Yoga Pose Optimization Using Deep Learning Techniques

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Abstract—In the digital age, as more yoga practitioners turn to online platforms for instruction, a notable gap has emerged in receiving real-time feedback on yoga poses. Despite the wealth of resources available, such as instructional videos and written guides, learners often struggle to ensure they're executing poses correctly without direct guidance. This lack of immediate feedback can lead to improper posture, potentially causing long-term health issues. Recognizing this challenge, a solution has emerged: automatic assessment of yoga postures using advanced technology.Expanding upon this concept, future iterations could explore additional functionalities, such as personalized feedback based on individual progress, integration with wearable devices for enhanced tracking, and gamification elements to make the learning process more engaging. Furthermore, by leveraging advancements in machine learning and computer vision, this technology could potentially be adapted to other forms of physical exercise, broadening its applications beyond yoga. Overall, the automatic assessment of yoga postures represents a promising advancement in leveraging technology to enhance the practice and accessibility of yoga for enthusiasts worldwide.

However, even after learning or receiving training from the best sources such as videos, blogs, articles or documents, the user does not have time to follow up whether he/she is controlling his/her body properly, and this will be done later. life problems, body posture and health problems. Existing equipment can help in this regard, but yoga practitioners have no way to know whether their body is good or bad without the help of a teacher. Therefore, automatic measurement of yoga poses is aimed at yoga pose knowledge,alerts can be given to practitioners using the Y_PN-MSSD model, in which Pose-Net and Mobile-Net SSD play an important role. This model is divided into three levels. Initially, there is a data collection/preparation phase where yoga poses from four users are recorded and an open file containing seven yoga poses. point for feature extraction training. Finally, yoga poses are recognized and the model helps the user complete yoga poses by tracking them in real time and correcting them instantly with 99.88% accuracy. In comparison, this model outperforms the Pose-Net CNN model. So this model could be the beginning of creating a system that will help people do yoga with the help of a smart, cheap and effective virtual yoga instructor.

Keywords—Yoga, Pose-Net, Mobile-Net, Accuracy,Yoga Pose CNN,Deep Learning

I. INTRODUCTION

In our rapidly evolving world, the fusion of information technology and scientific advancements has brought about a paradigm shift in how we live, work, and interact. This transformative synergy has not only heightened convenience and efficiency but has also paved the way for groundbreaking innovations across various spheres of human endeavor. Among these, the integration of technology into healthcare has been particularly transformative, revolutionizing medical diagnosis, treatment, and patient care. Moreover, beyond the realm of traditional medicine, the recognition of alternative practices such as yoga, Zumba, martial arts, and other physical activities as vital components of holistic well-being has gained significant traction.

Yoga, with its roots tracing back to ancient India, embodies a holistic approach to wellness, encompassing physical postures, breath control, meditation, and philosophical teachings. Its multifaceted benefits for physical, mental, and spiritual health have garnered widespread acclaim in modern times, making it a cornerstone of wellness practices worldwide.

A. PROBLEM STATEMENT

Optimizing yoga poses using deep learning tools

Develop deep learning models that identify body balance, sta bility, and body shape through images and data to improve y oga poses for practitioners. The goal is to increase the effecti veness of yoga practice, reduce the risk of injury, and provid e users with immediate feedback. However, achieving prope r alignment and posture is essential to getting the most out of each pose and preventing injuries. Traditional teaching meth ods often do not provide immediate feedback, making it diffi cult for practitioners to adjust their form.

The advent of artificial intelligence (AI) technologies, propelled by advancements in machine learning and computer vision, has ushered in a new era of innovation in the realm of yoga and wellness. Technologies such as Pose-Net and Mobile-Net SSD represent cutting-edge tools that hold immense potential for revolutionizing yoga practices. Despite the complexities involved in accurately detecting human body posture, these AI-driven solutions offer promising avenues for enhancing the effectiveness and accessibility of yoga training.

In today's fast-paced society, where time constraints and lifestyle demands often impede regular attendance at traditional yoga classes, the demand for flexible, technology-enabled solutions has surged. The convenience of practicing yoga at home, coupled with the desire for personalized guidance and feedback, has fueled the development of tech-driven yoga platforms and applications.

The yoga optimization data set is imported into our project from Kaggle in comma separated values (csv) format. With the use of pandas, numpy, and scikit-learn, the data set is analyzed. The elements with inconsequential values are omitted from the overall result. The data set is divided into two separate sets: the testing set and the preparation set. With the use of the preparation set, multiple machine learning models are created. The performance of each machine learning model is then evaluated using the testing set. An accuracy score is computed.

1. Data Collection and Preparation Stage: In this phase, yoga postures are systematically captured from a diverse range of sources, including trained yoga professionals and open-source datasets. This comprehensive approach ensures the robustness and inclusivity of the training data, enabling the model to accurately recognize a wide array of yoga poses.

2. Feature Extraction Stage: Once the data is collected, the feature extraction process begins, wherein Pose-Net is employed to identify key anatomical landmarks and establish spatial relationships between them. This step is crucial for accurately capturing the nuances of each yoga pose and facilitating precise posture recognition.

3. Posture Recognition Stage: Building upon the extracted features, the model utilizes the Mobile-Net SSD layer to perform real-time posture recognition. By analyzing the spatial arrangement of key body landmarks, the model can accurately identify and classify yoga poses, providing users with instant feedback on their form and alignment.

The performance of the Y_PN-MSSD model is rigorously evaluated using robust evaluation metrics, including confusion matrix analysis and comparative studies with existing models. This thorough assessment ensures the reliability and efficacy of the proposed solution, paving the way for its integration into mainstream yoga training practices.

