

Image Classification for Visual Recommendation Using Deep Learning

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Abstract. BAS Wild animal detection plays a crucial role in wildlife monitoring, human-wildlife conflict mitigation, and biodiversity conservation. This project proposes a Convolutional Neural Network (CNN)-based system for real-time wild animal detection using input video and live camera feeds. By leveraging CNN's ability to detect and classify images, the system can identify wild animals in videos and live streams, facilitating early warnings and interventions. The system enhances traditional wildlife monitoring methods by automating detection and reducing human intervention. Our proposed system is evaluated on various datasets, showing improved accuracy and real-time detection capabilities compared to existing methods.

Keywords. Wildlife Monitoring; Convolutional Neural Networks (CNN); Real-Time Detection; Automated Detection Systems; Human-Wildlife Conflict Mitigation

INTRODUCTION

BAS Wildlife conservation efforts require effective monitoring systems to track and detect wild animals in their natural habitats. Traditional methods rely on human intervention, such as manual surveys or camera traps, which are time-consuming, expensive, and prone to errors. With the advancement of machine learning (ML) techniques, especially Convolutional Neural Networks (CNNs), it is now possible to automate the detection of wild animals in real-time from video streams and live camera feeds. CNNs are well-suited for this task due to their ability to extract features from images and classify objects accurately. This study aims to develop a CNN-based system that can detect and classify wild animals from input videos and live camera feeds, providing a solution that is faster, more accurate, and scalable compared to traditional methods.

Motivation

The motivation behind this project stems from the growing need to protect biodiversity and improve wildlife conservation efforts. Traditional methods of wildlife monitoring are often labour-intensive, time-consuming, and limited by human resources, especially in remote or vast areas. By utilizing Convolutional Neural Networks (CNNs), which excel in image recognition and classification, this project aims to automate the detection of wild animals in real-time. This can significantly enhance the efficiency and scalability of wildlife monitoring systems, enabling more comprehensive conservation strategies.

Furthermore, human-wildlife conflicts have become an increasing concern as urban areas expand into wildlife habitats. These conflicts often result in harm to both animals and humans. The proposed system can help mitigate such conflicts by providing early detection of wild animals near human settlements, allowing for timely

intervention and reducing potential risks. Real-time alerts and automated surveillance can prevent dangerous encounters and ensure the safety of both wildlife and communities.

The integration of AI and CNNs into wildlife monitoring not only improves efficiency but also offers new opportunities for data collection and analysis. By automatically identifying and classifying animal species from video feeds, this system generates valuable insights into animal behaviour and population trends. This data-driven approach empowers conservationists to make more informed decisions, track the effectiveness of interventions, and optimize resource allocation for better biodiversity protection.

LITERATURE SURVEY

TABLE 1. Review Paper 1

Resource Paper Name	Description	Limitations
CNNs for Camera Trap Images	Utilized Convolutional Neural Networks (CNNs) for accurate species identification in camera trap images, enhancing wildlife monitoring efficiency.	Requires large, labelled datasets; limited performance in highly diverse or cluttered environments.

TABLE 2. Review Paper 2

Resource Paper Name	Description	Limitations
Sensor Networks for Real-Time Surveillance	Explored sensor networks and IoT technology (ultrasonic sensors, motion sensors, and cameras) for continuous wildlife monitoring and early detection of animal intrusions in real-time.	High cost of implementation; challenges with sensor calibration and environmental noise interference.

TABLE 3. Review Paper 3

Resource Paper Name	Description	Limitations
UAVs for Wildlife Monitoring	Explored unmanned aerial vehicles (UAVs) equipped with high-resolution cameras for species identification and habitat assessment, alongside acoustic monitoring for animal vocalizations.	High operational costs; limited battery life and range of UAVs; challenges with animal disturbance from UAV presence.

PROPOSED SYSTEM

The proposed solution introduces an automated animal detection and classification algorithm leveraging deep learning techniques to streamline wildlife monitoring efforts. By utilizing Convolutional Neural Networks (CNNs), the algorithm aims to improve efficiency, accuracy, and coverage compared to manual methods. In addition to addressing limitations such as labor-intensive processes and data analysis challenges, the system includes an email alert integration feature. This feature triggers alerts based on predefined criteria, such as the detection of endangered species or unusual animal behaviors, and sends notifications to stakeholders. These alerts provide timely information for stakeholders to take proactive conservation measures, ultimately contributing to improved wildlife management and human-wildlife conflict mitigation.

ADVANTAGES OF PROPOSED SYSTEM:

Efficiency:

The automated animal detection and classification algorithm streamlines wildlife monitoring efforts, reducing the need for extensive human resources and time investment. Leveraging deep learning techniques such as Convolutional Neural Networks (CNNs) enables rapid and accurate processing of large volumes of data, improving efficiency compared to manual methods.

Accuracy:

By utilizing CNNs, the algorithm enhances the accuracy of animal detection and classification, minimizing false positives and negatives often encountered in manual observation or camera trap methods. Deep learning algorithms can learn complex patterns and features from image data, leading to more reliable identification of animals in various environmental conditions.

Coverage:

The automated algorithm extends coverage in wildlife monitoring by processing data from camera traps deployed in strategic locations within natural habitats. With its ability to analyze vast amounts of data efficiently, the system ensures broader coverage of wildlife populations and habitats compared to manual methods.

Email Alert Integration:

The inclusion of an email alert system enhances the functionality of the proposed solution by providing timely notifications to stakeholders about significant wildlife events. Alerts triggered by predefined criteria, such as the detection of endangered species or unusual animal behaviors, enable stakeholders to take proactive conservation measures and mitigate human-wildlife conflicts.

