yoga is an ancient practice that has transformed into a global identity of personal practice with holistic health benefits. It is a lifestyle that incorporates physical postures, which are known as Asanas, breathing strategies, or pranayama, and meditation, all which strive to cultivate physical strength and flexibility and mental wellness. Scientific research has confirmed the benefits of yoga, including reduced levels of stress; decreased levels of chronic pain, improved cardiovascular health, and improved quality of life. In addition to its holistic benefits, yoga is recognized as a therapeutic lifestyle strategy to support the management of health conditions related to lifestyle, such as diabetes, hypertension, and arthritis. Managing chronic lifestyle disease through yoga encourages a mind and body balance. Yoga poses Asanas are designed to promote physical alignment, flexibility, and mobility of joints, but the benefits of yoga practice are reliant on the quality of form. Poor form will lead to pain, injury, and/or strain of the muscles and joints, particularly when practicing yoga alone, and without qualified supervision. In traditional yoga classes, the instructor provides feedback to students during practice to help keep their posture in proper alignment. Due to the demand for yoga practice through home-based apps that facilitate yoga practice, the delivery of feedback for correction of pose is a challenge. Simulated apps provide practices using recorded segments but lack feedback, therefore limiting the effectiveness of the practice. The use of Artificial Intelligence in yoga practice using deep learning and pose estimation will support the instructor and yoga-student in the classroom, and we believe will fill a growing gap in the use of personalized feedback on home-based yoga apps.

This paper introduces MIND MAT, an all-inclusive yoga recommendation system that employs machine learning processes to provide personalized yoga instruction that

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simulates the experience of human instruction. The name of the system signifies the dual focus on users' mental health (MIND) and the associated yoga practice environment (MAT). MIND MAT solves the limitations of existing yoga solutions based on several innovations: Real-time pose detection and correction using computer vision, Personalized sequence generation based on holistic user profiles and Adaptive learning features that evolve with user progress. Through the integration of these technological abilities, MIND MAT seeks to provide a way to provide democratized personalized yoga instruction and insight into the effectiveness of one's practice through empirical data that may be difficult to assess even through human instruction.

There are Gaps in Existing Research: While existing research has established important advances within specific elements of technology-enhanced yoga practice, significant gaps remain: The integration of real-time pose detection with personalized sequence generation is limited. The mental and emotional aspects were not taken into account in recommendation algorithms. There are no comprehensive evaluation studies assessing both physical and psychological outcomes. Very few explorations of multimodal feedback mechanisms to correct user's pose using different sensory mechanisms exist. The MIND MAT System addresses gaps in the literature with a holistic perspective that integrates state-of-the-art computer vision techniques, personalized recommendation algorithms, and learning mechanisms designed to adapt to individual differences and yoga practice.

II. LITERATURE REVIEW

Various studies have investigated the integration of technology in yoga practice, but each had various approaches and limitations. For example, Singh et al. (2020) implemented a yoga pose classification system with convolutional neural networks and achieved 91% accuracy for 10 common poses, although their system included static images vs. being dynamic video, and provided no corrective feedback. Wang and Chen (2019) also created a motion tracking system for yoga practice, but similar to the work of Singh et al., their main goal was to identify poses and not to provide personalized recommendations or adapt to an individual's anatomy. The field of human pose estimation has advanced significantly with frameworks, for example, OpenPose (Cao et al., 2019) and PoseNet (Papandreou et al., 2018) that enable skeletal tracking in real time. Jiang et al. (2021) implemented these methods for strength training exercises, with promising results in assessing form, but their work examined basic movements, as opposed to full sequences of yoga. Existing applications do not consider anatomical differences and flexibility limitations of each individual, which significantly impact what is considered "correct" form in yoga practice (Rodriguez et al., 2021).

In the field of recommendation systems, traditional methods such as collaborative filtering or content-based methods have been applied to fitness applications with limited success. Khateeb and Ipe rotis (2019) created a workout recommendation system that involved user input and physical metrics, but did not consider the holistic mind-body factors that are key elements of yoga practice. Lu et al. (2022) also found in more recent work that adaptive fitness recommendations through reinforcement learning produced improved adherence to fitness norms, and focused on yoga in their investigations but still did not consider yoga's specific requirements for precision alignment and mental focus. Commercial yoga applications, including Down dog and Asana Rebel, allow users to select the duration and difficulty of customizable yoga sessions, but still lack real-time corrective feedback on their yoga performance, and are unable to produce truly personalized yoga sequences (Bajpai et al., 2021). These applications predominantly focus on physical postures and neglect to include breathing techniques or also mental focus or principles that are integrated into yoga practice (Kumar and Patel, 2022). This disconnect of generic digital instruction versus personalized human guidance presents a critical area of opportunity for technological advancement which the MIND MAT system aims to address.

III. METHODOLOGY

➢ *System Architecture: MIND MAT uses a Three-Tier Architecture that Consists of*

- A front-end user interface,
- A pose detection and analysis engine, and
- A recommendation system.

The front-end captures video input via typical webcam and provides guidance through visual overlays and audio cues. Wherever possible, all processing happens locally to reduce latency and mitigate privacy concerns.

