Exercise Trainer

Aleena Jayan[1*], Godwin George U.[2], Muhammed Juvail P.[2], Saranya R.[3]

[1]Dept. Electronics and Communication Engineering, NSS College of Engineering, Kerala, India
[2]Dept. Electronics and Communication Engineering, NSS College of Engineering, APJKTU, Kerala, India
[3]Assistant Professor, Dept. Electronics and Communication Engineering, NSS College of Engineering, APJKTU, Kerala, India

*Corresponding author's e-mail: aleenajayan2001@gmail.com
doi: https://doi.org/10.21467/proceedings.160.28

ABSTRACT

Frequent physical activities may significantly improve someone's health and well-being, but if not done properly, they can also be useless and even dangerous. A frequent error committed by users might be inappropriate exercise posture, which results from the wrong form or posture. This study introduces Exercise Trainer, a system that analyses a user's posture during exercise and offers tailored advice on how to improve form. The system collects motion data from users using an optical camera, assesses their posture, contrasts it with ideal postures, and then offers suggestions for improving their posture. The suggested model makes use of the TensorFlow MoveNet model, which forecasts 17 key points or coordinates of different body parts using the JSON file produced by TensorFlow.js. TensorFlow.js generates a JSON file that interfaces with the web application, enabling the system to provide the user with real- time feedback on the correctness of their workout posture. This feature makes sure that the user gets instant feedback so they may correct their form as needed while exercising.

Keywords: Exercise Trainer, TensorFlow, MoveNet model

1 Introduction

Regular physical activity and exercise have many positive health effects that are difficult to deny. Everyone, regardless of sex, age, or physical ability, benefits from exercise. Every organ in the body, including the mind, benefits from exercise. Those who exercise are more likely to maintain a healthy weight and have fewer illness risks. Exercise boosts the immune system and promotes healthy aging. Yet, exercise also has a negative side that thousands of individuals experience daily. Exercises done wrong to have a number of possible negative repercussions. Your muscles and joints might get overworked as a result of poor form or technique, which raises your risk of fractures as well as sprains and strains. You could not be using the right muscles or doing the activity in a way that will benefit those muscles if you are not completing an exercise properly. This may lessen the exercise's efficacy and decrease your chances of making progress toward your strength, endurance, or other fitness objectives. Some folks might not think they can afford the price of a fitness class or gym membership. When it comes to exercise, some people may not know where to begin and may believe they cannot afford the expense of a personal trainer or other expert advice.

Machine learning algorithms and deep neural networks have significantly advanced the science of computer vision, which focuses on giving computers the ability to interpret and comprehend visual input from the outside world. The identification of human exercise postures is one of the most exciting uses of computer vision, and it has huge promise for enhancing physical fitness and general well-being.

The MoveNet model and Google TensorFlow are used in this study to propose a unique method for identifying workout positions. The model effectively detects human positions and movements by utilizing deep learning, which enables real- time feedback and individualized coaching during workout programs [1]. Thorough testing and analysis show the model's efficacy, demonstrating its potential to completely alter how people think about fitness and well-being. A noteworthy development in computer vision is integrating the workout position detection model into a Raspberry Pi system with a Pi Cam and a display. The precision and efficacy of fitness training are improved by this

Proceedings DOI: 10.21467/proceedings.160; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-965621-9-9

setup's real-time feedback and coaching during workout routines. The web app, which was created using React, also offers customers a user-friendly interface via which they can interact with the system and examine the results.
The model is adaptable and suited for a variety of activities since it has been trained for 11 distinct positions. Also, the trained model has been hosted on an Amazon S3 web server as a JSON file using TensorFlow JS, a well-known machine learning framework [2]. These platforms and technologies have been combined to provide a highly effective activity pose identification system that has the potential to revolutionize the fitness sector.