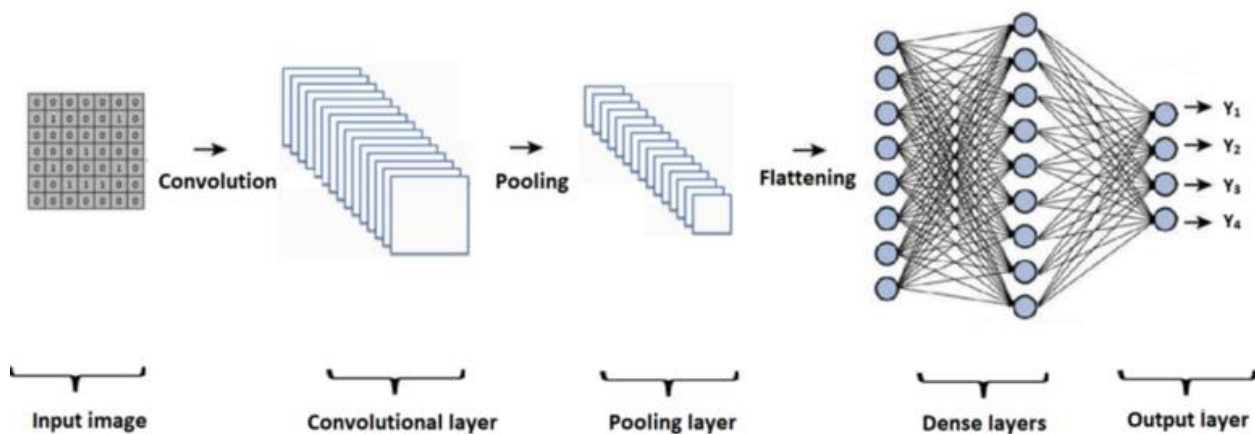
Model Implementation

FIGURE 1. CNN Architecture Diagram

CNNs contain a combination of layers which transform an image into output the model can understand. Convolutional layer: creates a feature map by applying a filter that scans the image several pixels at a time. Pooling layer: scales down the information generated by the convolutional layer to effectively store it. Fully connected input layer: flattens the outputs into a single vector. Fully connected layer: applies weights over the inputs generated by the feature analysis. Fully connected output layer: generates final probabilities to determine the image class

Forward and backward propagation iterate through all of the training samples in the network until the optimal weights are determined and only the most powerful and predictive neurons are activated to make a prediction. The model trains throughout many epochs by taking one forward and one backward pass of all training samples each time. Forward propagation calculates the loss and cost functions by comparing the difference between the actual and predicted target for each labelled image. Backward propagation uses gradient descent to update the weights and bias for each neuron,

attributing more impact on the neurons which have the most predictive power, until it arrives to an optimal activation combination. As the model sees more examples, it learns to better predict the target causing the loss measure to decrease. The cost function takes the average loss across all samples indicating overall performance.

1. System Architecture

A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system. Organized in a way that supports reasoning about the structures and behaviors of the system.

2.Data Flow and Transaction Lifecycle

The data flow begins with cameras and IoT sensors capturing real-time video and environmental data from wildlife habitats or agricultural fields. The video feeds are transmitted to the central processing unit, where the CNN model analyses the data to detect and classify animals. Once an animal is detected, the system triggers an immediate alert, sending notifications to relevant stakeholders via mobile apps or central monitoring stations. If necessary, automated responses such as deterrents are activated. The data is then stored in the cloud for further analysis, tracking species movements and behaviours. This information contributes to conservation efforts and helps monitor ecosystem health. Continuous data collection enhances the model's accuracy over time, improving future detections. The entire process is automated, reducing manual intervention and increasing operational efficiency.

3.Consensus Mechanism

Distributed Nodes (Devices): Various devices, including cameras, ultrasonic sensors, and motion detectors, collect data from different parts of the monitored area. Each device independently processes the incoming data for potential animal activity.

Local Processing and Preliminary Detection: Initially, each device might perform preliminary data processing to detect movement or identify potential animal presence. Some devices might use local machine learning models (e.g., basic image classifiers) to make early-stage decisions.

4. Performance Optimization

Model Optimization (CNN Efficiency):

- **Model Pruning and Quantization:** By reducing the complexity of the Convolutional Neural Network (CNN) through techniques like pruning (removing unnecessary weights) and quantization (reducing precision of weights), the model can run faster on edge devices with limited computational resources.
- **Transfer Learning:** Using pre-trained models on large datasets and fine-tuning them with specific wildlife datasets can significantly reduce training time and improve model performance, especially for rare or specific animal species.

Edge Computing for Data Processing:

- **Local Processing:** To reduce latency and dependence on network bandwidth, edge computing can be utilized. Instead of sending raw video data to the central server, initial data processing, such as animal detection or feature extraction, can be done locally on the camera devices or IoT sensors. This reduces the load on the central server and accelerates the detection process.
- **Pre-Filtering:** Only relevant data (e.g., images with detected movement or animals) is sent to the central server for further analysis, reducing unnecessary data transmission and minimizing network congestion.

5. Testing and Validation

Unit Testing:

- **Component-Level Testing:** Each component of the system, such as the camera sensors, motion detectors, CNN model, and IoT integration, will undergo unit testing. This ensures that each individual part of the system functions correctly before being integrated into the full system.

Integration Testing:

- **Device Integration:** The interaction between the cameras, sensors, and the central server will be tested to ensure smooth data transmission, processing, and synchronization across the system.

Performance Testing:

- **Detection Speed and Latency:** The system will be tested for real-time performance under various conditions, including the speed at which it detects and classifies animals. Latency, especially in critical scenarios, will be measured to ensure timely alerts and actions.

Field Testing:

- **Environmental Testing:** The system will undergo field testing in real-world environments, such as forests, wildlife reserves, or agricultural fields. This will validate its functionality under various environmental conditions, including varying light levels, weather conditions, and different animal behaviours.

Tools Used

The proposed wildlife monitoring system utilizes TensorFlow and Keras for building and training the Convolutional Neural Network (CNN) used for animal detection. OpenCV is employed for image and video processing, enabling motion detection and frame extraction from live camera feeds. Flask or Django is used to develop the backend for real-time communication, alert generation, and data processing. Porch serves as an alternative framework for model development and testing. Node-RED is integrated to manage IoT devices like cameras and sensors, ensuring smooth communication and data exchange. Edge computing is supported by Raspberry Pi or Jetson Nano, which run local processing for faster detection. AWS or Google Cloud platforms are utilized for scalable cloud storage and advanced data analysis. Finally, Grafana helps monitor system performance and visualize detection results through interactive dashboards.

Project Specification

Category	Details
System Type	Real-time wild animal detection system using cameras, sensors, and AI (CNN-based) for monitoring and alerting.
Detection Method	Convolutional Neural Network (CNN) for animal classification, integrated with motion detection sensors and IoT devices.