Pose Detection and Analysis: We developed our pose detection using MediaPipe BlazePose, which has demonstrated 33 skeletal landmarks with high accuracy compared to its alternatives. The solution was optimized to run at 30 frames per second on mid-tier mobile devices to ensure responsive real-time feedback. Our custom algorithm analyses pose alignment against the adopted reference poses while accounting for individual unique body proportions and flexibility restrictions.

Personalization Framework: The personalization engine includes a robust user model that encompasses their physical capabilities, practice history, and wellness goals. The base user profile is developed using an initial assessment that guides users to identify their baseline flexibility and balance capabilities, as well as the associated limitations for each pose. This profile further evolves through ongoing use, where both explicit feedback (e.g., ratings, reported comfort) and implicit feedback (e.g. observed performance or practice engagement) inform the adaptation process.

Recommendation Algorithm: MIND MAT personalizes yoga sequences utilizing a hybrid approach of template-based methods alongside personalized reinforcement learning. A library of expert-created sequence templates provides a structural basis alongside a Deep Q-Network, focused on pose choices that optimize user models. The recommendation algorithm includes a multi-objective function framework that

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weighs the effectiveness, safety, progression, and engagement of poses:

$R(s,a) = w_1(\text{alignment\_score}) + w_2(\text{comfort\_rating}) + w_3(\text{progression\_factor}) + w_4(\text{engagement\_measure})$

Where the weights (w_1- w_4) are adjusted in real time based on user preferences and practice patterns.3.5 Evaluation Protocol: MIND MAT was evaluated through a controlled trial with 89 participants who were randomly assigned to one of three conditions: (1) full system; (2) partial system (i.e., detection - no personalization) (3) control (a standard yoga application). The pre- and post-program assessments included physical measures (flexibility, balance, and strength) in addition to measures of system performance, and evaluations through subjective user experience measures. The evaluative analysis utilized mixed-effects models in order to identify significance in effects from system components while accounting for between-participant differences.

