



International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 2(3) (2026)



ijerst.editor@gmail.com
editor@ijerst.com

Research Paper

An Adaptive Deep Learning Framework for Automated Fitness Coaching with Motion Feedback

Mergu Akshith Goud¹, Palakuri Vinuthna², Ambati Sai³, Yerukumajji Akash⁴, Dr G. JawaharlalNehru⁵

^{1,2,3,4}Students, Department of Computer Science and Engineering, Sree Dattha Group of Institutions, Sheriguda, Ibrahimpatnam, Telangana, India

⁵Associate Professor, Department of Computer Science and Engineering, Sree Dattha Group of Institutions, Sheriguda, Ibrahimpatnam, Telangana, India

Abstract— The rapid development of the use of AI in healthcare and fitness has generated potential for the creation of intelligent & automated personal coaching solutions that enhance user engagement as well as performance. This study introduces an adaptable deep learning framework for automated fitness coaching with motion feedback, emphasizing the identification of exercise activities and the provision of tailored workout recommendations. Conventional fitness systems frequently rely on manual oversight, wearable devices, or comprehensive user-specific data, including body metrics and posture analysis, so constraining their accessibility & scalability. Certain existing systems utilize machine learning methodologies for activity recognition; nevertheless, they exhibit only modest efficacy and lack quick adaptability & individualized feedback. Moreover, numerous methodologies prioritize model comparison over enhancing user-centric recommendations & system usability. The proposed method employs a custom-built YOLOv11 convolution neural networks, to identify and categorize 36 distinct exercise postures from photographs given by users. The system automatically creates tailored workout plans and offers posture correction recommendations based on identified activity as well as fundamental user input, such as age. The framework is executed via a web-based interface featuring modules for user identification, model training as well as loading, visualisation of

training results through accuracy as well as loss graphs, including real-time activity detection including recommendation capabilities. The suggested system enhances accuracy, adaptability, & practical usefulness by integrating deep learning along with an interactive learning platform, rendering it an excellent solution for individualized fitness instruction performance optimization.

Keywords— Deep Learning, Personal Fitness Coaching, Motion Feedback, YOLOv11, Exercise Recognition, Convolutional Neural Networks (CNN), Activity Classification, Personalized Workout Recommendation, Human Pose Detection, Web-Based Application, Real-Time Monitoring, Performance Optimization

I. INTRODUCTION

The global acceptance of artificial intelligence (AI) based technologies in health care, wellness, and fitness is accelerating, generating new prospects for the creation of intelligent & automated personal coaching systems. These systems aim to enhance user's health, fitness performance, and involvement by offering superior advice and monitoring during exercise sessions [5]. Traditional fitness programs primarily rely on human inputs, predetermined workout regimens, or external wearable technology, thereby diminishing their flexibility and constraining personalization [8]. Numerous systems also lack the provision of feedback in real time, which is crucial

for rectifying posture and enhancing workout efficacy [9].

In recent years, many studies have concentrated on the application of machine learning as well as deep learning methodologies for human activity identification & fitness coaching [4]. Certain systems employ image recognition and AI-driven models to recognize exercises and assist users at home; nonetheless, they continue to encounter issues with accuracy & adaptability [2]. Additional research indicates that activity systems for recognition typically exhibit only moderate efficacy and lack robust generalizability across diverse users and situations [13]. Furthermore, several AI-driven fitness trainer applications only concentrate on workout tracking and fail to offer adequate individualized recommendations or remedial feedback [10].

Many advanced methodologies, like AI fitness models & digital twin systems, aim to enhance the personalization and analysis of physical activity [6]. Nevertheless, these systems typically necessitate comprehensive user-specific data, such as body measurement data, sensor inputs, as well as motion records, which are challenging to gather and sustain in practical situations [7]. This reliance on intricate data renders such systems less practical as well as diminishes their accessibility for the broad populace [11]. Consequently, a more scalable & user-friendly approach is required to deliver precise activity recognition and individualized advice without dependence on complex data inputs [12].

This research presented an AI-driven personal fitness coaching system utilizing a custom-built YOLOv11 Convolution Neuronal Network (CNN) algorithm for exercise detection [1]. The model can identify and categorize 36 distinct workout postures from photographs supplied by users, rendering the system both efficient and dependable [2]. This method primarily depends on visual input rather than intricate biometric as well as sensor-based data, hence streamlining the procedure while preserving satisfactory accuracy [13]. The technology develops individualized training routines and offers posture correction coaching to enhance safety and performance, based on detected activity and fundamental user characteristics such as age [10].