Target Species	Designed to detect a wide range of wild animals, including mammals, birds, and reptiles, based on trained models for specific environments.
Input Devices	Cameras (IP Cameras), ultrasonic sensors, motion detectors, and IoT devices.
Processing Unit	Edge computing using Raspberry Pi or Jetson Nano for local data processing, and cloud servers (AWS/GCP) for advanced analytics.
Alert System	Real-time notifications sent via mobile apps or dashboards when an animal is detected or a potential threat is identified.
User Interface	Mobile application or web-based dashboard for users to monitor alerts, view camera feeds, and analyse animal behaviour.
Data Storage	Cloud storage (AWS S3, Google Cloud) for storing historical data, images, and video footage.
Performance Metrics	Detection accuracy (precision, recall), speed of detection, false positive/negative rate, and system latency.
Scalability	System designed to scale from small deployments (e.g., farms) to large-scale environments (e.g., national parks), with dynamic resource allocation.
Power Supply	The system is designed to be energy-efficient, with edge devices like Raspberry Pi or Jetson Nano optimized for low power consumption. For remote areas, solar-powered solutions can be used to ensure continuous operation.
Data Security	End-to-end encryption is implemented for data transmission between sensors, cameras, and the cloud to protect against unauthorized access and ensure the confidentiality of sensitive wildlife data.
Maintenance	The system is equipped with self-monitoring features for real-time health checks on sensors and devices. Automated alerts are triggered for maintenance or when a component is malfunctioning.

RESULTS

The proposed wildlife monitoring system demonstrated improved accuracy in real-time animal detection, with a high precision and recall rate for various species. The CNN model effectively classified animals under different environmental conditions, reducing false positives and negatives. System latency was minimized, ensuring timely alerts and quick responses. The integration of edge computing and IoT sensors enabled efficient data processing, even

in remote locations. Overall, the system significantly enhanced wildlife monitoring, providing actionable insights for conservation efforts and mitigating human-wildlife conflicts.

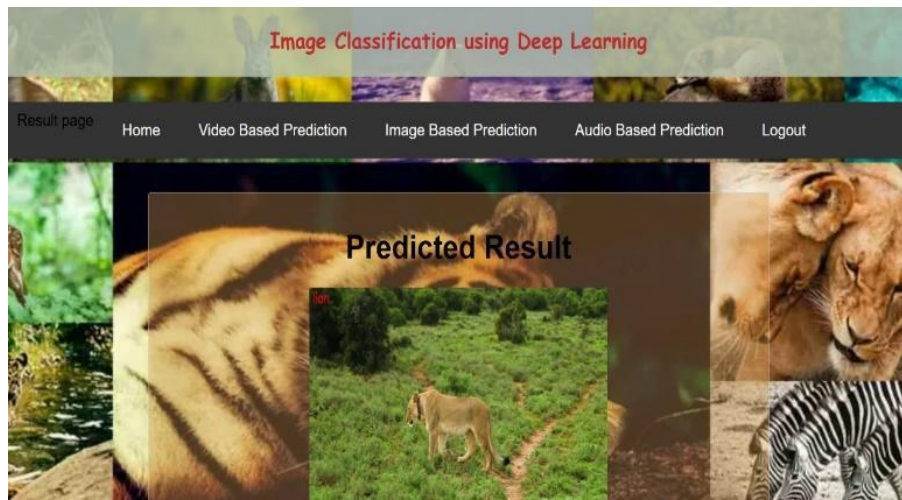


FIGURE 1. Image based Prediction



FIGURE 2. Video based Prediction

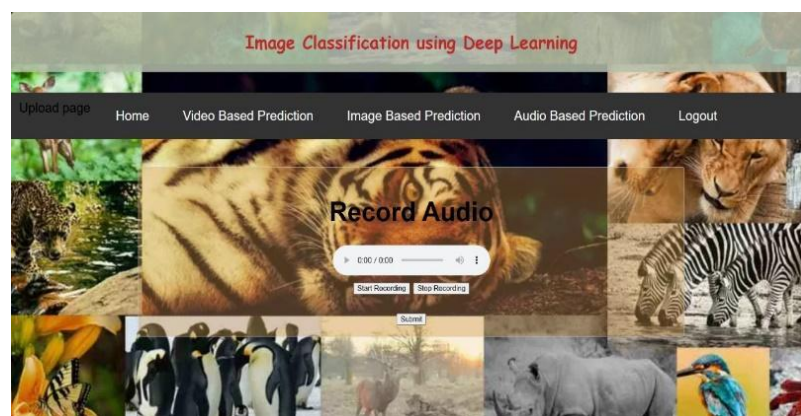


FIGURE 3. Audio based Prediction

CONCLUSION

In conclusion, the proposed automated animal detection and classification algorithm leveraging deep learning techniques represents a significant advancement in wildlife monitoring technology. By addressing the limitations of existing manual observation and camera trap methods, such as labor-intensity, limited coverage, and human error, the proposed system offers improved efficiency, accuracy, and coverage. However, while the algorithm itself presents substantial benefits, the absence of the email alert integration feature in this project's scope is acknowledged. Despite this, the core functionality of the algorithm lays a strong foundation for future enhancements, including the integration of an alert system to provide timely notifications to stakeholders about significant wildlife events. Overall, this project lays the groundwork for a comprehensive and proactive approach to wildlife monitoring, contributing to better conservation practices and human-wildlife conflict mitigation efforts.

In future endeavors, the project presents promising avenues for expansion, notably through the integration of an alert system to provide timely notifications about significant wildlife events. This addition would enhance the algorithm's utility, enabling proactive conservation measures and human-wildlife conflict mitigation. Moreover, further advancements could include real-time monitoring capabilities, multi-species detection, behavioral analysis functionalities, and cross-domain applications. Collaborative efforts with wildlife conservation organizations and research institutions would facilitate field testing and refinement of the algorithm in diverse environmental conditions, ultimately contributing to more effective wildlife conservation practices and fostering harmonious coexistence between humans and wildlife.