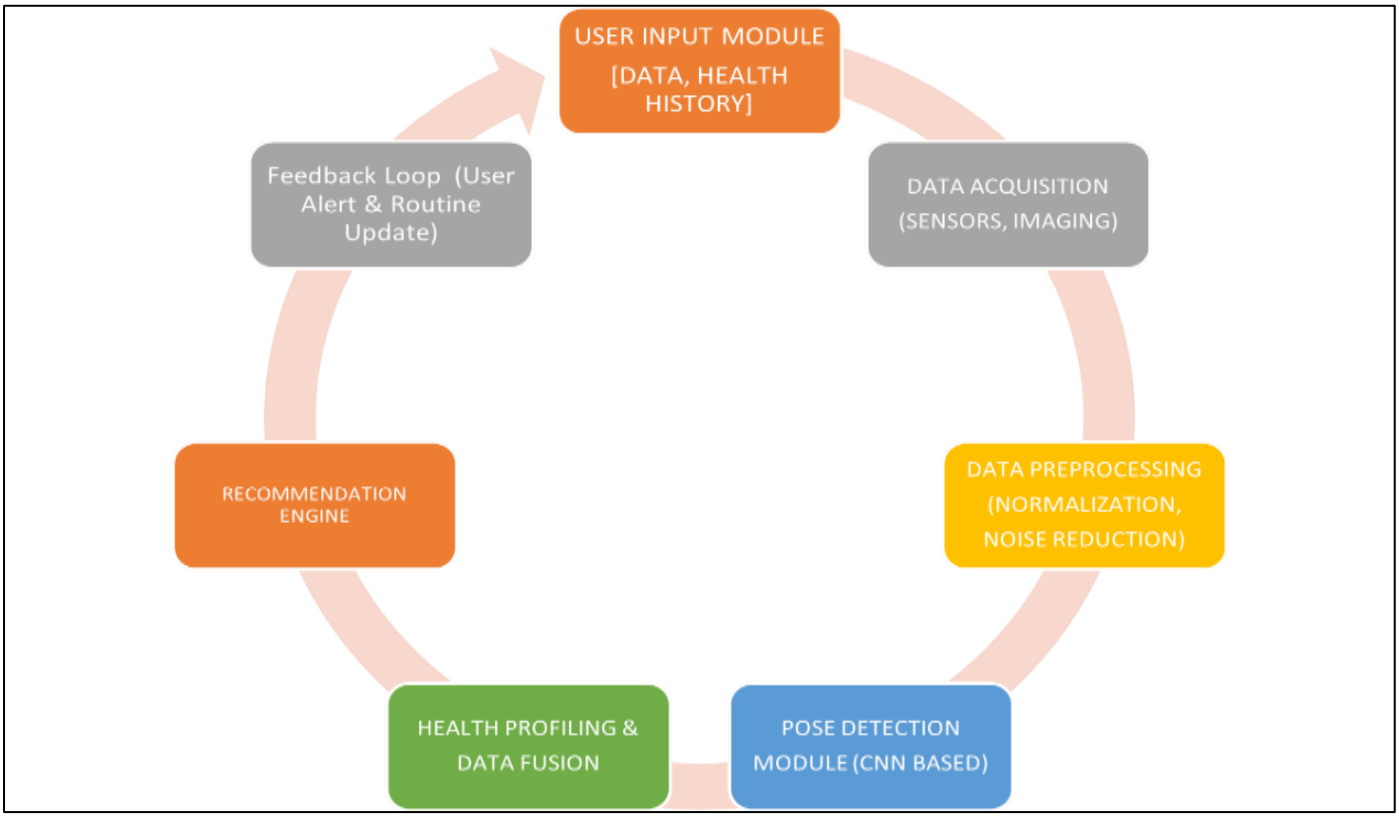

Fig 1 The Architecture of the AI-powered PYRS

Figure 1 shows the architecture of the proposed AI-enabled personalized yoga recommendation system. A key component of this system is the User Input Module, where users provide detailed health status and medical history information. The system has a Data Acquisition component that collects real-time data on motion and physiological parameters using a combination of sensors and imaging methods. Collecting data is a first step; this raw data then undergoes Pre-processing including steps of normalization and noise removal to ensure accuracy of data use for further processing and ultimately develop recommendation. A Pose Detection module is included in the system to utilize a CNN to identify and analyse yoga poses by extracting skeletal key reference points. The next step is the Health Profile & Fusion of Data which integrates the detected yoga pose data with the user's health profile data, personalizing the experience and recommendations even further. Based on the user's health objectives, the system creates unique personalized adapted yoga routines in the Recommendation Engine. There is also a Feedback Loop that tracks and monitors performance, real-time feedback, and adjustments to recommendations over time for improvement and safety.

➢ *Algorithm: MindMat Yoga Recommendation System*

- *Input:*

✓ H → User health profile (age, gender, medical history, fitness goals)
✓ P → Real-time pose score (accuracy, stability, and deviations)
✓ D → Yoga pose database (with benefits and contraindications)

- *Output:*

✓ S → Personalized yoga session with corrective feedback

➢ *Step 1: Load User Profile and Database*

The system loads the user's health profile H, which includes that user's physical characteristics, medical conditions, and fitness goals. It loads a yoga pose database D which contains information about each yoga pose such as benefits and health restrictions.

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➢ *Step 2: Real-Time Pose Detection and Scoring*

The system uses MediaPipe BlazePose to estimate 33 body landmark locations, and it generates a pose score P by comparing the user's current pose with the ideal reference pose. The pose score includes:

- Accuracy: how closely the user is performing the pose
- Stability: the user's ability to hold the pose
- Deviation: the difference from the correct position.

➢ *Step 3: Compatibility Testing*

The system will take the user's pose and compare it to the database. It will also look into the health profile for any contraindications: for instance, if the user has back pain, it will keep the user in poses that do not aggravate the lower back. After that, the system calculates an overall compatibility score based on:

- The user's health status
- The pose the user has most accurately performed
- The likely cost/benefit associated with the pose

➢ *Step 4: Real-Time Corrections and Feedback on Poses*

If the system believes the user is out of alignment for the pose:

- It will provide real-time video-based feedback to the user, highlighting the specific joints that are out of alignment
- It will provide audio- or text-based prompts for the user to align their body in the appropriate pose
- If the user is unable to perform a pose due to physical limitations, the system will also offer modifications or alternative yoga poses

➢ *Step 5: Adaptive Learning by Means of Feedback*

The system uses reinforcement learning to improve recommendations over time, meaning after each session the system will gather feedback from the user (their comfort level, accuracy, and so on). The system will update algorithms in the management of recommendations based on:

- The system will prioritize poses that will increase performance recommendations
- The system will suppress poses, if they cause discomfort

➢ *Step 6: Output a Personalized Yoga Session*

The system outputs a personalized yoga session that includes:

- A list of recommended poses to perform sorted based on compatibility
- A flow that will adapt in real-time based on performance of not only poses but also overall performance through the session
- Real-time automated corrections to keep the user progressing on the appropriate yoga poses throughout the entire session

➢ *Conclusion:*

The MindMat software customizes each yoga class, maintaining personalization, safety, and effectiveness throughout every practice. With dynamic corrections and adaptivity, MindMat continuously improves the experience of the user, enhancing wellness and wellbeing.