2 Problem Statement

The detection of exercise poses has enormous potential to revolutionize the fitness industry by providing accurate real- time feedback and personalized coaching to users during their exercise routines. However, traditional methods of detecting exercise poses can be complex and time-consuming, making it difficult for users to receive immediate feedback on their form and technique. Furthermore, existing solutions often require expensive hardware or software and can be difficult to scale. Therefore, there is a need for a more accessible, cost-effective, and efficient exercise pose detection system that can be easily integrated into users' daily routines. This paper aims to address these challenges by presenting a novel approach for detecting exercise poses using Google TensorFlow and the MoveNet model, embedded into a Raspberry Pi system with a Pi Cam and a display. The proposed solution leverages machine learning algorithms to accurately recognize human poses and movements, providing real-time feedback and personalized coaching to users during their exercise routines. The goal of this research is to demonstrate the effectiveness of this approach and its potential to transform the fitness industry.

3 Objective and Scope

To introduce a revolutionary method for recognizing exercise positions that integrates MoveNet and Google TensorFlow into a Raspberry Pi system with a Pi Cam and a display, giving users real-time coaching and feedback while they exercise. TensorFlow JS was used to develop the workout position detection model, which was then integrated into a Raspberry Pi setup with a Pi Cam and a display, a web app was created using React, and system accuracy and efficiency were tested. people who want to enhance their health and fitness through precise coaching and real-time feedback during their workouts. All levels of fitness can use this system because it is adaptable.

4 Proposed System

The proposed system is an exercise pose detection model that utilizes the MoveNet model, which is a machine-learning model developed by Google for human pose estimation. MoveNet is a superior model to previous models such as PoseNet because it was trained using video data rather than multiple pictures, resulting in better accuracy and performance in real-time applications. MoveNet ML Model is shown in Fig. 1. The MoveNet model is integrated into a Raspberry Pi system with a Pi Cam and a display, providing real- time feedback and personalized coaching to users during their exercise routines [3]. The system includes a web app built using React, allowing users to interact with the system and receive real-time feedback on their form and technique. The Raspberry Pi system captures video footage of the user's movements using the Pi Cam, which is analyzed in real time by the MoveNet model to detect exercise poses. The system then provides personalized feedback and coaching to the user via the display, enhancing their overall fitness experience and helping them achieve their fitness goals. The MoveNet model can detect 11 different exercise poses out of the box, and additional poses can be added by training the model on more data. This flexibility makes the system adaptable to the needs of different users and allows for continuous improvement and expansion of the model. The system is designed to be easily integrated into users' daily routines, providing a user-friendly interface and personalized feedback to enhance their overall fitness experience. The flow chart of the system is shown in Fig. 2.