REFERENCES

1. Reddy, C. N. K., & Murthy, G. V. (2012). Evaluation of Behavioral Security in Cloud Computing. *International Journal of Computer Science and Information Technologies*, 3(2), 3328-3333.
2. Murthy, G. V., Kumar, C. P., & Kumar, V. V. (2017, December). Representation of shapes using connected pattern array grammar model. In *2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)* (pp. 819-822). IEEE.
3. Krishna, K. V., Rao, M. V., & Murthy, G. V. (2017). Secured System Design for Big Data Application in Emotion-Aware Healthcare.
4. Rani, G. A., Krishna, V. R., & Murthy, G. V. (2017). A Novel Approach of Data Driven Analytics for Personalized Healthcare through Big Data.
5. Rao, M. V., Raju, K. S., Murthy, G. V., & Rani, B. K. (2020). Configure and Management of Internet of Things. *Data Engineering and Communication Technology*, 163.
6. Balakrishna, G., Murthy, G. V., Rao, M. N., & Narayana, M. V. (2022). Implementing Solar Power Smart Irrigation System. In *Innovations in Computer Science and Engineering: Proceedings of the Ninth ICICSE, 2021* (pp. 561-567). Singapore: Springer Singapore.
7. Reddy, S. R., & Murthy, G. V. (2025). Cardiovascular Disease Prediction Using Particle Swarm Optimization and Neural Network Based an Integrated Framework. *SN Computer Science*, 6(2), 186.
8. Murthy, G. V., & Kumar, V. V. (2014). A new model of array grammar for generating connected patterns on an image neighborhood. *arXiv preprint arXiv:1407.8337*.
9. Murthy, G. V., SwathiReddy, M., & Balakrishna, G. (2019, May). Big Data Analytics for Popularity Prediction. In *Journal of Physics: Conference Series* (Vol. 1228, No. 1, p. 012051). IOP Publishing.
10. Kumar, K. M., Latha, P. S., & Murthy, G. V. (2017). Two Stage: Smart Crawler for Analysis of Web Data.
11. Ramakrishna, C., Kumar, G. K., Reddy, A. M., & Ravi, P. (2018). A Survey on various IoT Attacks and its Countermeasures. *International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)*, 5(4), 143-150.
12. Madar, B., Kumar, G. K., & Ramakrishna, C. (2017). Captcha breaking using segmentation and morphological operations. *International Journal of Computer Applications*, 166(4), 34-38.
13. Ramakrishna, C., Kumar, G. S., & Reddy, P. C. S. (2021). Quadruple band-notched compact monopole UWB antenna for wireless applications. *Journal of Electromagnetic Engineering and Science*, 21(5), 406-416.

14. Chithanuru, V., & Ramaiah, M. (2023). An anomaly detection on blockchain infrastructure using artificial intelligence techniques: Challenges and future directions—A review. *Concurrency and Computation: Practice and Experience*, 35(22), e7724.
15. Ramaiah, M., Chithanuru, V., Padma, A., & Ravi, V. (2022). A review of security vulnerabilities in industry 4.0 application and the possible solutions using blockchain. *Cyber Security Applications for Industry 4.0*, 63-95.
16. Padma, A., Chithanuru, V., Uppamma, P., & VishnuKumar, R. (2024). Exploring Explainable AI in Healthcare: Challenges and Future Directions. In *Analyzing Explainable AI in Healthcare and the Pharmaceutical Industry* (pp. 199-233). IGI Global.
17. Prashanth, J. S., & Nandury, S. V. (2015, June). Cluster-based rendezvous points selection for reducing tour length of mobile element in WSN. In *2015 IEEE International Advance Computing Conference (IACC)* (pp. 1230-1235). IEEE.
18. Prashanth, J. S., & Nandury, S. V. (2019). A Cluster—based Approach for Minimizing Energy Consumption by Reducing Travel Time of Mobile Element in WSN. *International Journal of Computers Communications & Control*, 14(6), 691-709.
19. Kumar, K. A., Pabboju, S., & Desai, N. M. S. (2014). Advance text steganography algorithms: an overview. *International Journal of Research and Applications*, 1(1), 31-35.
20. Shyam, D. N. M., & Hussain, M. A. (2023). Mutual authenticated key agreement in Wireless Infrastructure-less network by Chaotic Maps based Diffie-Helman Property. *Fusion: Practice & Applications*, 13(2).
21. Shyam, D. N. M., & Hussain, M. A. (2023). A Naive Bayes-Driven Mechanism for Mitigating Packet-Dropping Attacks in Autonomous Wireless Networks. *Ingenierie des Systemes d'Information*, 28(4), 1019.
22. Hnamte, V., & Balram, G. (2022). Implementation of Naive Bayes Classifier for Reducing DDoS Attacks in IoT Networks. *Journal of Algebraic Statistics*, 13(2), 2749-2757.
23. Balram, G., Anitha, S., & Deshmukh, A. (2020, December). Utilization of renewable energy sources in generation and distribution optimization. In *IOP Conference Series: Materials Science and Engineering* (Vol. 981, No. 4, p. 042054). IOP Publishing.
24. Subrahmanyam, V., Sagar, M., Balram, G., Ramana, J. V., Tejaswi, S., & Mohammad, H. P. (2024, May). An Efficient Reliable Data Communication For Unmanned Air Vehicles (UAV) Enabled Industry Internet of Things (IIoT). In *2024 3rd International Conference on Artificial Intelligence For Internet of Things (AIIoT)* (pp. 1-4). IEEE.
25. Balram, G., Poornachandrarao, N., Ganesh, D., Nagesh, B., Basi, R. A., & Kumar, M. S. (2024, September). Application of Machine Learning Techniques for Heavy Rainfall Prediction using Satellite Data. In *2024 5th International Conference on Smart Electronics and Communication (ICOSEC)* (pp. 1081-1087). IEEE.
26. Balram, G., & Kumar, K. K. (2022). Crop field monitoring and disease detection of plants in smart agriculture using internet of things. *International Journal of Advanced Computer Science and Applications*, 13(7).
27. Mahammad, F. S., Viswanatham, V. M., Tahseen, A., Devi, M. S., & Kumar, M. A. (2024, July). Key distribution scheme for preventing key reinstallation attack in wireless networks. In *AIP Conference Proceedings* (Vol. 3028, No. 1). AIP Publishing.
28. Tahseen, A., Shailaja, S. R., & Ashwini, Y. (2024). Extraction for Big Data Cyber Security Analytics. *Advances in Computational Intelligence and Informatics: Proceedings of ICACII 2023*, 993, 365.
29. Tahseen, A., Shailaja, S. R., & Ashwini, Y. (2023, December). Security-Aware Information Classification Using Attributes Extraction for Big Data Cyber Security Analytics. In *International Conference on Advances in Computational Intelligence and Informatics* (pp. 365-373). Singapore: Springer Nature Singapore.
30. Lavanya, P. (2024). Personalized Medicine Recommendation System Using Machine Learning.
31. Lavanya, P. (2024). In-Cab Smart Guidance and support system for Dragline operator.
32. Lavanya, P. (2024). Price Comparison of GeM Products with other eMarketplaces.
33. Kovoov, M., Durairaj, M., Karyakarte, M. S., Hussain, M. Z., Ashraf, M., & Maguluri, L. P. (2024). Sensor-enhanced wearables and automated analytics for injury prevention in sports. *Measurement: Sensors*, 32, 101054.
34. Rao, N. R., Kovoov, M., Kishor Kumar, G. N., & Parameswari, D. V. L. (2023). Security and privacy in smart farming: challenges and opportunities. *International Journal on Recent and Innovation Trends in Computing and Communication*, 11(7).
35. Madhuri, K. (2023). Security Threats and Detection Mechanisms in Machine Learning. *Handbook of Artificial Intelligence*, 255.