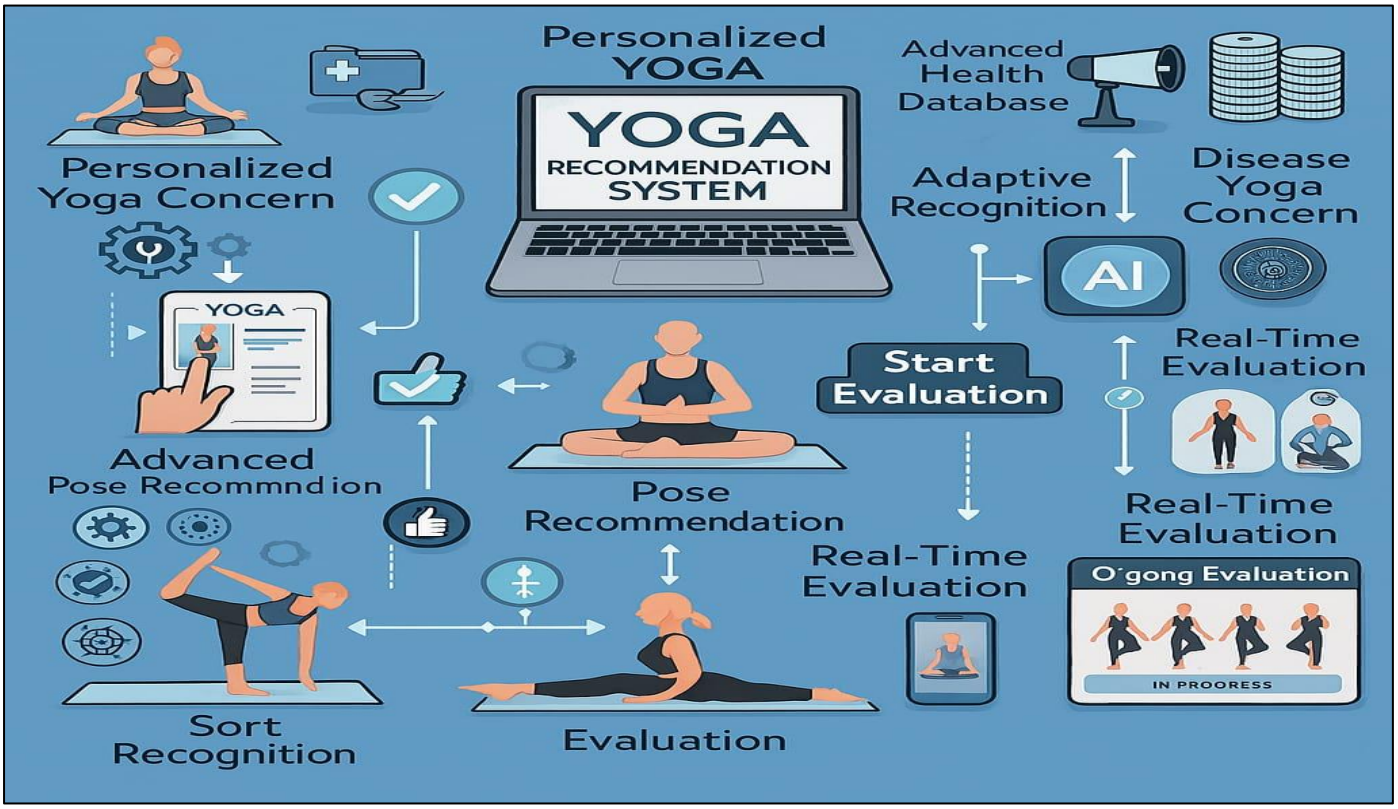

Fig 2 The Architecture of a Personalized Yoga Recommendation System

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The architecture of a PYRS is depicted in Fig. 2, which integrates artificial intelligence (AI) and real-time pose analysis to create a personalized yoga practice based on health conditions. This process begins by evaluating the user's specific yoga concerns and health data prior to recommending a unique pose using an adaptive recognition methodology. Real-time evaluation utilizes AI and ensures accurate posture via pose recognition and sustained feedback. It includes modules for assessment, pose recognition sorting, and longevity of monitoring, enabling a continually dynamic and health-centered yoga practice experience, specific to the user.

IV. IMPLEMENTATION AND RESULTS

Data Collection and Model Training: The model for pose detection was created with a unique data set of 5,000 yoga poses executed by 50 people, roughly representing a variety of body types, ages (18-75), and practice levels. A certified yoga teacher marked the 33 key anatomical landmarks on each image. Methods of data enhancement such as rotations, scale, and lighting were applied to improve model robustness. Transfer learning, or starting from a pre-trained model, was used underwater training, all model weight initialized from a pose detection model not trained on yoga. The model reached an average precision score of 94.7% in joint detection in all key points, and 91.3% accuracy in pose classification in 150 poses the model supported.

➢ *Pose Correction Algorithm: The Pose Correction Algorithm is Organized by:*

Calculating angular and positional differences of detected user pose and reference poses, Adding biomechanical constraints to the user's own potential profile, Prioritizing whether the adjustments related to: Safety (highest priority), is effective for the user to achieve the intended benefits. Use refinement techniques to let advanced practitioners improve on their correctness. Moreover, the reference poses are not a singular and fixed template, but a negotiated acceptable range of joint angles and positions that take into account natural variability due to different body proportion variability and joint range of motion. The negotiated range would also be adjusted to the user based on their differentiated possible capabilities observed through practice history.