The proposed approach is executed on a web-based platform comprising modules for authentication of users, model training with loading, display of training performance through accuracy and loss graphs, along with real-time activity identification with

recommendation capabilities [14]. This design guarantees that the system is user-friendly, accessible, and appropriate for actual time workout monitoring [11]. The suggested strategy illustrates the effective application of deep learning in creating an intelligent, adaptive, & user-centric fitness coaching system that deals with the shortcomings of current methodologies [6].

II. LITERATURE SURVEY

Haoran Ji et al. (2022), [2] examine the increasing demand for home-based training options, particularly following the COVID-19 epidemic, which restricted access to clubs. The authors developed an AI-driven fitness coaching system which provides real-time exercise assistance, contrasting with the passive instruction of conventional online workout videos. The device utilizes a stationary camera to record the user's motions and employs pose recognition methods to distinguish various exercise postures. The identified poses undergo further analysis to assess the accuracy of motions, with a focus on this evaluation, the system provides feedback through visual or auditory instructions. The framework comprises three primary components: posture recognition, movement analysis, & feedback generation. Experimental findings indicate that the suggested system operates efficiently and delivers an engaging training experience, rendering it a valuable solution for enhancing exercise quality & user engagement in a home setting.

Mahendran Narayanan et al. (2021), [3] provide a fitness assistance application aimed at assisting users in achieving proper posture during exercise and yoga practices. Although several fitness solutions emphasize food planning, workout tracking, including wearable technology, they frequently lack sufficient guidance during exercise sessions, particularly in remote settings. To resolve this issue, the scientists created a system named Fitness Tutor, which utilize posture estimation algorithms to provide real-time guidance to users. The device functions by juxtaposing the user's posture against a reference image & subsequently offering recommendations based on the discrepancies identified. It employs the PoseNet model executed in TensorFlow in conjunction with p5.Javascript to construct a skeletal model of the human anatomy for examination. This method enables users to engage in workouts autonomously while still obtaining feedback on their position. Experimental findings indicate that the system efficiently employs pose

estimation to provide real-time guidance, rendering it a valuable instrument for enhancing exercise precision and the overall fitness experience with training.

Hristo Novatchkov et al., (2013), [5] This study examines the application of artificial intelligence (AI) in sports training, namely in weight training activities. The primary aim was to employ pattern recognition algorithms to assess the execution of workouts on gym equipment. Sensors were affixed to weight training apparatus to quantify critical parameters such as strength and movement displacement while exercise sessions. Utilizing the gathered data, supplementary metrics such as velocity and duration were computed. These traits were subsequently employed to create machine learning models that can autonomously assess workout performance and deliver valuable feedback. The study had 15 volunteers with minimal expertise, who executed repeated sets of leg press workouts. Their performance was assessed by expert trainers utilizing recorded films for classification and evaluation purposes. The findings suggested that the recommended models attained high accuracy in evaluating exercise quality, illustrating that AI methodologies can proficiently assist athletes and coaches by enhancing training quality, maximizing performance, and aiding in injury prevention.

Alessandro Petrini et al. (2020),[7] describe a fitness monitoring methodology utilizing the notion of human based Digital Twins (DTs), wherein each virtual model embodies an athlete and incessantly monitors their daily activities, including dietary intake, physical exertion, and sleep habits. Upon accumulating adequate data as time passes, the digital twin can forecast the athlete's performance throughout training sessions and recommend enhancements if the outcomes are unsatisfactory. The technique is included into a platform named SmartFit, which assists trainers and coaches in monitoring and managing athlete performance more efficiently. Data is gathered using IoT-enabled wearable gadgets and manual inputs such as mood as well as diet, and such information is seen as dynamic data that represents the athlete's current condition. As further data is collected, it is saved and utilized to enhance the system's predictive accuracy. The findings indicate that this method can produce dependable predictions and significant recommendations, which can aid in enhancing athlete performance. The system, while intended for sporting

applications, can also be used for various fitness and activity monitoring purposes.