Deep learning, a fundamental component of this study, offers unparalleled capabilities in processing and analyzing complex datasets with minimal human intervention. By harnessing the power of deep neural networks, the proposed model can autonomously learn and adapt to diverse yoga poses and variations, thereby enhancing its accuracy and reliability over time.

In addition to its immediate applications in yoga training, the proposed automatic assessment system holds significant potential for broader applications in healthcare, fitness monitoring, and sports performance analysis. By leveraging AI-driven technologies, practitioners can gain valuable insights into their movement patterns, identify areas for improvement, and mitigate the risk of injuries, thereby promoting overall well-being and longevity.

Most of the people could get benefited with this approach. Here, accuracy plays a major role because the model which gives maximum accuracy will be the model which could stand for a long time. Hence, the model which we are using has the much ability of giving maximum accuracy.

Figure1 [1] Yoga Poses

II. LITERATURE REVIEW

[2](Sumeet Saurav, Prashant Gidde,Sanjay Singh:2024)The paper investigates advanced deep learning models for yoga pose recognition, addressing issues of speed and reliability in current methods. Four different models were tested, including hybrid CNN-LSTM and 3D CNN models. The best model achieved high accuracy (98.80% to 99.07%) and ran at 31 frames per second. After optimization with TensorRT SDK, it performed at 8 frames per second on an Nvidia Xavier embedded platform, making it viable for devices with limited resources.
The study developed deep learning models for real-time yoga pose recognition that offer both high accuracy and speed. The optimized model is suitable for use on resource-constrained devices, enhancing the practicality of yoga practice without human supervision. This advancement contributes to better yoga technology and opens new possibilities for self-training.

[3](Sagar Wadhwa,Anshumaan Garg,Geethika Munjal:2024)This paper explores using deep learning to analyze yoga postures, combining traditional yoga with modern technology. CNNs are employed to identify detailed patterns in yoga poses. YOLO outperformed MediaPipe and OpenPose with 92.5% precision.Deep learning has significantly improved the analysis of yoga postures, merging ancient practices with new technology. The high precision of CNNs and YOLO shows that technology can enhance yoga practice, making it more effective and contributing to personal well-being.

[4](Prachi Kulkarni,Shailesh Gawai,Siddhi Bhabad, Abhilasha Patil,Shraddha Choudhari:2024)This paper presents a system that uses deep learning and multimodal data to provide real-time feedback on yoga poses. It discusses the challenges of achieving accuracy and robustness, and its potential applications in various environments.The proposed system enhances yoga practice

by providing accurate, real-time feedback and helping users correct their poses. It is applicable in different settings and could benefit from future integration with technologies like AR and VR to further improve the yoga experience.

[5](Kadam Payal, Kadam Sudhir, Bidwe Ranjeet, Shinde Namita, GinnareNandini, Kesari Nikhar:2024)This paper describes an app that uses machine learning to identify yoga poses and give voice feedback. It was trained using web-scraped data with a KNN classifier, achieving 83.6% accuracy and 82.3% F1-Score for real-time pose correction.The app provides real-time feedback on yoga poses, helping users practice correctly and avoid injuries. With its current performance, it has the potential to make yoga practice safer and more accessible.

[6](V. Lavanya, Kalila C N A, Premkumar K, Rohith R:2024)This project utilizes AI and deep learning to offer real-time pose detection and correction, aiming to improve yoga practice and prevent injuries.The system enhances yoga practice by providing instant feedback on pose alignment, helping users practice safely and effectively. This technology can transform how people engage with yoga, making it more accessible and enjoyable.

[7](Sakshi, Sandeep Saini:2024)This study combines yoga and deep learning to offer personalized yoga experiences. hybrid model was used for pose estimation with 93.43% accuracy and provided real-time feedback on breathing and focus. It was tested on a Raspberry Pi-4 with 90.9% accuracy.The integration of deep learning with yoga provides high-accuracy pose estimation and personalized feedback, making yoga practice more effective and enjoyable. Future developments could include risk analysis and injury prevention.

[8](Ratnesh Prasad Srivastava, Lokendra Singh Umrao, Ramjeet Singh Yadav:2024)This paper introduces a system for accurate yoga pose estimation and feedback using 3D pose estimation and LSTM. It was trained on a custom dataset and achieved 92.34% accuracy.The system improves the accessibility and affordability of yoga practice by providing accurate feedback on poses. Its custom dataset and high accuracy make it a valuable tool for enhancing yoga practice.

[9](G Shirisha, Neha R Bhat, Akshata S Hamasagar, Ananya A Hosamani, Priyadarshini Patil:2024)This project focuses on improving yoga pose estimation using deep learning. It developed a model to accurately identify and analyze yoga poses, providing useful feedback.The improved model for yoga pose estimation offers high accuracy and detailed feedback, which can enhance yoga practice and technique. It contributes to the field of computer vision and supports real-time feedback systems.

[10](Debabrata Swain, Santosh Satapathy, Pramoda Patro, Aditya Kumar Sahu:2024)This project creates a self-guided yoga system using deep learning to recognize and correct poses. It analyzes video sequences with CNN and LSTM and provides real-time feedback on pose accuracy.The system provides accurate pose recognition and correction, making it easier for individuals to practice yoga correctly without a trainer. The real-time feedback feature enhances the safety and effectiveness of yoga practice.

[11](Shruthi Kothari:2020)This paper explores creating a self-instruction yoga system using human pose estimation. It utilizes various machine learning and deep learning techniques for accurate pose classification in real-time videos.The project lays the groundwork for a self-instruction system for yoga practice at home, using deep learning for accurate pose classification and real-time feedback. This technology has broad potential applications in health monitoring and other areas.

