YOLO-ESCA: A HIGH-PERFORMANCE SAFETY HELMET STANDARD WEARING BEHAVIOUR DETECTION MODEL BASED ON IMPROVED YOLOV5

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Abstract: The detection of safety helmet standard wearing behaviour plays a critical role in ensuring workplace safety in industries such as construction and manufacturing. YOLO-ESCA, an advanced detection model, was created using enhanced YOLOv5 improves feature extraction and detection accuracy by integrating the Efficient Channel Attention (ECA) module. YOLOv3, YOLOv3-tiny, YOLOv5 variations (s, m, l, x, and x6), and the most recent iterations of YOLOv8 and YOLOv9 are among the models that the system uses. By strengthening the attention mechanism and increasing the model's sensitivity to important aspects of helmet- wearing behaviour, YOLOv5x with the ECA module improves performance. Additionally, YOLOv5x6 and the most recent YOLO versions offer a thorough analysis, guaranteeing excellent precision in identifying safety helmets in a variety of scenarios. The ECA module's integration with YOLOv5 models provides a speed-accuracy balance. A frontend interface with user authentication is created using the Flask framework for user interaction and testing, offering a safe and user-friendly platform. In order to improve workplace safety and adherence to industry standards, this system is made to maximize helmet detection efficiency and minimize accidents brought on by incorrect helmet use.

Keywords:YOLO-ESCA , Image Processing , Safety helmet detection , YOLOv5 , Workplace Safety, Real-time Detection, Object Detection Algorithms.

INTRODUCTION

A number of factors, including labour intensity, the intersection of several processes, and complicated operating environments, contribute to the high frequency of safety mishaps in the construction industry. One of the "three treasures" of construction, safety helmets can avoid the majority of injuries that happen when building. Furthermore, wearing a helmet can help avoid deadly injuries. However, wearing a helmet incorrectly might result in secondary injuries that ultimately cause tragedy in some accidents, such as those involving persons falling from great heights. The national standard "head protective safety helmet" (GB2811-2019) states that a safety helmet shall be fitted to the size of the chin belt or head circumference cap. must make sure it is securely worn and not inadvertently slipped or misaligned. Even the most simple brain injury may necessitate medical and psychological care to address memory issues, behavioural abnormalities, depression, and personality changes, even in the event of an accident. Therefore, in order to address potential hazards, personnel must appropriately wear safety helmets. However, construction workers do not adhere to national regulations because of a lack of safety awareness. Conventional manual management is ineffective, wastes resources, and makes it more difficult to prevent mishaps. As a result, automatic helmet-wearing situation recognition is essential. The goal is to use sophisticated YOLO-based algorithms to create a reliable detection model for detecting safety helmet wearing behaviour. Using the most recent YOLOv8 as well as YOLOv3, YOLOv3-tiny, and YOLOv5 variations (s, m, l, x, x6) Using YOLOv9 models, the system seeks to optimize detection precision in a range of settings. The Efficient Channel Attention (ECA) module is integrated into YOLOv5x to improve feature extraction and sensitivity to important features in helmet-wearing behaviour. Using the Flask framework, the objective is to develop an intuitive user interface that guarantees accurate detection, user identification, and eventually encourages adherence to workplace safety regulations. Due to a lack of monitoring and inefficient detection techniques, industrial establishments with inadequate adherence to safety helmet rules run a higher risk of worker head injuries. In order to prevent injuries,

many industries, including manufacturing and construction, require the use of helmets. However, non-compliance frequently results from inadequate enforcement of these regulations, endangering worker safety. Inappropriate helmet use increases the risk of serious head injuries for workers in factories, construction sites, and other dangerous settings, endangering their health and means of subsistence. In addition to endangering worker safety, a rise in head injury cases places a financial strain on companies and healthcare systems as a result of prospective lawsuits and medical costs. YOLO-ESCA, a reliable detection model, will be created to efficiently track helmet use using cutting-edge.