Bakhytzhan Omarov et al. (2023)[13] discuss the creation and assessment of a system powered by deep learning intended for the real-time monitoring of students' physical activity. The suggested methodology employs convolutional neural networks (CNNs) to precisely monitor and evaluate various exercises executed by pupils, facilitating a comprehensive assessment of their performance. The system utilizes powerful AI approaches to deliver data that are both accurate as well as faster than conventional monitoring methods. The study emphasizes how this technology might facilitate tailored training by providing real-time feedback, hence enhancing physical education methods. Experiments conducted on several student cohorts indicate that the model effectively recognizes and assesses actions. The authors highlight that this methodology is not confined to educational settings but may be used to wider health and fitness contexts. The work demonstrates how AI-driven solutions may revolutionize traditional fitness tracking into a smarter, efficient, and tailored method, enhancing health and training results.

III. DATASET DESCRIPTION

In our proposed research, we utilized a physical activity data comprising various photos and video examples of human exercises. This dataset is primarily utilized to train and evaluate the method of deep learning for identifying diverse workout and yoga poses. It comprises approximately 36 distinct workout forms, including squat, lunge, push-up, plank, frog position, and various other prevalent physical activities. Each exercise category comprises numerous photographs taken from various positions, perspectives, lighting conditions, and backdrops, facilitating enhanced model learning and accurate performance in real-world scenarios. The dataset is compiled from publically accessible sources and includes custom photos, guaranteeing differences in body alignment, orientation, along with environment. Moreover, several video clips are incorporated in the dataset to evaluate real-time activity recognition. All photos are categorized according to their corresponding exercise classes to facilitate the model's learning through supervised learning methodologies.

After dataset collection, it undergoes a preprocessing phase essential for preparing the collected information for model training. During this phase, all photos are shrunk to a uniform dimension, and values

for pixels are standardized to enhance model efficacy. The dataset is structured into folders categorized by class, facilitating training and classification. Data augmentation methods, including rotation, flipping, and scaling, are employed to expand the dataset and mitigate overfitting. These measures enhance the model's ability to generalize and accommodate variances in input data. The dataset is subsequently partitioned into sets for training and validation to accurately assess model performance. Utilizing this curated dataset, the model acquires knowledge of various posture patterns & can precisely categorize activities. During evaluation, the system analyzes user-uploaded photos or videos to predict activities based on the model that has been trained, facilitating current time fitness suggestions and feedback.

IV. PROPOSED WORK

Execution of the proposed approach adheres to a sequential process, commencing with the initiation of the application and culminating in the generation of fitness suggestions. The system is constructed utilizing a Python-based web structure, wherein the server is initially initiated that the application is connected via a web browser through a local host URL. The primary interface features a user login page in which individuals input their credentials to gain access to the system. Upon successful login, the user is led to the primary dashboard, which features various modules like model training, training graph visualization, image-based activity recognition, and video-based activity recognition. This configuration renders the system intuitive and accessible for users.

The system's fundamental component is the deep learning model utilizing the YOLOv11 based Convolutional Neural Networks (CNN) method. During the training stage, the model is developed utilizing the curated fitness dataset comprising various exercise categories. Throughout this method, the system acquires the ability to identify and categorize various workout postures. Upon completion of the training, the system presents classification accuracy for every workout category. This aids in comprehending the model's performance across various tasks. The training outcomes demonstrate that the model can proficiently acquire posture patterns and differentiate among several exercises.

The framework offers a training graph module for a comprehensive analysis of model performance, visualizing several metrics like loss, precision, and recall. The graphs depict numbers of epochs at the x-

axis as well as performance values on y axis. The graphs illustrate that, as training advances, loss values diminish while accuracy as well as precision enhance, signifying that the model learns efficiently and improving with time. This visualization assists in assessing if the model is adequately trained or requires additional refinement.

The activity detection module allows the user to upload an activity-related image, which the system processes utilizing the trained model. The YOLO-based approach identifies the body position in the photograph and categorizes the exercise, such as squat, frog pose and many more. Upon recognizing the activity, this system formulates a tailored training regimen that incorporates suggestions based on the recognized activity and user-specific factors such as age. The output additionally furnishes pertinent information, like strength levels, repetitions, as well as safety guidelines, which assist users in executing workouts accurately and properly.

The system enables facilitates activity identification from videos, allowing users upload the video file for examination. The model analyses the video sequentially and identifies activities in real time. The identified activity is presented on the screen displaying visual bounding boxes encircling the observed posture. Users can view the outcomes and pause the movie as necessary. The system integrates deep learning with a user interactive online interface to deliver an entire solution for exercise detection, real-time feedback, and tailored fitness suggestions, thereby enhancing practical fitness applications.