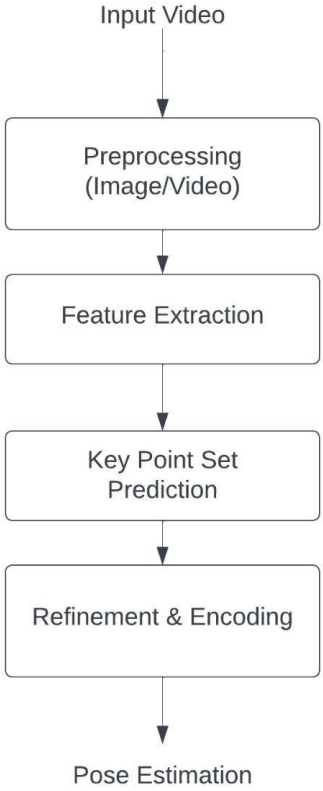

Figure 1: *ML Model Diagram*

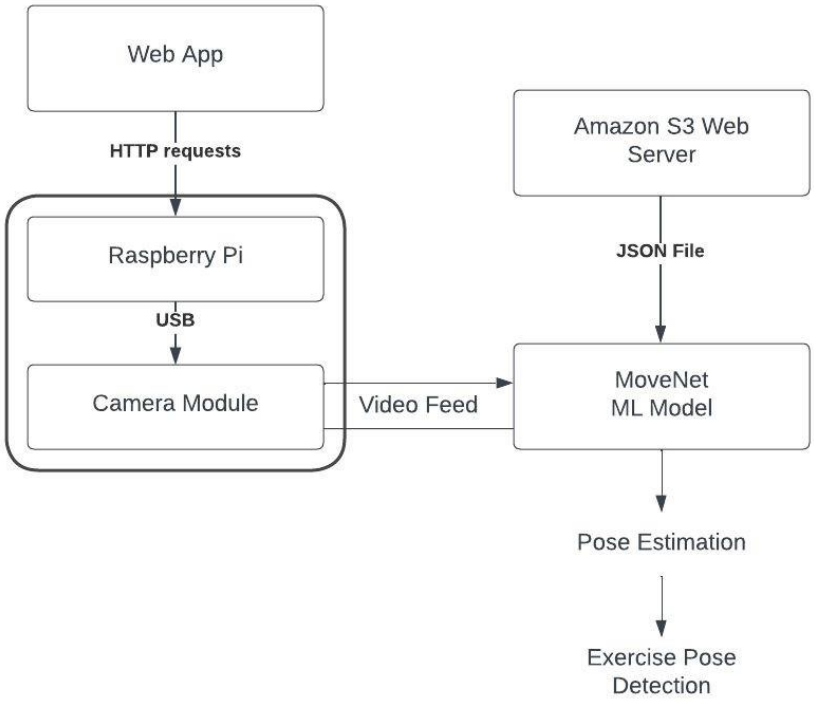

Figure 2: *Flow Chart of Exercise Pose Detection System*

5 Hardware Description

The proposed exercise pose detection system is designed to be integrated into a Raspberry Pi, which is a low-cost and energy-efficient single-board computer. The system uses a Raspberry Pi camera module (Pi Cam) to capture video footage of the user's movements and analyze them in real-time using machine learning algorithms. The Raspberry Pi

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

camera module is a small, low-cost camera that connects directly to the Raspberry Pi's onboard CSI (Camera Serial Interface) port. It has a resolution of up to 8 megapixels and can capture video at 1080p at 30 frames per second. The Pi Cam is ideal for capturing high-quality video footage of the user's movements, making it an excellent choice for this system. In addition to the Raspberry Pi and Pi Cam, the system also includes a display for providing real-time feedback to the user. The display can be connected to the Raspberry Pi's HDMI port, providing a clear and user-friendly interface for users to interact with the system. The display can be any size, depending on the user's preferences, and can be mounted on the Raspberry Pi or placed separately. Overall, the hardware requirements for the proposed exercise pose detection system are minimal, making it an accessible and cost-effective solution for users. The Raspberry Pi and Pi Cam provide a powerful and efficient platform for analyzing video footage in real-time, while the display allows for easy and user-friendly interaction with the system.

6 Result and Discussion

There are a number of possible advantages for fitness enthusiasts adopting the MoveNet model and Raspberry Pi-based proposed system for exercise position identification. The device can assist users do exercises with perfect form, lower the chance of injury, and improve their overall fitness experience by offering real-time personalized feedback and coaching on exercise technique. In comparison to conventional pose estimation models, the system's usage of the MoveNet model offers a number of benefits, including real-time processing and the capacity to identify numerous poses in a single video frame.

The proposed system's need for a steady internet connection to host the MoveNet model on Amazon S3 is one potential drawback. In places with poor internet access or excessive latency, this might be difficult. Lighting, camera positioning, and other environmental elements may also have an impact on the system's accuracy. But by applying the right system design and implementation techniques, such as optimizing camera positioning and making use of the right illumination, these constraints can be overcome. Overall, the proposed method has the potential to offer fitness lovers a useful tool for enhancing their workout form and technique. The system is adaptable and configurable, and it may be scaled and modified to suit different poses.