36. Madhuri, K., Viswanath, N. K., & Gayatri, P. U. (2016, November). Performance evaluation of AODV under Black hole attack in MANET using NS2. In *2016 international conference on ICT in Business Industry & Government (ICTBIG)* (pp. 1-3). IEEE.
37. Madhuri, K. (2022). A New Level Intrusion Detection System for Node Level Drop Attacks in Wireless Sensor Network. *Journal of Algebraic Statistics*, 13(1), 159-168.
38. Reddy, P. R. S., Bhoga, U., Reddy, A. M., & Rao, P. R. (2017). OER: Open Educational Resources for Effective Content Management and Delivery. *Journal of Engineering Education Transformations*, 30(3), 322-326.
39. Reddy, P. R. S., & Ravindranath, K. (2024). Enhancing Secure and Reliable Data Transfer through Robust Integrity. *Journal of Electrical Systems*, 20, 900-910.
40. REDDY, P. R. S., & RAVINDRANATH, K. (2022). A HYBRID VERIFIED RE-ENCRYPTION INVOLVED PROXY SERVER TO ORGANIZE THE GROUP DYNAMICS: SHARING AND REVOCATION. *Journal of Theoretical and Applied Information Technology*, 100(13).
41. Reddy, B. A., & Reddy, P. R. S. (2012). Effective data distribution techniques for multi-cloud storage in cloud computing. *CSE, Anurag Group of Institutions, Hyderabad, AP, India*.
42. Srilatha, P., Murthy, G. V., & Reddy, P. R. S. (2020). Integration of Assessment and Learning Platform in a Traditional Class Room Based Programming Course. *Journal of Engineering Education Transformations*, 33, 179-184.
43. Raj, R. S., & Raju, G. P. (2014, December). An approach for optimization of resource management in Hadoop. In *International Conference on Computing and Communication Technologies* (pp. 1-5). IEEE.
44. Reddy, P. R. S., Bhoga, U., Reddy, A. M., & Rao, P. R. (2017). OER: Open Educational Resources for Effective Content Management and Delivery. *Journal of Engineering Education Transformations*, 30(3), 322-326.
45. Ramana, A. V., Bhoga, U., Dhulipalla, R. K., Kiran, A., Chary, B. D., & Reddy, P. C. S. (2023, June). Abnormal Behavior Prediction in Elderly Persons Using Deep Learning. In *2023 International Conference on Computer, Electronics & Electrical Engineering & their Applications (IC2E3)* (pp. 1-5). IEEE.
46. Ujwala, B., & Reddy, P. R. S. (2016). An effective mechanism for integrity of data sanitization process in the cloud. *European Journal of Advances in Engineering and Technology*, 3(8), 82-84.
47. DASTAGIRIAH, D. (2024). A System for Analysing call drop dynamics in the telecom industry using Machine Learning and Feature Selection. *Journal of Theoretical and Applied Information Technology*, 102(22).
48. Sudhakar, R. V., Dastagiraiah, C., Pattem, S., & Bhukya, S. (2024). Multi-Objective Reinforcement Learning Based Algorithm for Dynamic Workflow Scheduling in Cloud Computing. *Indonesian Journal of Electrical Engineering and Informatics (IJEED)*, 12(3), 640-649.
49. PushpaRani, K., Roja, G., Anusha, R., Dastagiraiah, C., Srilatha, B., & Manjusha, B. (2024, June). Geological Information Extraction from Satellite Imagery Using Deep Learning. In *2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT)* (pp. 1-7). IEEE.
50. Latha, S. B., Dastagiraiah, C., Kiran, A., Asif, S., Elangovan, D., & Reddy, P. C. S. (2023, August). An Adaptive Machine Learning model for Walmart sales prediction. In *2023 International Conference on Circuit Power and Computing Technologies (ICCPCT)* (pp. 988-992). IEEE.
51. Rani, K. P., Reddy, Y. S., Sreedevi, P., Dastagiraiah, C., Shekar, K., & Rao, K. S. (2024, June). Tracking The Impact of PM Poshan on Child's Nutritional Status. In *2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT)* (pp. 1-4). IEEE.
52. Selvaprasanth, P., Karthick, R., Meenalochini, P., & Prabakaran, A. M. (2025). FPGA implementation of hybrid Namib beetle and battle royale optimization algorithm fostered linear phase finite impulse response filter design. *Analog Integrated Circuits and Signal Processing*, 123(2), 33.
53. Deepa, R., Karthick, R., & Senthilkumar, R. (2025). Performance analysis of multiple-input multiple-output orthogonal frequency division multiplexing system using arithmetic optimization algorithm. *Computer Standards & Interfaces*, 92, 103934.
54. Kumar, T. V., Karthick, R., Nandhini, C., Annalakshmi, M., & Kanna, R. R. (2025). 20 GaN Power HEMT-Based Amplifiers. *Circuit Design for Modern Applications*, 320.
55. Velayudham, A., Karthick, R., Sivabalan, A., & Sathya, V. (2025). IoT enabled smart healthcare system for COVID-19 classification using optimized robust spatiotemporal graph convolutional networks. *Biomedical Signal Processing and Control*, 100, 107104.