SUMMARY

Recent studies have explored using advanced deep learning and machine learning models to improve real-time yoga pose recognition and feedback.
Researchers tested various deep learning models, including CNN-LSTM and 3D CNN models, achieving high accuracy (98.8%-99.07%) and fast processing.
After optimization, the best model ran on a low-power device at 8 frames per second, making it feasible for self-guided yoga practice.
Another study used CNNs and YOLO for pose detection, with YOLO showing superior accuracy (92.5%) compared to other models, bridging traditional yoga and modern technology to enhance personal practice.
A proposed system combines deep learning with multimodal data to provide real-time, accurate feedback, useful in multiple settings and potentially benefiting from future integration with AR and VR.
Other studies developed simpler applications for real-time feedback, such as an app using a KNN classifier trained on web-scraped data, achieving 83.6% accuracy and offering voice feedback for safer practice.
A model for pose alignment feedback aims at injury prevention, while another focuses on personalized feedback for breathing and focus, using a hybrid model with an accuracy of 90.9%.
These studies collectively advance yoga practice with technology, enhancing accessibility, effectiveness, and safety.

III. METHODOLOGY

Figure2 Architecture of the Methodology

ANALYSING DATA SET

This phase includes both data acquisition and original dataset from the architecture. Before starting the project, it's crucial to perform an analysis of the data set.

DATA COLLECTION AND PRE PROCESSING

This phase includes data processing stage from the architecture. We acquised our data set from Kaggle. Initially, we must check for any duplicate values and, if found, remove them using .drop duplicates().
In this data set, null values are represented by '..', but the system interprets them as strings rather than null values. Our primary task is to replace all instances of '..' with pandas.NA.
For NaN values, we can opt to replace them with the mean, mode, or median. Alternatively, if a row contains a significant number of NaN values, it may be prudent to remove that row.Since we are training and testing datasets, all pre processing techniques should be applied to both.

DATA SPLITTING

This phase includes filtered data set stage from the architecture. We split the data into training and testing datasets. Evaluation can be directly applied to the testing dataset.

MODELS USED

This phase includes classification stage from the architecture. Evaluation can be done using the model we chosen on the data set.

MODEL TRAINING

This phase includes feature selection stage from the architecture. Model training involves optimizing both variance and bias to attain optimal values. During this phase, the model comprehensively grasps all its features and captures the inherent structure within the provided data. The primary objective of model training is to derive a mathematical function based on the available data. This function is subsequently employed to process inputs and generate outputs, essentially making predictions based on this established function.

MODEL EVALUATION

This phase includes results stage from the architecture. Model evaluation serves the purpose of assessing the predictive capability of the model and gauging its performance. This assessment is carried out using a testing data set. Various metrics such as Accuracy is used for this purpose.

MODEL SELECTION

The model is chosen by comparing various metrics, and the most optimal one is utilized for making predictions.

A. POSE NET

It is a deep learning framework that identifies joint activities in images or videos related to human motion. Joints are considered as keypoints, measured by segment identity, from 0.0 to 1.0, with 1.0 being the highest score. Among the layers, the eye maximum activation function of the last layer is replaced by a sequence of all layers. Figure 3 shows its high-level architecture. The performance of this model is device and output dependent and is completely different. So the model is suitable to capture all the various pose positions of the image regardless of the size. Here the encoder, localizer and regressor do three things. The encoder creates an encoded vector containing the features of the input image represented as a 1024 dimensional vector.The localizer creates vectors with local features.

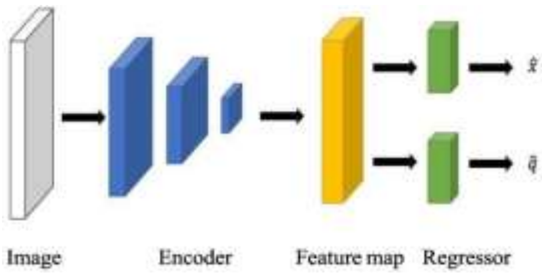

Figure3 [12] Pose Net Architecture

1. Encoder: Serving as the foundational element of the model, the encoder is tasked with generating an encoding vector. This vector encapsulates the salient features of the input image within a dense 1024-dimensional representation. Through intricate processing mechanisms, the encoder extracts and distills essential information crucial for subsequent stages of analysis, laying the groundwork for accurate pose estimation.

2. Localizer: Building upon the foundation established by the encoder, the localizer component takes on the responsibility of refining the encoded features. By focusing on specific regions of interest within the input image, the localizer enriches the model's understanding of nuanced details in human body movement. This localized refinement process enhances the model's ability to discern subtle variations in posture, thereby contributing to heightened accuracy in joint position identification.

3. Regressor: The final component of the architecture, the regressor, plays a pivotal role in fine-tuning the predicted joint positions. Leveraging a series of interconnected layers within the model, the regressor performs regression on the joint positions, refining them based on learned features from both the encoder and localizer. Through this iterative refinement process, the regressor ensures that the predicted joint positions align closely with the ground truth, resulting in precise and reliable estimations.

The described model represents a significant advancement in the field of human pose estimation technology. Its robust architecture, coupled with its adaptability and accuracy, holds promise for a wide range of applications, including healthcare, sports science, and beyond. As research and development in this domain continue to progress, the model stands poised to catalyze transformative advancements, offering new insights into human movement dynamics and fostering innovation in diverse fields.

B. MOBILE NET

Also known as product testing model, it is a model that calculates the inputs used to create bounding boxes and divides them by the inputs. The single-shot camera (SSD) in this model uses Mobile-Net to achieve high-quality visualization that will run faster on mobile devices. The model has offset values (cx, cy, w, h), where cx is the input, cy is the output, w is the weight, and h is the score. The score has a confidence value of 20 items with a background value of 0. The model then calculates the solution by combining the output level. First-time users should choose the postures according to their own preferences and needs. The user should face the camera. In order to work properly and get the right pattern, users should do yoga in a well-lit area. Figure 4 shows the architecture details of Mobile-Net.The sound of time encourages the yogi or user to practice yoga for longer periods of time.If the user encounters a problem in the demonstration, the user can access the advice section to see the solution in the FAQ. Table 1 shows the various layers involved in using Y_PN-MSSD. The result of Pose-Net is to find the position of each joint,while the role of Mobile-Net is to determine the physical body and to describe the body and the movement expressed by connecting the joints.