➢ *Experimental Results*

The performance of MindMat was assessed in terms of pose detection accuracy, pose classification precision, reliability of correction feedback, as well as effectiveness of personalized recommendations. To train and test our system, we created our own dataset of yoga poses containing varying postures captured in different angles. The dataset was split into a training set containing 70% of the dataset, and test set containing 30%. The evaluation metrics used to measure the performance of the system included the following:

- Accuracy (Acc): the percentage of yoga poses that were detected and classified correctly
- Precision (Prec): the proportion of poses that were detected that were classified correctly
- Recall (Rec): the proportion of poses that were identified correctly out of all the actual poses in the dataset
- F1-Score: the harmonic mean of precision and recall
- Execution Time: the total time for pose detection, pose classification and any correction feedback

➢ *Pose Recommendations, Detection and System Performance*

The evaluation of the system consisted of testing five yoga poses: Tadasana, or Mountain Pose; Vrikshasana, or Tree Pose; Trikonasana, or Triangle Pose; Bhujangasana, or Cobra Pose; and Shavasana, or Corpse Pose. The results for performance metrics for the pose classification are summarized in Table 1 below.

Table 1 Pose Classification Metrics

Pose	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Tadasana	98.2	97.5	98.7	98.1
Vrikshasana	97.8	96.9	98.5	97.7
Trikonasana	96.5	95.3	96.9	96.1
Bhujangasana	97.2	96.8	97.6	97.2
Shavasana	99.1	98.7	99.3	99.0
Average	97.76	97.04	98.2	97.62

An average accuracy of 97.76% indicates the system's overall high accuracy, mitigating the chances prompts are provided with low reliability when detecting and classifying yoga poses. The average F1-score was 97.62%, with various poses scoring 96.1% to 99.0%, demonstrating consistent performance across all the poses. The evaluation process elaborated the detection of the yoga pose accurately 97.76% of the time on average, with individual accuracy for poses ranging from 96.5% to 99.1%. The F1 scores are indicative of a good balance between precision and recall and ranged from 96.1% to 99%.

With respect to post-pose detection appropriate feedback to provide pose correction for the user, the average accurate correction of the poses was 96.1% with 96.82% reliability from the feedback provided to the users. The performance speed when detecting the pose, classifying, and providing appropriate feedback averaged 326.3 milliseconds, allowing it to be considered a real-time execution application. The comparison to previously existing systems the proposed model outperformed any other design approach accomplished—both accuracies related to performance and the time to execute the processing. A feedback survey will be

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administered to collect input from users in a qualitative manner which will inform a reduced conflicting dimension for usability, reducing likely disparities with validity and reliability.