LITERATURE SURVEY

S No.	Titles	Methodology	Results
1.	AI City Challenge 2023: Real-Time Helmet Violation Detection Using YOLOv5 Enhanced by Genetic Algorithms	The YOLOv5 model, which was trained on the 2023 NVIDIA AI City Challenge dataset, is used in this work to detect helmet violations in real time .While data augmentation and sampling strategies enhance performance as measured by precision, recall, and mAP measures, genetic algorithms optimize hyperparameters.	Using training data, the YOLOv5 model obtained precision of 0.848, recall of 0.599, and mAP of 0.641. The model successfully detected helmet violations for the test dataset, achieving a mAP of 0.6667 and placing fourth in the public leaderboard. .
2.	An investigation on the safety helmet detection algorithm for power workers based on enhanced YOLOv5.	A 160×160 feature map is added to the YOLOv5 network to enhance small target detection. Anchor boxes are optimized for helmet detection using K- means clustering. This method lowers misdetection rates while improving the model's accuracy.	Overall accuracy for the upgraded YOLOv5 model is 95%, with helmet recognition accuracy increasing to 94.6%. The model has great real-time detection capabilities, improves safety in the power industry, and drastically lowers missed and misdetected small targets.

3.	An enhanced YOLOv5s-based safety helmet identification algorithm is used.	To improve feature extraction, a DenseBlock module is used in place of the slice structure in the YOLOv5s model. The addition of the SE-Net channel attention module enhances the detection of small targets. A novel detection layer and data augmentation aid in handling crowded circumstances.	The enhanced YOLOv5s model outperforms YOLOX-L and PP-YOLOv2 by 1.05% and 1.21%, respectively, and increases mAP@0.5 by 6.57% over the original YOLOv5s. In situations involving small and dense target detection, it exhibits good generalization.
4.	Enhanced YOLO V3 Deep Model for Helmet Detection.	Densenet is used to replace the YOLO V3 model's backbone in order to increase feature extraction. In order to handle problems like stains, occlusions, and low-resolution images, the resulting YOLO-Densebackbone network is tested on helmet detection.	The YOLO-Densebackbone model outperforms the conventional YOLO V3 in difficult helmet detection conditions such as stains, occlusions, and low-resolution photos, achieving a 2.44% increase in detection accuracy while keeping the same detection rate.

1. Data loading: The data set will be loaded with this module.
2. Image Processing : To standardize the input for the model, image processing starts with turning the image to a blob object. Bounding boxes are then declared to identify items within the image, and the class is defined. After that, a NumPy array is created from the image for processing. The network layers are read and the output layers are extracted following the loading of the previously trained model. For improved analysis, the image is subjected to additional processing, such as scaling, mask creation, and BGR to RGB conversion.
3. Data Augmentation : By performing different image modifications, data augmentation improves the training dataset. This entails rotating the image to catch various angles and randomizing it to add diversity. orientations, and altering the picture using methods like flipping or resizing. These methods improve the model's robustness and generalization to new data.

4. **Model generation:** By performing different image modifications, data augmentation improves the training dataset. This entails rotating the image to catch various angles and randomizing it to add diversity. orientations, and altering the picture using methods like flipping or resizing. These techniques enhance the model's ability to generalize to new inputs and its resilience.
5. **User signup & login:** Using this module will get registration and login.
6. **User input:** Using this module will give input for prediction.
7. **Prediction:** final predicted displayed.

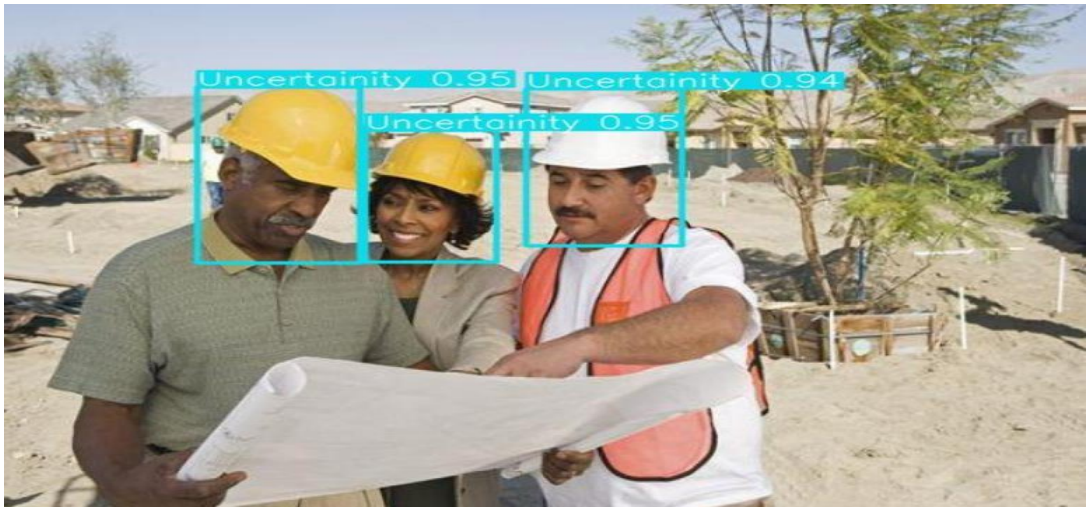
Extension: To improve safety helmet recognition, we have further improved our methodology by incorporating the most recent YOLOv8 and YOLOv9 versions with the sophisticated YOLOv5x6 model. This addition seeks to increase the precision and dependability of detecting objects in construction settings. Furthermore, we will use the Flask framework to create an intuitive front end with secure user authentication for efficient testing and assessmen