The description follows the integration of well-known products, the connections to create boxes and distribute products available in these areas. This model, known as the object detection model, uses the powerful Single Shot Storage (SSD) technology and combines with the Mobile-Net architecture to improve the object detection performance, especially for the fast operation of mobile devices. According to today's computer vision, this model uses a special model to provide offset values (cx, cy, w, h), each offset value is important in the product search process.

Within the architecture of the model, a fundamental approach is adopted, leveraging extracted features as the backbone for subsequent computations. This strategy involves the reduction of additional layers to determine the resolution, effectively streamlining the processing pipeline. The resolution computation is achieved through the concatenation of outputs from six distinct levels, each contributing crucial information to the final result.

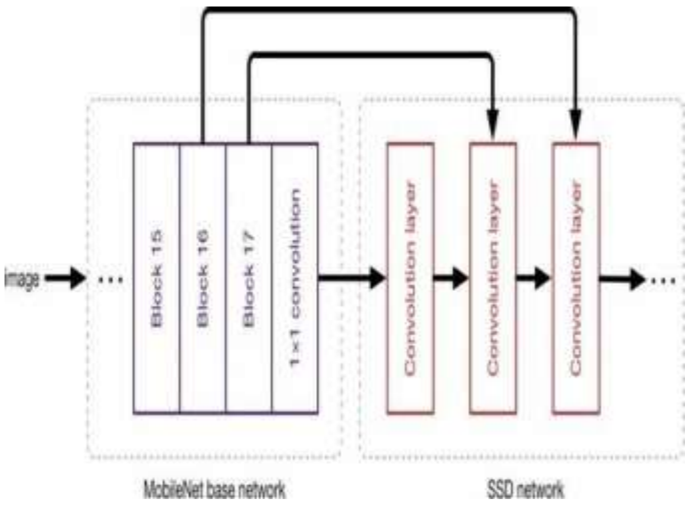

Figure4 [13] Mobile Net SSD Architecture

The offset values play an important role in correcting the position of objects in the image. Here, "cx" represents the center of the checkbox along the horizontal axis of the input image, and "cy" represents the vertical axis. "w" represents the width of the binding box, and "h" represents its height. Together, these offset values help to clearly define object boundaries, thus simplifying positioning within the image frame. female gender. This score is used as a confidence index for a previous group of 20 different items, with a score of 0 usually reserved for the background. By analyzing the confidence scores of the detected objects, the model is able to distinguish between different types of objects, thus improving the reliability and interpretation of the object detection process. It has many advantages, the most important of which is to increase computational performance and speed up the process. The Mobile-Net architecture is known for its lightweight and efficient design, which allows the target search function to work without any compromise on accuracy or performance, even limiting mobile devices.

The product perception model described in essence represents a combination of technology and design designed to provide unparalleled performance and versatility in the operation of a computer. Its expertise in accurately identifying and classifying objects in images, combined with the optimization of mobile transmission, makes it an important tool for applications such as control to guide reality. As technology continues to evolve, this model should support the development of computer vision and create a future where intelligent discovery devices are ubiquitous and important.

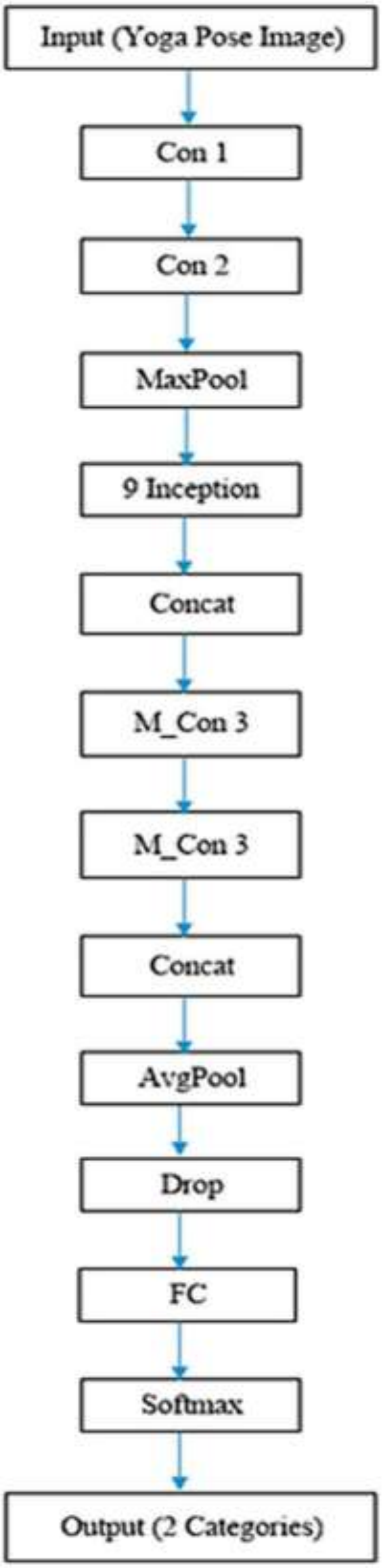

Figure5 Working of Y_PN_MSSD model

C. React js

React (also known as React.js or ReactJS) is a free and open-source front-end JavaScript library[4][5] for building user interfaces based on components by Facebook Inc. It is maintained by Meta (formerly Facebook) and a community of individual developers and companies.