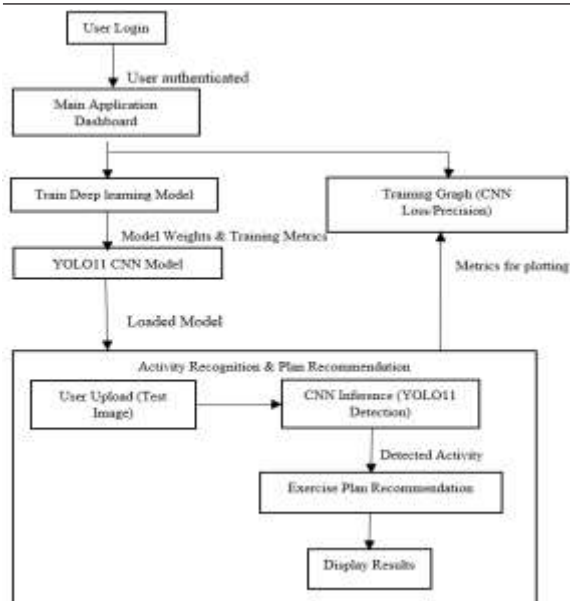


Figure 1: System Architecture for Deep Learning-Based Fitness Activity Recognition System

V. RESULT AND DISCUSSION

The initial phase of proposed system is the user login screen, where users must input their credentials to gain access to the program. This interface offers a straightforward and secure method for authentication by requesting a password and a username. Upon the user inputting the accurate credentials and selecting the login option, the platform authenticates the information and permits entry to the primary dashboard.

After successful authentication, the user is able to train a deep learning algorithm utilizing the dataset. Throughout training, the model acquires the ability to recognize various workout positions. The system then presents the classification accuracy for all actions. Figure [2] illustrates that the model attains high accuracy across many exercise categories, signifying its effective pattern recognition. This outcome validates the efficacy of the training process and establishes the model's reliability for activity recognition.

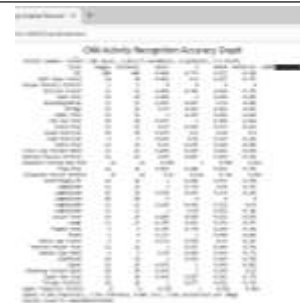




Figure 4: Activity Recognition and Exercise Plan Recommendation

The device additionally accommodates video input for instantaneous activity recognition. The uploaded video undergoes frame-by-frame processing, with ongoing action detection. Figure [5] illustrates that the system recognizes exercises such as squats and lunges, displaying them while video playback. This illustrates the system's ability to manage dynamic inputs and offer continuous monitoring, rendering it appropriate for current time fitness applications.

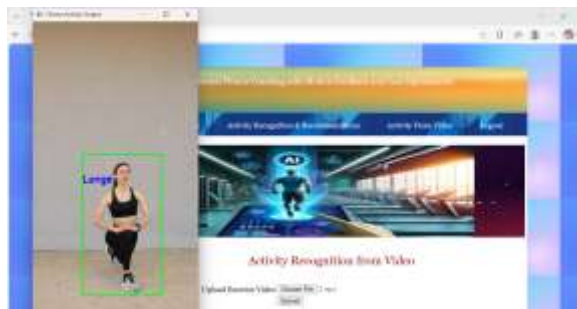


Figure 5: Activity Recognition from Video Input

DISCUSSION

The outcomes of the proposed method indicate that deep learning may significantly enhance fitness activity identification and tailored workout recommendations. Conventional fitness applications primarily offer static guidance and lack feedback in real time, hindering users' ability to rectify their posture and precisely monitor their performance. The primary aim of this project was to create intelligent fitness coaching platform capable of autonomously identifying workout activities and providing appropriate recommendations. This study involved training a deep learning model with a dataset of various exercise postures, allowing the system to identify activities from both photos and videos. The training outcomes demonstrate that the model attains commendable accuracy across several workout categories, & the performance graphs illustrate consistent enhancement with diminished loss and heightened precision over epochs. The technology

accurately recognizes exercises including squat, frog posture, and lunge, and offers tailored plans comprising repetitions, difficulty levels, and safety guidelines. This method diminishes the necessity for manual oversight and enhances the accessibility of fitness assistance for users. The technology provides a more dynamic and practical solution by integrating activity recognition and recommendation generating, surpassing conventional methods. The incorporation of deep learning enhances system reliability, adaptability, & usability, rendering it appropriate for practical fitness applications.