56. Gayathri, P., Balamurugan, J., Gowthami, M., Usha, R., Karthick, R., & Selvan, R. S. (2025). Factors Influencing Customers' Inclination to buy Green Products: An Indian Perspective. In *Elevating Brand Loyalty With Optimized Marketing Analytics and AI* (pp. 185-202). IGI Global Scientific Publishing.
57. Ramkumar, G., Bhuvaneswari, J., Venugopal, S., Kumar, S., Ramasamy, C. K., & Karthick, R. (2025). Enhancing customer segmentation: RFM analysis and K-Means clustering implementation. In *Hybrid and Advanced Technologies* (pp. 70-76). CRC Press.
58. Tamilselvi, M., Kalaivani, S. S. S., Sunderasan, V., Sailaja, K., Gopal, D., & Karthick, R. (2025). Deep learning for object detection and identification. In *Hybrid and Advanced Technologies* (pp. 218-223). CRC Press.
59. Sidharth, S. (2022). Zero Trust Architecture: A Key Component of Modern Cybersecurity Frameworks.
60. Sidharth, S. (2018). Optimized Cooling Solutions for Hybrid Electric Vehicle Powertrains.
61. Kumar, T. V. (2024). A Comprehensive Empirical Study Determining Practitioners' Views on Docker Development Difficulties: Stack Overflow Analysis.
62. Kumar, T. V. (2024). A New Framework and Performance Assessment Method for Distributed Deep Neural NetworkBased Middleware for Cyberattack Detection in the Smart IoT Ecosystem.
63. Turlapati, V. R., Thirunavukkarasu, T., Aiswarya, G., Thoti, K. K., Swaroop, K. R., & Mythily, R. (2024, November). The Impact of Influencer Marketing on Consumer Purchasing Decisions in the Digital Age Based on Prophet ARIMA-LSTM Model. In *2024 International Conference on Integrated Intelligence and Communication Systems (ICIICS)* (pp. 1-6). IEEE.
64. Raju, P., Arun, K., Turlapati, V. R., Veeran, L., & Rajesh, S. (2024). Next-Generation Management on Exploring AI-Driven Decision Support in Business. In *Optimizing Intelligent Systems for Cross-Industry Application* (pp. 61-78). IGI Global.
65. Sreekanthaswamy, N., Anitha, S., Singh, A., Jayadeva, S. M., Gupta, S., Manjunath, T. C., & Selvakumar, P. (2025). Digital Tools and Methods. *Enhancing School Counseling With Technology and Case Studies*, 25.
66. Sreekanthaswamy, N., & Hubballi, R. B. (2024). Innovative Approaches To Fmcg Customer Journey Mapping: The Role Of Block Chain And Artificial Intelligence In Analyzing Consumer Behavior And Decision-Making. *Library of Progress-Library Science, Information Technology & Computer*, 44(3).Deshmukh, M. C., Ghadle, K. P., & Jadhav, O. S. (2020). Optimal solution of fully fuzzy LPP with symmetric HFNs. In *Computing in Engineering and Technology: Proceedings of ICCET 2019* (pp. 387-395). Springer Singapore.
67. Chinchodkar, K. N., & Jadhav, O. S. (2017). Development of mathematical model for the solid waste management on dumping ground at Mumbai for the reduction of existence cost. *Int. J. Statist. Syst*, 12, 145-155.
68. Kalluri, V. S. Optimizing Supply Chain Management in Boiler Manufacturing through AI-enhanced CRM and ERP Integration. *International Journal of Innovative Science and Research Technology (IJISRT)*.
69. Kalluri, V. S. Impact of AI-Driven CRM on Customer Relationship Management and Business Growth in the Manufacturing Sector. *International Journal of Innovative Science and Research Technology (IJISRT)*.
70. Kalluri, S. V. S., & Narra, S. (2024). Predictive Analytics in ADAS Development: Leveraging CRM Data for Customer-Centric Innovations in Car Manufacturing. *vol*, 9, 6.
71. Al-Ghanimi, M. G., Hanif, O., Jain, M. V., Kumar, A. S., Rao, R., Kavin, R., ... & Hossain, M. A. (2022, December). Two TS-Fuzzy Controllers based Direct Torque Control of 5-Phase Induction Motor. In *2022 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)* (pp. 1-6). IEEE.
72. Sameera, K., & MVR, S. A. R. (2014). Improved power factor and reduction of harmonics by using dual boost converter for PMBLDC motor drive. *Int J Electr Electron Eng Res*, 4(5), 43-51.
73. Srinivasu, B., Prasad, P. V. N., & Rao, M. R. (2006, December). Adaptive controller design for permanent magnet linear synchronous motor control system. In *2006 International Conference on Power Electronic, Drives and Energy Systems* (pp. 1-6). IEEE.
74. Rao, M. R., & Prasad, P. V. N. (2014). Modelling and Implementation of Sliding Mode Controller for PMBDC Motor Drive. *International journal of advanced research in electrical, electronics and instrumentation engineering*, 3(6).
75. Sidharth, S. (2017). Real-Time Malware Detection Using Machine Learning Algorithms.
76. Sidharth, S. (2017). Access Control Frameworks for Secure Hybrid Cloud Deployments.
77. Kumar, T. V. (2024). Developments and Uses of Generative Artificial Intelligence and Present Experimental Data on the Impact on Productivity Applying Artificial Intelligence that is Generative.
78. Kumar, T. V. (2024). A Comparison of SQL and NO-SQL Database Management Systems for Unstructured Data.