React can be used to develop single-page, mobile, or server-rendered applications with frameworks like Next.js. Because React is only concerned with the user interface and rendering components to the DOM, React applications often

rely on libraries for routing and other client-side functionality.A key advantage of React is that it only rerenders those parts of the page that have changed, avoiding unnecessary re-rendering of unchanged DOM elements.

React code is made of entities called components. 10–12 These components are modular and reusable. 70 React applications typically consist of many layers of components. The components are rendered to a root element in the DOM

using the React DOM library. When rendering a component, values are passed between components through props (short for "properties"). Values internal to a component are called its state.
The two primary ways of declaring components in React are through function components and class components.

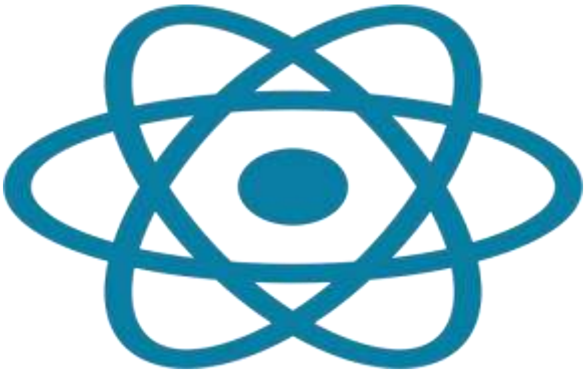

Figure6 [14] React js symbol

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D. DATA SET

The proposed model is trained and tested on open source data , which includes seven yoga poses: cobra, chair, dog, shoulder, triangle, tree, and fat kid. The data is available at the following link: https://www.kaggle.com/datasets/amanupadhyay/yoga-poses.Fig 6 shows an example of each pose. It should also be noted that profile images without poses are also taken into account. Here, the first image belongs to the No Pose dataset category, followed by tree, shoulder stand and triangle images in the first row, while in the back are chair, cobra, dog and Soldier pose images in a single row.Although some images in the file have different orientations, they were changed by taking the yoga mat as a reference and making necessary adjustments before training the images. Images without regular orientation and without yoga mats are not considered for training and testing.

Figure7 [15] Different yoga poses

The yoga poses used in the dataset are 7 and they are

1) Cobra - Bhujangaasana
2) Triangle - Thrikonaasana
3) Tree - Vrikshaasana
4) Dog - Adhomukhaasana
5) Chair - Utkataasana
6) Warrior - Veerabadhraasana
7) Shoulder Stand - Sarvangaasana

Along with these no pose images are also used in order to get the pose feedback I.e, whether the pose is correctly replicated or not.

It is imperative to highlight that the dataset also includes images from a designated "no-pose" category. These images serve as crucial negative examples, providing the model with contextually diverse data points to enhance its ability to discern between poses and non-poses accurately. By incorporating these negative examples, the model is equipped with a more comprehensive understanding of the yoga pose landscape, thereby bolstering its robustness and discriminatory capabilities.
Through the inclusion of multiple individuals executing each pose with minor modifications, coupled with the incorporation of negative examples, the dataset encapsulates a broad spectrum of pose variations and contextual scenarios. This comprehensive approach not only enriches the training process but also equips the model with the requisite robustness and adaptability to effectively recognize and classify yoga poses across diverse real-world conditions and contexts.
In order to mitigate potential variations in orientations within the dataset, a rigorous preprocessing step was employed to standardize the images by aligning them with a reference yoga mat before initiating the training phase. This alignment process ensured uniformity and consistency across the dataset, thereby minimizing confounding factors and enhancing the model's ability to discern subtle pose variations accurately. Images lacking regular orientation or those devoid of a recognizable yoga mat were deliberately excluded from both the training and testing processes to maintain data integrity and fidelity.

During the dataset partitioning phase, great care was ta ken to ensure representative sampling and coverage of pose variations. The data was divided into different clu sters with 320 scenarios created for training and 30 uni que scenarios for rigorous testing. This classification he lps train a good model while ensuring good evaluation of performance metrics during testing.

Figure8 [16] Cobra(Bhujangaasana)

Figure9 [17] Triangle(Trikonaasana)

Figure12 [20] Chair(Utkataasana)

Figure10 [18] Tree(Vrikshaasana)

Figure13 [21] Warrior(Virabhadhraasana)

Figure11 [19] Dog(Adhomukhaasana)

Figure14 [22] Shoulder Stand(Sarvanaasana)

E. EXISTING Vs PROPOSED

EXISTING SYSTEM:

- Learning Yoga in the presence of the trainer(Yoga centers):

Learning Yoga with a Teacher (Yoga Center): A basic summary of the current system This has been developed over centuries. . It combines traditional yoga practices with modern teachings to create a harmonious, ethical and social environment for practitioners.These elements include teachers/instructors, students, facilities, courses, yoga models, equipment and community support.
This costs time and money. The Person should physically go to yoga center to practice yoga. For this they have to pay money to the yoga center. So now a days people are becoming more busy where they do not have time to visit yoga centers and learn yoga. This is the main drawback of this existing system.

Figure15 [23] Yoga class(offline)

- Learning through uploaded videos in the social media platforms.

Figure16 [24] Picture showing that user learning yoga through uploaded videos

Learning yoga from videos posted on social media platforms h as some disadvantages . Most importantly, there is no feedback or immediate treatment, which increases the risk of incorrect p ractice and injury. In addition, videos on social media often foc us on the physical body and ignore important aspects of yoga s uch as breathing (pranayama), meditation, and yoga philosophy . Lack of development makes it difficult for students to practice regularly, and many concepts can be confusing for beginners. I n addition, there is no social support or accountability, which re duces motivation and consistency. The quality of information a lso varies because social media platforms do not verify the cred entials of content creators, making it difficult to ensure that inf ormation is safe and secure. Finally, while social media videos can be useful tools, they lack the depth, safety, and personal car e.