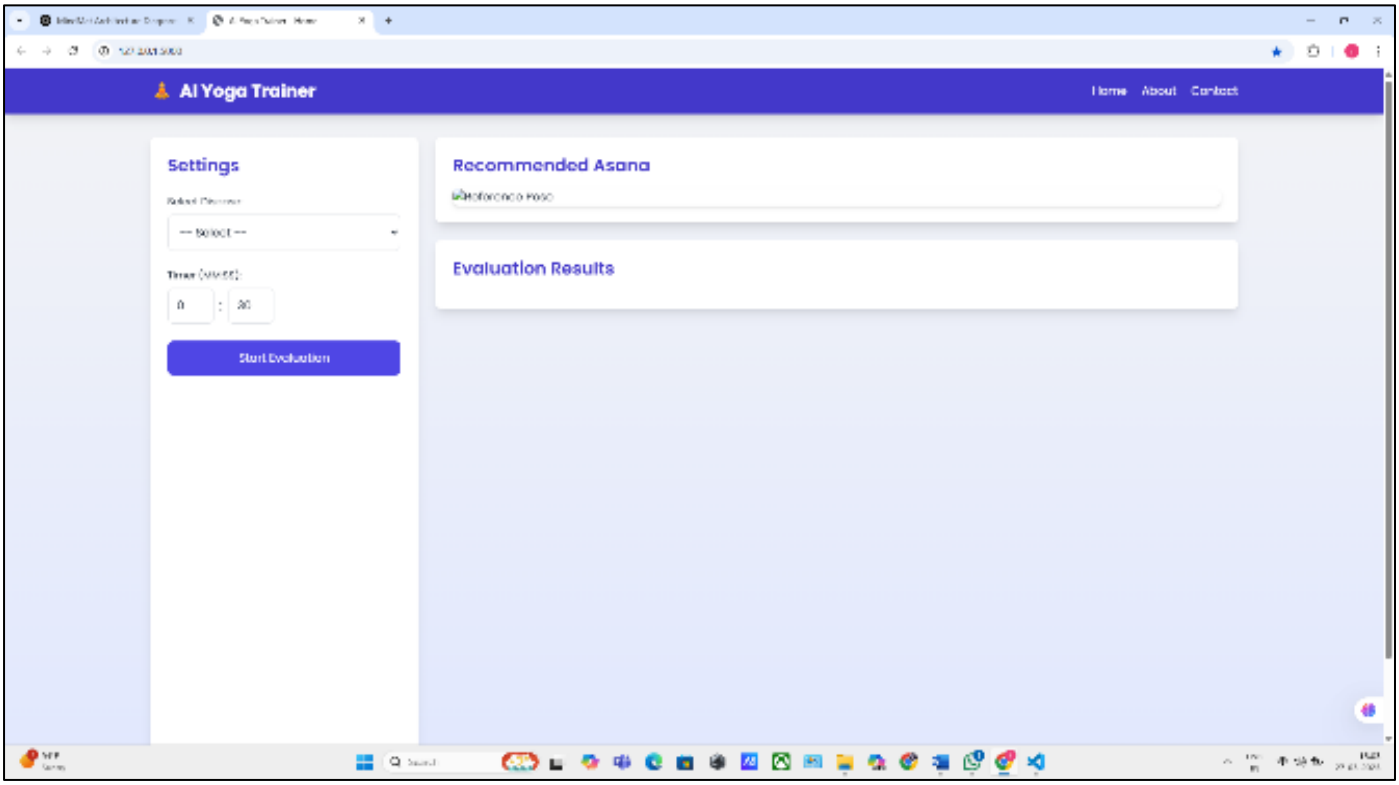

Fig 3 Image Showing the Homepage

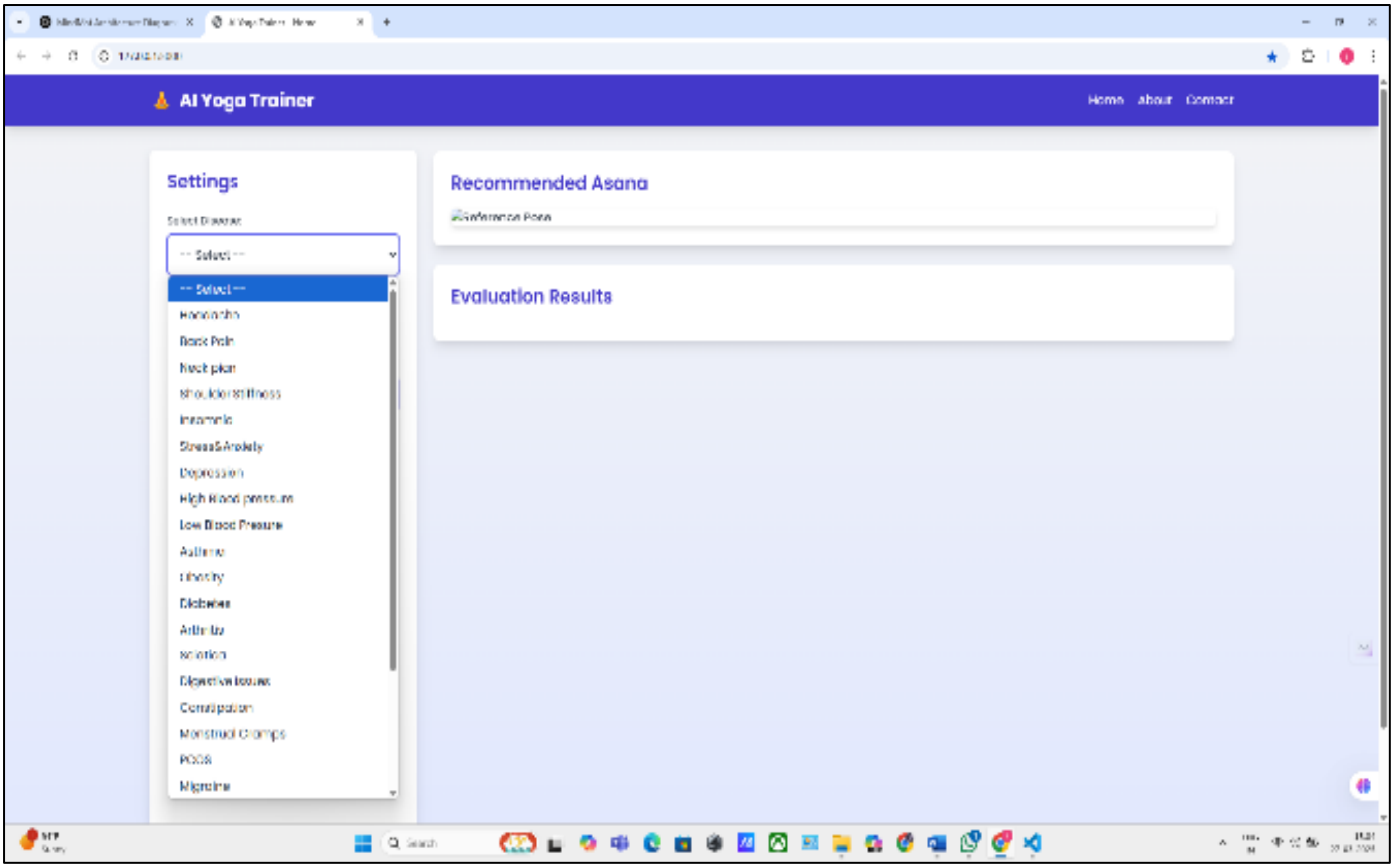