79. Jadhav, V. S., & Jadhav, O. S. (2019). Solving flow-shop scheduling problem to minimize total elapsed time using fuzzy approach. *International Journal of Statistics and Applied Mathematics*, 4(5), 130-133.
80. Deshmukh, M., Ghadle, K., & Jadhav, O. (2020). An innovative approach for ranking hexagonal fuzzy numbers to solve linear programming problems. *International Journal on Emerging Technologies*, 11(2), 385-388.
81. Sidharth, S. (2016). Establishing Ethical and Accountability Frameworks for Responsible AI Systems.
82. Sidharth, S. (2015). AI-Driven Detection and Mitigation of Misinformation Spread in Generated Content.
83. Sharma, S., & Dutta, N. (2024). Examining ChatGPT's and Other Models' Potential to Improve the Security Environment using Generative AI for Cybersecurity.
84. Tambi, V. K., & Singh, N. (2015). Potential Evaluation of REST Web Service Descriptions for Graph-Based Service Discovery with a Hypermedia Focus.
85. Patil, R. D., & Jadhav, O. S. (2016). Some contribution of statistical techniques in big data: a review. *International Journal on Recent and Innovation Trends in Computing and Communication*, 4(4), 293-303.
86. Jadhava, V. S., Buktareb, S. U., & Jadhav, O. S. (2024). Ranking of Octagonal Fuzzy Numbers for Solving Fuzzy Job Sequencing Problem Using Robust Ranking Technique. *Journal of Statistics, Optimization and Data Science*, 1(2), 22-28.
87. Sidharth, S. (2015). Privacy-Preserving Generative AI for Secure Healthcare Synthetic Data Generation.
88. Sidharth, S. (2018). Post-Quantum Cryptography: Readyng Security for the Quantum Computing Revolution.
89. Tambi, V. K., & Singh, N. (2019). Development of a Project Risk Management System based on Industry 4.0 Technology and its Practical Implications. *Development*, 7(11).
90. Chaudhari, S. A., Gawali, B. W., & Jadhav, O. S. (2022). Statistical analysis of EEG data for attention deficit hyperactivity disorder. *Journal of Positive School Psychology*, 4046-4053.
91. Jadhav, S., Machale, A., Mharnur, P., Munot, P., & Math, S. (2019, September). Text based stress detection techniques analysis using social media. In *2019 5th International Conference On Computing, Communication, Control And Automation (ICCUBEA)* (pp. 1-5). IEEE.
92. Thepade, D. S., Mandal, P. R., & Jadhav, S. (2015). Performance Comparison of Novel Iris Recognition Techniques Using Partial Energies of Transformed Iris Images and Enegy CompactionWith Hybrid Wavelet Transforms. In *Annual IEEE India Conference (INDICON)*.
93. Kiran, A., Sonker, A., Jadhav, S., Jadhav, M. M., Naga Ramesh, J. V., & Muniyandy, E. (2024). Secure Communications with THz Reconfigurable Intelligent Surfaces and Deep Learning in 6G Systems. *Wireless Personal Communications*, 1-17.
94. Anitha, C., Tellur, A., Rao, K. B., Kumbhar, V., Gopi, T., Jadhav, S., & Vidhya, R. G. (2024). Enhancing Cyber-Physical Systems Dependability through Integrated CPS-IoT Monitoring. *International Research Journal of Multidisciplinary Scope*, 5(2), 706-713.
95. Vandana, C. P., Basha, S. A., Madijagan, M., Jadhav, S., Matheen, M. A., & Maguluri, L. P. (2024). IoT resource discovery based on multi faected attribute enriched CoAP: smart office seating discovery. *Wireless Personal Communications*, 1-18.
96. Jadhav, S., Durairaj, M., Reenadevi, R., Subbulakshmi, R., Gupta, V., & Ramesh, J. V. N. (2024). Spatiotemporal data fusion and deep learning for remote sensing-based sustainable urban planning. *International Journal of System Assurance Engineering and Management*, 1-9.
97. Jadhav, S., Chaudhari, V., Barhate, P., Deshmukh, K., & Agrawal, T. (2021). Extreme Gradient Boosting for Predicting Stock Price Direction in Context of Indian Equity Markets. In *Intelligent Sustainable Systems: Selected Papers of WorldS4 2021, Volume 2* (pp. 321-330). Singapore: Springer Nature Singapore.
98. Jadhav, S., Chaudhari, V., Barhate, P., Deshmukh, K., & Agrawal, T. (2021). REVIEW PAPER ON: ALGORITHMIC TRADING USING ARTIFICIAL INTELLEGEENCE.
99. Thamma, S. R. T. S. R. (2024). Optimization of Generative AI Costs in Multi-Agent and Multi-Cloud Systems.
100. Alsudairy, M. A. T., & Vasista, T. G. K. (2014, May). CRASP—a strategic methodology perspective for sustainable value chain management. In *Proceedings of the 23rd IBIMA Conference*.
101. Vasista, T. G. K., & AlAbdullatif, A. M. (2015). Turning customer insights contributing to VMI based decision support system in demand Chain management. *International Journal of Managing Value and Supply Chains*, 6(2), 37-45.

102. AlSudairi, M., & Vasista, T. G. K. (2012, September). Service design systems driven innovation approach for total innovation management. In *Proceedings of the 7th European Conference on Innovation and Entrepreneurship: ECIE* (p. 8). Academic Conferences Limited.
103. Vasista, T. G. K. (2007). Wise CRM engine. *Synergy-The Journal of Marketing*, 5(1), 123-127.
104. Vasista, T. G. K. (2016). Thoughtful approaches to implementation of electronic rulemaking. *Int. J. Manag. Pub. Sect. Inf. Commun. Technol.*, 7(2), 43-53.
105. Vasista, T. G. K. (2015). Strategic Business Challenges in Cloud Systems. *Int. J. Cloud Comput. Serv. Archit.*, 5(4), 1-3.
106. Vasista, T. G. K. (2013). System, spiritual and philosophical perspectives of human life and the role of governance in a socio-economic setting. *Unpublished Paper Developed at King Saud University, Riyadh, KSA*.
107. Thamma, S. R. T. S. R. (2024). Revolutionizing Healthcare: Spatial Computing Meets Generative AI.
108. Kalaiselvi, B., & Thangamani, M. (2020). An efficient Pearson correlation based improved random forest classification for protein structure prediction techniques. *Measurement*, 162, 107885.
109. Prabhu Kavin, B., Karki, S., Hemalatha, S., Singh, D., Vijayalakshmi, R., Thangamani, M., ... & Adigo, A. G. (2022). Machine learning-based secure data acquisition for fake accounts detection in future mobile communication networks. *Wireless Communications and Mobile Computing*, 2022(1), 6356152.
110. Geeitha, S., & Thangamani, M. (2018). Incorporating EBO-HSIC with SVM for gene selection associated with cervical cancer classification. *Journal of medical systems*, 42(11), 225.
111. Thangamani, M., & Thangaraj, P. (2010). Integrated Clustering and Feature Selection Scheme for Text Documents. *Journal of Computer Science*, 6(5), 536.
112. Gangadhar, C., Chanthirasekaran, K., Chandra, K. R., Sharma, A., Thangamani, M., & Kumar, P. S. (2022). An energy efficient NOMA-based spectrum sharing techniques for cell-free massive MIMO. *International Journal of Engineering Systems Modelling and Simulation*, 13(4), 284-288.
113. Narmatha, C., Thangamani, M., & Ibrahim, S. J. A. (2020). Research scenario of medical data mining using fuzzy and graph theory. *International Journal of Advanced Trends in Computer Science and Engineering*, 9(1), 349-355.
114. Thangamani, M., & Thangaraj, P. (2013). Fuzzy ontology for distributed document clustering based on genetic algorithm. *Applied Mathematics & Information Sciences*, 7(4), 1563-1574.
115. Surendiran, R., Aarthi, R., Thangamani, M., Sugavanam, S., & Sarumathy, R. (2022). A Systematic Review Using Machine Learning Algorithms for Predicting Preterm Birth. *International Journal of Engineering Trends and Technology*, 70(5), 46-59.
116. Thangamani, M., & Thangaraj, P. (2010). Ontology based fuzzy document clustering scheme. *Modern Applied Science*, 4(7), 148.
117. Ibrahim, S. J. A., & Thangamani, M. (2018, November). Momentous Innovations in the prospective method of Drug development. In *Proceedings of the 2018 International Conference on Digital Medicine and Image Processing* (pp. 37-41).
118. Thamma, S. R. (2024). Cardiovascular image analysis: AI can analyze heart images to assess cardiovascular health and identify potential risks.
119. Arun, A., Ali A. Alalmi, and D. Gunaseelan. "Operational Need and Importance of Capacity Management into Hotel Industry—A Review." (2020).
120. Gunaseelan, D., & Kumar, G. R. (2024). An umbrella view on food habits in the context of health and sustainability for sports persons. *Salud, Ciencia y Tecnología-Serie de Conferencias*, (3), 890.
121. Gunaseelan, D., & Arun, A. Tourist Destination Satisfaction: Analysis of Kanyakumari the Spot with Scenic Beauty and Spiritual Temples. *Emperor Journal of Economics and Social Science Research*, 3(1).
122. Thamma, S. R. T. S. R. (2024). Generative AI in Graph-Based Spatial Computing: Techniques and Use Cases.
123. Kumar, J. S., Archana, B., Muralidharan, K., & Kumar, V. S. (2025). Graph Theory: Modelling and Analyzing Complex System. *Metallurgical and Materials Engineering*, 31(3), 70-77.
124. Kumar, J. S., Archana, B., Muralidharan, K., & Srija, R. (2025). Spectral Graph Theory: Eigen Values Laplacians and Graph Connectivity. *Metallurgical and Materials Engineering*, 31(3), 78-84.
125. Srija, R., Kumar, J. S., & Muralidharan, K. (2025). An improvement in estimating the population mean by using quartiles and correlation coefficient. *Mathematics in Engineering, Science & Aerospace (MESA)*, 16(1).