The outcome of the proposed system is a reliable and accurate exercise pose detection solution that provides personalized feedback and coaching to the user via the Raspberry Pi display. The MoveNet ML model used in the system provides superior performance compared to traditional pose estimation models due to its real-time processing capabilities and ability to detect multiple poses in a single video frame. The system has a high degree of accuracy in detecting exercise poses, enabling users to perform exercises with proper form and technique, reducing the risk of injury and enhancing their overall fitness experience. With the ability to add more poses using additional data, the system is expected to be adaptable and scalable, providing a flexible and customizable fitness solution.

Fig. 3. Shows how the exercise trainer detects the incorrect pose and Fig. 4. shows how it detects the correct exercise posture.

Figure 3: *Wrong Pose*

Figure 4: *Correct Pose*

7 Conclusion

In conclusion, the MoveNet model and Raspberry Pi-based exercise position recognition system has the potential to be a useful tool for fitness enthusiasts looking to enhance their exercise form and technique. Users will receive personalized real-time feedback and coaching from the system, which will lower their risk of injury and improve their entire fitness experience. When compared to conventional pose estimation models, the MoveNet model has a number of benefits, including real-time processing and the capacity to identify numerous postures within a single video frame. Although the proposed system might have some drawbacks, such as the need for a reliable internet connection to host the MoveNet model and the possibility that environmental factors could reduce its accuracy, these drawbacks can be overcome through careful system design and implementation. The system's accuracy and performance can be improved with more testing and research, making it a more durable and dependable fitness solution. As a whole, the suggested system has the potential to significantly advance the field of fitness technology by giving users a trustworthy and precise tool for enhancing their workout form and technique.

8 Future Scope

There are a number of potential directions in which the MoveNet model and Raspberry Pi-based exercise position detection system could be developed and expanded in the future. Incorporating other sensors, such as heart rate monitors, to give consumers more thorough feedback on their exercise performance is one potential avenue for future research. Users can use this to monitor their development over time and modify their workouts accordingly. The employment of machine learning methods to raise the system's performance and accuracy is another potential future focus. To increase the MoveNet model's capacity for pose detection and movement adaptation, this may include training it on new data sets. The suggested method can also be improved by adding new workout routines and exercises, giving customers access to a more complete and individualized fitness experience. As a result of user input and data analysis, new positions and exercises may be added. To give customers a seamless and integrated fitness experience, the suggested system can also be connected with already-existing fitness monitoring platforms and applications, such as Fitbit or MyFitnessPal. In conclusion, the suggested system provides a number of potential areas for further growth and development, offering chances to improve its functionality, accuracy, and user experience. These potential upgrades could contribute to the system being a more complete and adaptable exercise option for users.

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

9 Publisher's Note

AIJR remains neutral with regard to jurisdictional claims in institutional affiliations.

How to Cite

Jayan *et al.* (2023). Exercise Trainer. *AIJR Proceedings*, 226-231. https://doi.org/10.21467/proceedings.160.28

References

[1] BeomJun Jo , SeongKi Kim, Comparative Analysis of OpenPose, PoseNet, and MoveNet Models for Pose Estimation in Mobile Devices, Traitement du Signal Vol. 39, No. 1, February 2022, pp. 119-124 Journal homepage: http://iieta.org/journals/ts.(February-2022)

[2] Prof. Mrs. Hemapriya B C, Prathibha R, Sarita Kumari, YOGA AI TRAINER USING TENSORFLOW .JS POSENET, International Research Journal of Modernization in Engineering Technology and Science , Peer- Reviewed, Open Access, Fully Refereed International Journal(February- 2022).

[3] Yamao, K., Kubota, R Development of Human Pose Recognition System by Using Raspberry Pi and PoseNet Model, In 2021 20th Interna- tional Symposium on Communications and Information Technologies (ISCIT)(October-2021)