- Virtual Yoga studios.

Virtual yoga studios offer convenience and flexibility, but they do have some disadvantages. The lack of self-guidance and immediate feedback makes it difficult for student s to adjust their bodies and avoid injury. There is a lack of com munity and accountability because virtual classes are often imp ersonal and there is no interaction with teachers or classmates. Additionally, instructors in a virtual environment can only prov ide instruction, limiting their ability to make real changes. The lack of dedication, the quiet environment and the quality of the courses also diminish the depth of the experience, making virtu al yoga less effective and more impactful than in-person practice.

Figure17 [25] Virtual Yoga practicing

These are the existing solutions for practicing yoga. They all have numerous disadvantages and our proposed system will surely clear few of those disadvantages.

Here are the proposed system advantages when compared to the existing systems:

- User can actually save there time by practicing yoga at there place.
- User can also save there money because they need not to go the yoga centers.
- Users will able to execute the pose perfectly by following the guidelines provided.
- Users will get the immediate feedback after executing the pose.
- They can able to know whether they executed correct pose or not.
- This will reduce the risk of injuries and protect users from long term health issues.

These are the major advantages of the proposed systems when compared to the existing system.

IV. IMPLEMENTATION

Coming to the major part of the whole work which is implementation, the following are the steps which have been followed:
The very first step is to collect the Image dataset and the dataset was taken from the kaggle website and after taking the dataset the next step is to convert the image dataset into numerical dataset for further execution.
The converted numerical data is in the form of csv file which is very comfortable to use for the proposed model.
Then data preprocessing should be done very carefully to avoid further complications.
The data which is preprocessed, the data is further moved into the next step using deep learning techniques.
The data which is divided into training is trained using the proposed model which is Y_PN_MSSD model which is the combination of 2 models they are Posenet and MobilenetSSD.

Here Posenet is used to mark all the keypoints of the body and we considered 17 keypoints in the body and they are

'NOSE': 0,
'LEFT_EYE': 1,
'RIGHT_EYE': 2,
'LEFT_EAR': 3,
'RIGHT_EAR': 4,
'LEFT_SHOULDER': 5,
'RIGHT_SHOUDLER': 6,
'LEFT_ELBOW': 7,
'RIGHT_ELBOW': 8
'LEFT_WRIST': 9,
'RIGHT_WRIST': 10,
'LEFT_HIP': 11,
'RIGHT_HIP': 12,
'LEFT_KNEE': 13,
'RIGHT_KNEE': 14,
'LEFT_ANKLE': 15,
'RIGHT_ANKLE': 16

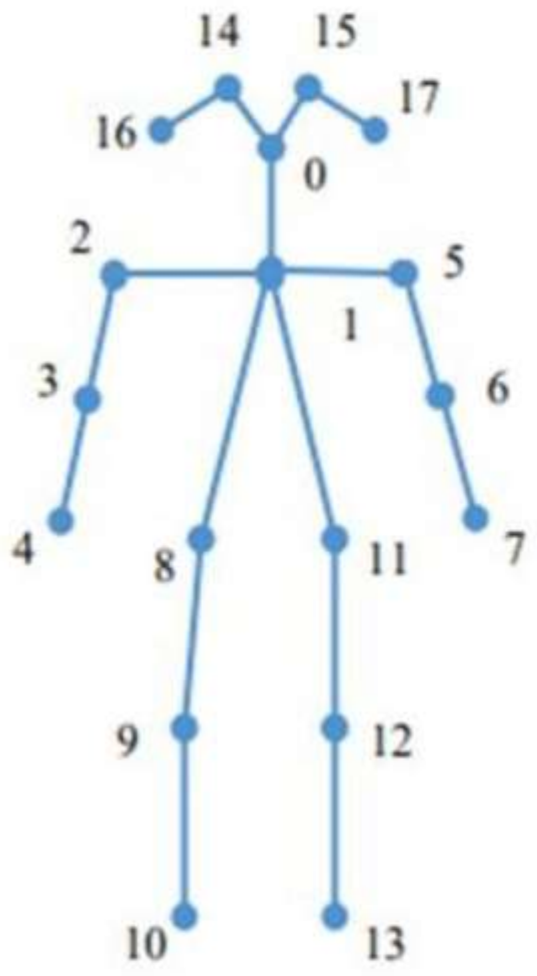

Figure18 [26] Keypoints Identified by Posenet(example)

The above figure shows the keypoints of the body identified by the Posenet but here, we can give any number any body part. It depends on our wish.
When we implement the whole project in the result the camera identifies your body based on these keypoints.
After completing the above phase next MobilenetSSD model execution will be done. This model is famously known for object detection. As this work is about to capture an image I.e, person executing yoga pose object detection plays a major. For this purpose the mobilenetssd model is a very good model.
This model is trained in a way so that , camera can detect the user and the further process can be done accordingly.
This step identifies the human in the frame and compares with the trained image to detect the correct posture.
Now both posenet and mobilenetssd plays together to compare the user input and the trained input. If the user input matches with the trained input perfectly then the result will be positive.

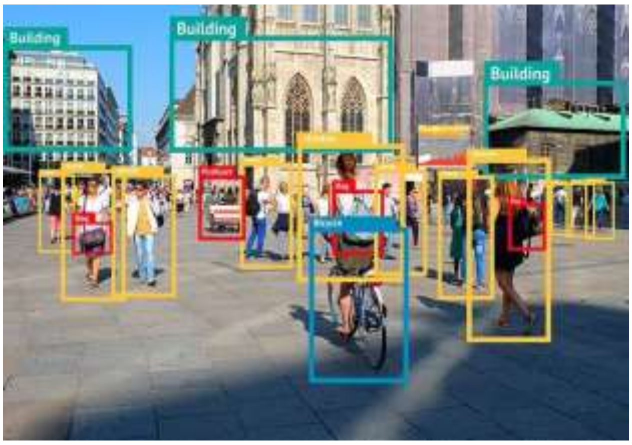

Figure19 [27] Object detection using MobileNetSSD

Here comes the final step of the implementation that is creating an interface to interact with the user. This is done using the technology called React js.