VI. CONCLUSION

This project intends to enhance fitness monitoring guidance and instruction through the application of deep learning as well as artificial intelligence methodologies. The suggested method illustrates how intelligent models can precisely identify various exercise activities and offer tailored workout suggestions based on input from users. Via training the algorithm on various workout postures, the system can provide consistent performance for both video and image inputs, accompanied by real-time feedback. This method diminishes reliance on manual oversight and offers a more engaging and user-centric experience compared to conventional fitness applications. The amalgamation of activity identification with plan recommendation facilitates users in executing exercises accurately and securely. The suggested approach underscores the promise of deep learning in developing adaptable and effective fitness coaching systems, which can augment user engagement, elevate workout quality, and facilitate improved health and physical fitness outcomes in practical applications.

REFERENCES

1. Sebastian Baumbach, Arun Bhatt, Andreas Dengel. "A Digital Personal Trainer for Health Clubs Sport Exercise Recognition Using Personalized Models and Deep Learning". January 2018.
2. Ji Haoran, Stephen Karungaru, Kenji Terada. "AI Fitness Coach at Home using Image Recognition". Feb 2022.
3. Mahendran N. "Deep Learning For Fitness". Indian Institute of Technology Tirupati Andhra Pradesh, India. 3 Sep 2021.
4. Rutuja Mhaskar, Preeti Verma, Baljit Kaur. "Performance Analysis Of Human Activity".

- Department of Electronics and Communication Engineering, National Institute of Technology ,Delhi – 110 036, India.2023.
5. HristoNovatchkov, Arnold BACA. “Artificial Intelligence in Sports on the Example of Weight Training”.University of Vienna, Centre for Sport Science and University Sports, Auf der Schmelz 6A, 1150 Vienna, Austria.2021.
6. 1.Ashwini Jadhav, .Nikita Sambari, PratikshaShinde.LalitaBorkar, SamikshaMohite.“Study of AI Fitness Model Using Deep Learning”. Assitant Professor, Dept. of Computer Engineering, Dr. D. Y. Patil Institute of Technology, Pimpri, Maharashtra,india- 2023.
7. Barbara Rita Barricelli, Elena Casiraghi, Jessica Gliozzo. “Human Digital Twin for Fitness Management”.Department of Information Engineering, UniversitydegliStudy di Brescia, 25123 Brescia, ItalyDepartment of Computer Science, UniversitydegliStudio di Milano, 20133 Milan, Italy,jan-2020.
8. Mr. RutvikSonawane, Mr. VaibhavAdke, Mr. AbhijeetPawar, Mr. ShubhamThok,Dr. Jaya Suryawanshi. “FITNESS TRAINER APPLICATION USING ARTIFICIAL INTELLIGENCE”.Department Of Information Technology, SavitribaiPhule Pune University NDMVP’S Karmaveer Adv. BaburaoThakre College Of Engineering, Nashik, Maharashtra, India. jun-2022.
9. Neha D, Dr. S.K ManjuBargavi.“Virtual Fitness Trainer using Artificial Intelligence”.MCA Student, Professor, School of CS & IT, Jain (Deemed-to-be University), Bangalore, India,March-2023.
10. Dr. S. M. Patil, Vaishnavi.D.Patil,Kanchan.MSharma, Shraddha.SChaudhari,Smita S Talekar. “Artificial Intelligence-Based Personal Fitness Trainer”.Professor, Department of Computer EngineeringStudents, Department of Computer Engineering,SKNSinhgad Institute of Technology and Science, Kusgaon(BK), Pune, Maharashtra, India,Nov-2022
11. GourangiTaware, Rohit Agarwal, Pratik Dhende, PrathameshJondhalekar, Prof.ShaileshHule. “AI-based Workout Assistant and Fitness guide”.Computer Department, PimpriChinchwad College of Engineering,Pune, India,Nov-2021.
12. AnujLamba, AnandKumarNayak, PranayPimple,VaibhavPatil, Dr.PawanBhaldare.Ram Kumar. “AI-Based Fitness Trainer”.B.Tech (Scholar) ,School of computer Science & Engineering, Sandip University, Nashik, India,jun-2023
13. BakhytzhanOmarov, NurlanNurmash, BauyrzhanDoskarayev, NagashbekZhilisbaev, MaxatDairabayev, ShamratOrazov,NurlanOmarov. “A Novel Deep Neural Network to Analyze and Monitoring The Physical Training Relation to Sports Activities”.International University of Tourism and Hospitality, Turkistan, Kazakhstan,Kazakh-British Technical University, Almaty, Kazakhstan,Nov-2023.
14. Sheras Ahmed, Andreas Dengel. “A Digital Personal Trainer for Health Clubs Sport Exercise Recognition Using Personalized Models and Deep Learning”.Assitant Professor, Dept. of Computer Engineering, jan-2022.
15. Poojari, R. Frameworks for Data Management and Lineage in Large-Scale Healthcare Data Systems.
16. Maturi, S. Y. (2024). Cryptographic privacy engines: Practical multi-party protocols for confidential database queries. Nanotechnology Perceptions, 20(S13), 2770–2785
17. Gajula, S. (2024). Adaptive zero trust architecture for securing financial microservices. Computer Fraud & Security, 2024(12), 643–655. <https://doi.org/10.52710/CFS.845>
18. Akinapalli, S. (2025). Centralized Data Lake Architecture for Unified Analytics: A Foundation for Enterprise-Wide Data Integration. Journal Of Engineering And Computer Sciences, 4(8), 414-422.
19. Adabala, P. K. (2024). Utilizing predictive analytics to improve efficiency and decision-making in ERP-connected supply chains. International Journal of Intelligent Systems and Applications in Engineering, 12(22s), 2465
20. Maturi, S. Y. -(2024). Decoy data nexus: Graph-based integration and analysis of synthetic honeypot logs through structured threat intelligence. International Journal of Computational and Experimental Science and Engineering (IJCESEN), 10(4), 4255–4261. <https://doi.org/10.22399/ijcesen.5010>