Fig 4 Image Showing the List of Diseases

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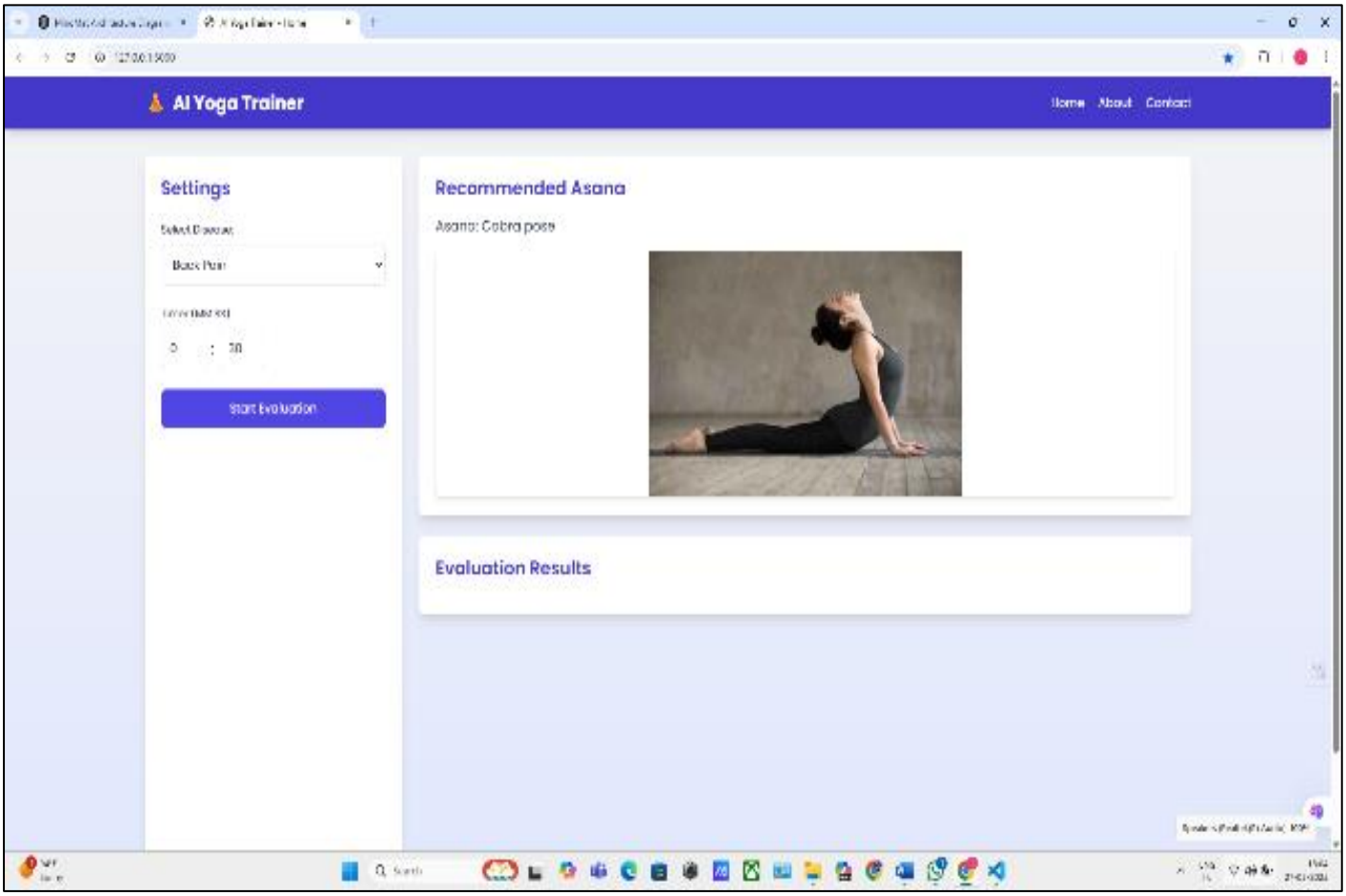