- Using React js an interface is created with an homepage which welcomes the user to use the yoga practicing application.
- Then the user can able to see the tutorial which shows the instructions of using the interface.
- And then there is something called about button which shows some information about the interface.
- There is another button called Let's start, when you click on this button the interface directs the user to the main page.
- The main page contains a select button which have 7 yoga poses and they are 1) Tree, 2) Cobra, 3)Chair, 4) Warrior, 5) Shoulder Stand, 6)Dog, 7)Triangle.
- User have to select a pose from the 7 yoga poses to practice.
- After selecting a pose on the right side the pose image will be displayed. Which helps the user to replicate the pose.
- Then in the left side the steps are provided to practice that particular pose.
- When the user put the yoga pose the camera starts detecting the keypoints of the user's body.
- On the top left corner there will be 2 boxes which calculates the time of the pose and the best time taken to keep the pose.
- And in the end the output will be displayed as green or red in colour.
- If the user executes the pose correctly the skeleton will be in green colour otherwise it displays white colour.
- Here white colour says that the user did not put the pose in a correct way. So after this indication the user can able to change the posture untill the skeleton becomes green colour.
- This is how the interface gives feedback and this will avoid user to get long term health issues due to injuries.
- After practicing the pose correctly user can click on the stop pose button which is at the top middle of the page.
- After this action user will be redirected to the homepage.

V. RESULTS

The result of this work will be in visual form where the user need to give the input through the camera. Then the following steps should followed strictly:
When we access the interface it asks us to allow camera to access and capture the pose.Then User have to select the pose.The next step is, the user have to read the instructions to practice the yoga pose.Then user have to click on Start pose so that user can see the image of that pose on the right side and can do that pose in front of the camera.If the user performs the correct pose, the skeleton will be green in color otherwise it shows white colour.
The following are the results:

Figure20 The HomePage of the interface

The above picture shows the home page of the interface. On the left side a name is displayed I.e, 'Yoga' and on the right side of the page 'About' button is mentioned. When user clicks on the About it opens some information related to the interface.
The title of the interface is 'A Yoga Trainer' it is displayed in the middle of the page as shown in the above figure.
There are 2 boxes located just below the title and they are 'Let's start' and 'Tutorials'. Here the Tutorials gives the information about how to use the interface.
And the another one I.e, Let's start directs into the main page. This is all about the home page of the interface.

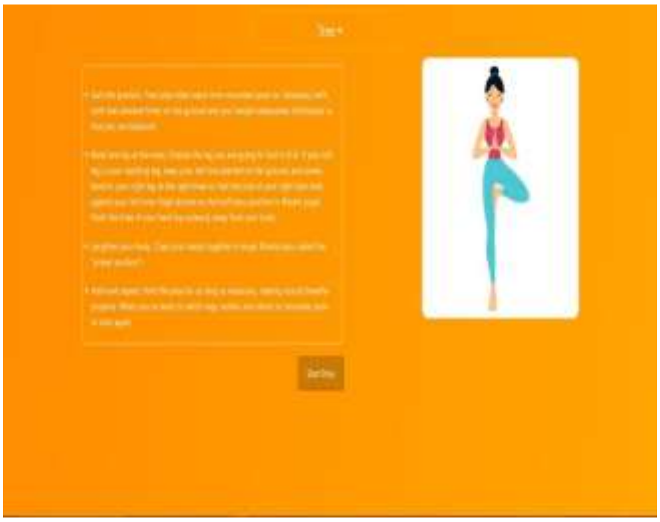

Figure21 Main Page

Above provided picture is the main page of the interface. The picture shows asks user to select the pose from the 7 poses provided.
In the above picture Tree pose is selected and as shown in the picture, at the right side of the page the pose image will be displayed.
And on the very left side of the page the steps to create the particular pose will be attained.
Also in the down a called 'Start Pose' is displayed which takes the user to the next page where the user can make the pose.

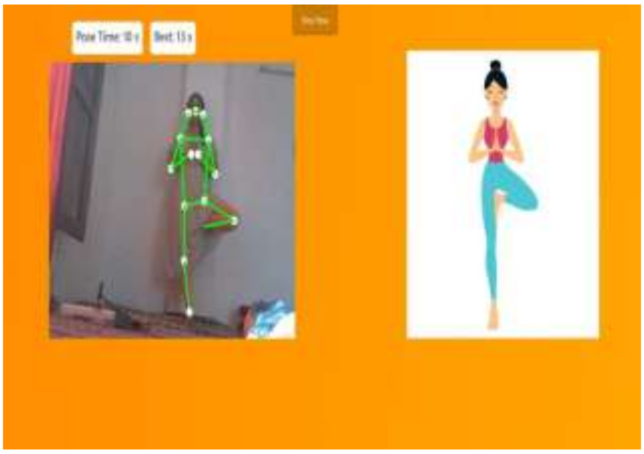

Figure22 Tree pose (correct execution)

The above figure shows that the user is trying to execute the pose called Tree Pose(Vrukshaasana). As the skeleton of the user is shown in green colour , it confirms that the user had put the pose correctly. And to access the camera user need to allow the camera permission otherwise the camera will not able to detect the user's body.