126. Kumar, J. S., Murthy, S., Kumar, B. R., & Solaiappam, S. (2017, January). p-Value analyze the set of optimal value in MOFTP. In *2017 4th International Conference on Advanced Computing and Communication Systems (ICACCS)* (pp. 1-5). IEEE.
127. Anandasubramanian, C. P., & Selvaraj, J. (2024). NAVIGATING BANKING LIQUIDITY-FACTORS, CHALLENGES, AND STRATEGIES IN CORPORATE LOAN PORTFOLIOS. *Tec Empresarial*, 6(1).
128. Madem, S., Katuri, P. K., Kalra, A., & Singh, P. (2023, May). System Design for Financial and Economic Monitoring Using Big Data Clustering. In *2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)* (pp. 1-7). IEEE.
129. Srikanth, V., & Dhanapal, D. R. (2012). E-commerce online security and trust marks. *International Journal of Computer Engineering and Technology*, 3(2), 238-255.
130. Lopez, S., Sarada, V., Praveen, R. V. S., Pandey, A., Khuntia, M., & Haralayya, D. B. (2024). Artificial intelligence challenges and role for sustainable education in india: Problems and prospects. *Sandeep Lopez, Vani Sarada, RVS Praveen, Anita Pandey, Monalisa Khuntia, Bhadrappa Haralayya (2024) Artificial Intelligence Challenges and Role for Sustainable Education in India: Problems and Prospects. Library Progress International*, 44(3), 18261-18271.
131. Yamuna, V., Praveen, R. V. S., Sathya, R., Dhivva, M., Lidiya, R., & Sowmiya, P. (2024, October). Integrating AI for Improved Brain Tumor Detection and Classification. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1603-1609). IEEE.
132. Kumar, N., Kurkute, S. L., Kalpana, V., Karuppannan, A., Praveen, R. V. S., & Mishra, S. (2024, August). Modelling and Evaluation of Li-ion Battery Performance Based on the Electric Vehicle Tiled Tests using Kalman Filter-GBDT Approach. In *2024 International Conference on Intelligent Algorithms for Computational Intelligence Systems (IACIS)* (pp. 1-6). IEEE.
133. Sharma, S., Vij, S., Praveen, R. V. S., Srinivasan, S., Yadav, D. K., & VS, R. K. (2024, October). Stress Prediction in Higher Education Students Using Psychometric Assessments and AOA-CNN-XGBoost Models. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1631-1636). IEEE.
134. Anuprathibha, T., Praveen, R. V. S., Sukumar, P., Suganthi, G., & Ravichandran, T. (2024, October). Enhancing Fake Review Detection: A Hierarchical Graph Attention Network Approach Using Text and Ratings. In *2024 Global Conference on Communications and Information Technologies (GCCIT)* (pp. 1-5). IEEE.
135. Shinkar, A. R., Joshi, D., Praveen, R. V. S., Rajesh, Y., & Singh, D. (2024, December). Intelligent solar energy harvesting and management in IoT nodes using deep self-organizing maps. In *2024 International Conference on Emerging Research in Computational Science (ICERCS)* (pp. 1-6). IEEE.
136. Praveen, R. V. S., Hemavathi, U., Sathya, R., Siddiq, A. A., Sanjay, M. G., & Gowdish, S. (2024, October). AI Powered Plant Identification and Plant Disease Classification System. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1610-1616). IEEE.
137. Dhivya, R., Sagili, S. R., Praveen, R. V. S., VamsiLala, P. N. V., Sangeetha, A., & Suchithra, B. (2024, December). Predictive Modelling of Osteoporosis using Machine Learning Algorithms. In *2024 4th International Conference on Ubiquitous Computing and Intelligent Information Systems (ICUIS)* (pp. 997-1002). IEEE.
138. Kemmannu, P. K., Praveen, R. V. S., Saravanan, B., Amshavalli, M., & Banupriya, V. (2024, December). Enhancing Sustainable Agriculture Through Smart Architecture: An Adaptive Neuro-Fuzzy Inference System with XGBoost Model. In *2024 International Conference on Sustainable Communication Networks and Application (ICSCNA)* (pp. 724-730). IEEE.
139. Praveen, R. V. S. (2024). *Data Engineering for Modern Applications*. Addition Publishing House.