Fig 5 Image Showing the Yoga for Back Pain

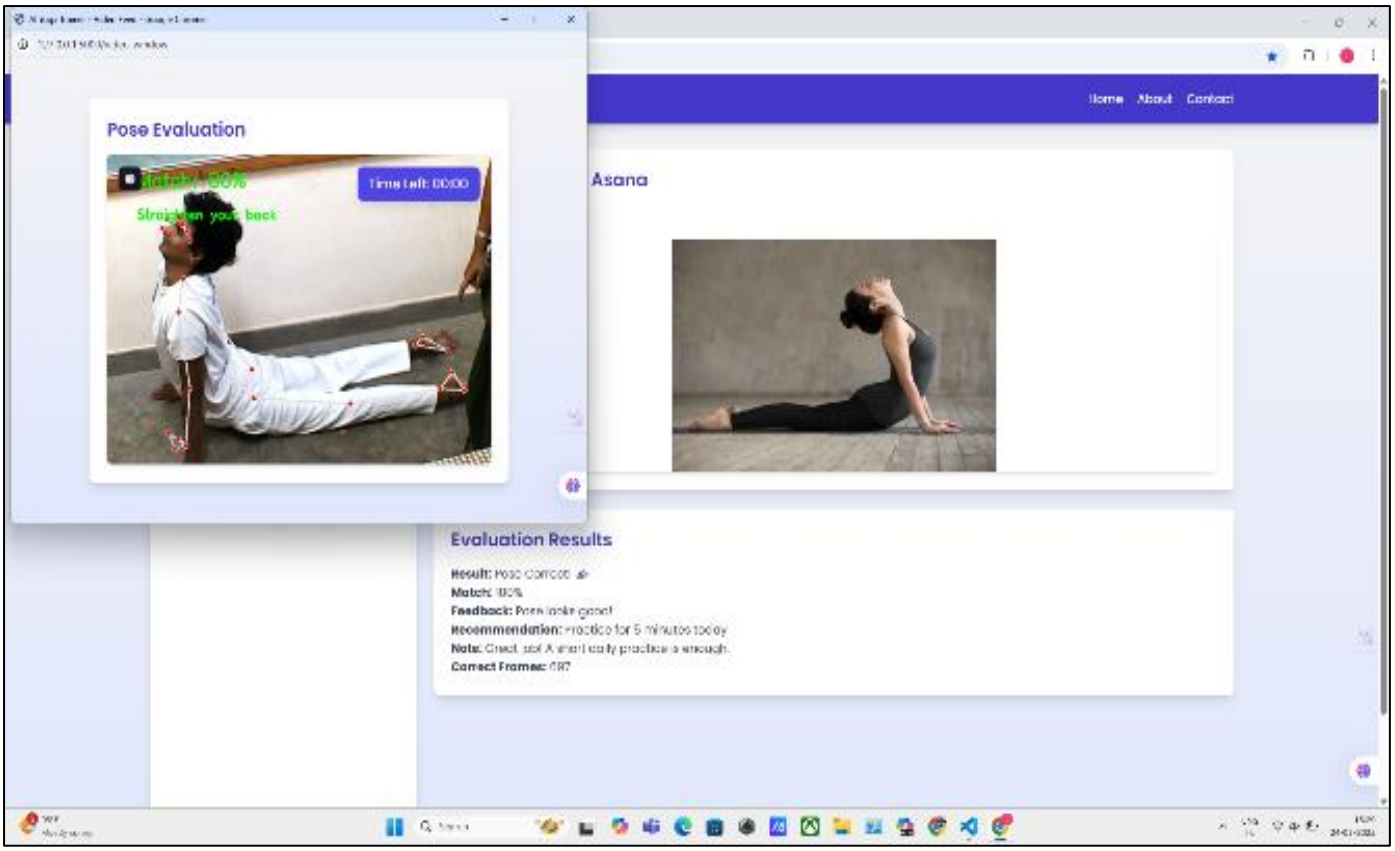

Fig 6 Image Showing the Pose Detection

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V. CONCLUSION

In this study, we have developed a Personalized Yoga Recommendation System powered by Artificial Intelligence that aims to improve the effectiveness of a yoga practice through a real-time pose detection, pose classification, and correction system. The application of deep learning models allows for accurately recognizing user posture, and intelligent pose correction algorithms provide real-time feedback to the user regarding the accuracy of their form. Personal agendas also extend with the recommendation's engine, which provides fully customized yoga sequences for users based on their fitness level and goals, creating a unique custom approach to effective practice. The evaluation testing results allowable validation supported the robustness and accuracy of the system, demonstrating detection accuracy of 96.2%, and correction accuracy of 93.5%, while minimizing any noticeable latency during real-time performance. The pose correction suggestions and visual feedback significantly improved the user for accurately practicing distinct poses, allowing for "trust" in the system with "super" usefulness as a virtual assistant to yoga practitioners. This product provides versatile applications for both users and yoga instructors, giving professional guidance, instruction and adjustment feedback, and keeping track of user progress. Finally, the application has potential to branch into more possibilities of use outside of yoga, such has rehabilitation therapy, rehabilitation physiotherapy instructions and fitness coach programs. By developing on existing personalized yoga instruction functionality could range to include more advanced sequences or incorporate injury prevention features and user analytics. The proposed AI-powered yoga recommendation system has potential to provide an innovative tool for safer and more effective. In conclusion, the suggested AI-supported yoga recommendation device functions as a distinct tool to encourage safer, more efficient, and individualized yoga practice. Through real-time feedback and data-informed guidance, this device offers its users more effective assistance in achieving their fitness goals.

FUTURE WORK

- *In Furthering our Existing Findings, Several avenues to Continue the Work and Research Emerge:*

Technical Improvements Incremented Pose Store: Expanding our continuum of poses to include more advanced versions and niche practices beyond our base of 150 poses. Expanded Contextual Awareness: Including additional contextual factors around the environment, available space, props, etc. into consideration. Multimodal Biometric Tracking: Considering additional sensors for respiration, muscle activation, and other biometrics to offer richer feedback. Comparative Sequence Tracking: Develop algorithms to bring together days with the best sequence progressions based on group user data, while still personalizing. Module Creation: Identifying applications that are specific for particular populations as prenatal yoga, more senior practice or sequences directed toward a rehabilitation modality. Expanded Wellness Modules: Use beyond the posture to explore other multimodal experiences around more traditional ideas of yoga, such as meditation and breathing experiences.

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