21. Pavan Kumar Adabala. (2026). Best Practices for Enterprise System Integration in Modern Organizations. *Journal of Information Systems Engineering and Management*, 11(2s), 1137–1146.
<https://doi.org/10.52783/jisem.v11i2s.14558>
22. Srikanth Kavuri. (2022). Large Language Model (LLM)-Based Automation for Software Test Script Generation. *Computer Fraud and Security*.
<https://doi.org/10.52710/cfs.836>
23. Shashank A. (2025). Metadata-driven data integration framework: Automating enterprise data integration through declarative approaches. *European Modern Studies Journal*, 9(4), 9.
24. Gajula, S. (2025). Cybersecurity in Supply Chain Management: Role of Identity and Access Management, Zero Trust, and Blockchain. *Asian Journal of Computer Science Engineering (AJCSE)*, 10(2), 1-11.
25. Harshitha, G. K., Nandigama, C., & Thiripalu, P. (2026). An exploration into identification of opportunities and challenges of establishing and running an enterprise in the area of biofuels. *Minnesota Journal of Business Law and Entrepreneurship*, 2026(1), 1159–1168.
26. Susarla, R. S., Boyapati, P. K., & Kandula, S. T. R. (2025, July). Cloud-Based Secure Data Storage in Smart Cities Using Central-Smoothing Hypergraph Neural Networks. In *2025 IEEE 4th World Conference on Applied Intelligence and Computing (AIC)* (pp. 279-284). IEEE.
27. Boyapati, P. K. Building a centralized data operations hub for healthcare enterprise integration. *IJSAT-Int. J. Sci. Technol.* 16 (2).
<https://doi.org/10.71097/IJSAT.v16.i2.3219>
28. Garapati, R. S., Aitha, A. R., Yandamuri, U. S., Gottimukkala, V. R. R., Nagubandi, A. R., & Kolla, S. H. (2026, March). Cloud-Native Orchestration of Multi-Counterparty Derivatives and Collateral in Manufacturing Enterprises via AI-Assisted Financial Audit Engines. In *2026 IEEE International Conference on AI Engineering and Innovations (AIEI)* (pp. 1-6). IEEE.
29. Kumar, Anuj. "Optimization of Process Parameters in Metal Additive Manufacturing for Defect Reduction Using Machine Learning." *International Journal of Engineering Research and Science & Technology*, Vol. 14, No. 1, 2018, pp. 41-60
30. Teja, T. V., Bharadwaj, D., Surabhi, K. R., Pokala, H. K., & Kavithamani, B. (2026, April). AI-Driven Quality of Service in Wireless Sensor Network Using Dueling Double Deep Q-Network with Lyapunov Drift-Plus-Penalty Method for Mobile Networks. In *2026 2nd International Conference on Intelligent Systems and Computational Networks (ICISCN)* (pp. 1-6). IEEE.
31. Kumar, Anuj. "Battery Thermal Management Systems for Electric Vehicles Using Phase Change Materials." *International Journal of Engineering, Science and Mathematics*, Vol. 10, Issue 3, 2021, pp. 202-211