User can also see the pose time and the best time. Which can actually improve the user's practice. And if the user want to stop the practice of that particular pose , they can click on the stop pose button. And this will redirect the user to the main page.

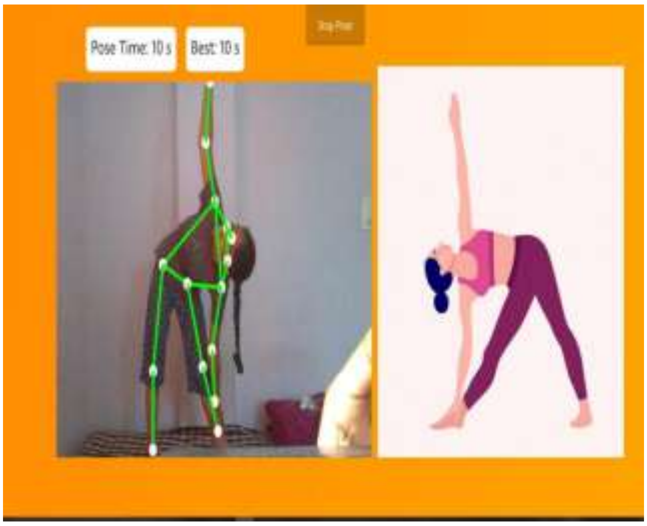

Figure23 Triangle Pose(correct pose)

The figure above is the practice of Triangle pose (Trikonaasana) and as the skeleton is green in colour that indicates , the pose is placed in a correct way.

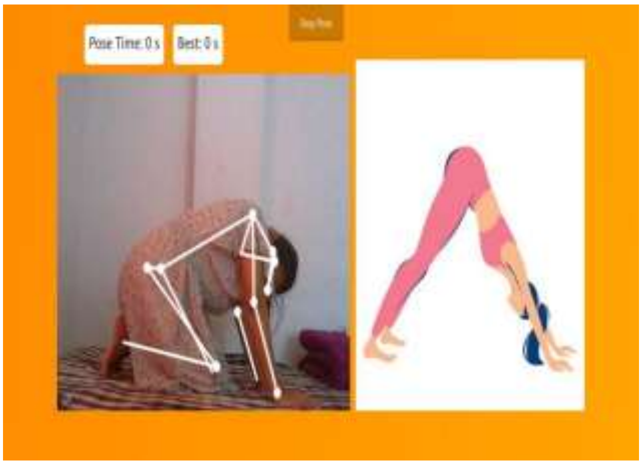

Figure24 Dog Pose (wrong execution)

The above figure indicates that the Dog pose (Adhomukhaasana) is not practiced in a correct way that is why the skeleton is in white colour and the pose time and the best time are 0 seconds. It shows like this until the user put the pose correctly.

VI. CONCLUSION

Proper posture is critical in yoga, and technology, particularly deep learning models, holds promise in ensuring correct performance.

The model leverages Pose-Net for feature point detection and Mobile-Net SSD for human detection in each frame, providing a robust combination for accurate posture recognition.

Comparative analysis with the Pose-Net CNN model reveals superior accuracy, highlighting the Y_PN-MSSD model's value not only for yoga but also for diverse applications in sports, surveillance, and healthcare where activity recognition and pose identification are crucial.

The design model is based on the integration of Pose-Net and Mobile-Net SSD using the performance of content detection and human detection in each frame.

Its development is divided into three main stages, each of which improves the efficiency and effectiveness of the model. and provides a comprehensive collection of open source documentation.

This includes ways to make a difference, supporting educational materials, and improving its compliance with various yoga poses. , a process that quickly pays off for expansion.

The goal of this stage is feature extraction, which carefully combines the main points of the human body to form the basis of good body recognition.

By training iterative iterations, the model improves its ability to recognize small differences in compliance, paving the way for the classification of yoga poses. Available.

The model provides users with recommendations and guidance, using insights from training to mastering yoga poses instantly. This tracking now allows doctors to treat their bodies better, thus developing a deeper understanding of relationships and processes.

The commitment is suitable for practitioners of all levels and backgrounds. Through the use of technology, it bridges the gap between traditional yoga teaching and the freedom of modern digital interventions, personal guidance and support.

Moreover, the potential to revolutionize yoga teaching remains limitless. With each iteration, it comes closer to realizing the vision of a virtual yoga teacher who can provide advice and support to practitioners worldwide, providing users with instant help and instant feedback to improve their postures as they practice.

This innovative approach sets it apart from traditional systems, allowing users to instantly update and improve their systems. Unlike the Pose-Net CNN model, the Y_PN-MSSD model achieves better accuracy, highlighting its effectiveness as a versatile tool with wide application in many fields.

VII. FUTURE SCOPE

In future, the yoga posture recognition application can be trained with more number of yoga poses.

Additionally, full-fledged training can be performed to build a fully adapted real time model for a real-time noise environment to act as a professional yoga trainer.

An audio-based alert can be included as part of the future scope to indicate a signal to the user when the correct posture is attained

In essence, the future development of this model is poised to revolutionize the landscape of yoga practice and instruction, democratizing access to this ancient discipline while upholding its core principles of proper form, technique, and mindfulness.

Through relentless innovation and refinement, the model will continue to empower individuals of all backgrounds and abilities to embark on a journey of self-discovery and holistic well-being through the practice of yoga.

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AUTHORS CONTRIBUTIONS

VinayKumar and Vinay were involved in Idea recognition and collection of the dataset. Vinayaka Datta, Vinesh, and Vinod were involved in the conceptualization, methodology, software. Vinay took care of investigation, resources, data curation, writing original draft, reviewing and editing of writing. Vinesh, Vinod and Datta. were involved in figures and tabulation of results . Vinod and Vinay were involved in validation . All authors contributed to the editing and production of the research.

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