Advantages:

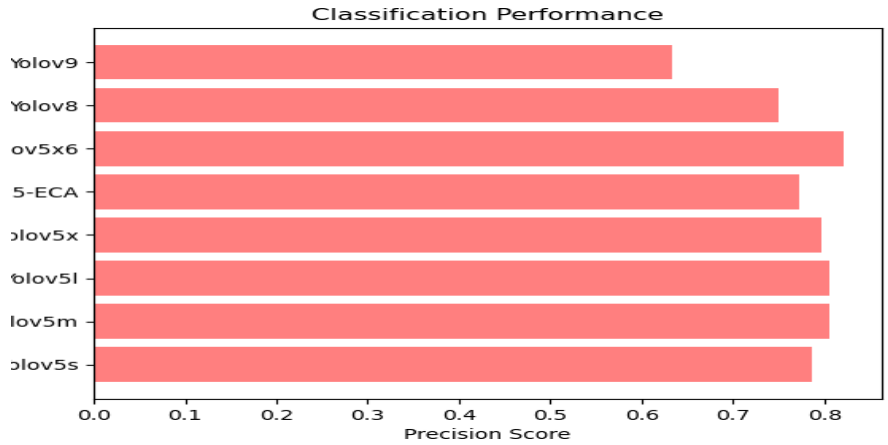
1. By greatly improving safety helmet detection accuracy, the sophisticated YOLO models encourage greater adherence to workplace safety laws.
2. Combining several YOLO versions enables a more thorough examination of helmet detection, guaranteeing dependable performance in a range of situations.
3. Users can engage with the detection system more easily and with greater usefulness thanks to the Flask front end's user-friendly interface.
4. By limiting access to authorized workers and strengthening security measures, the implementation of robust authentication processes guarantees the protection of sensitive data.

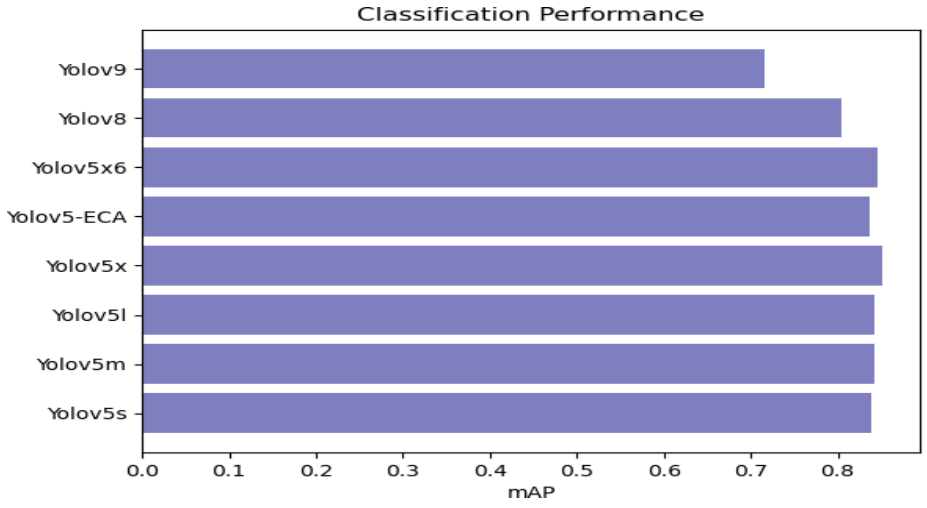
EXPERIMENT AND RESULTS

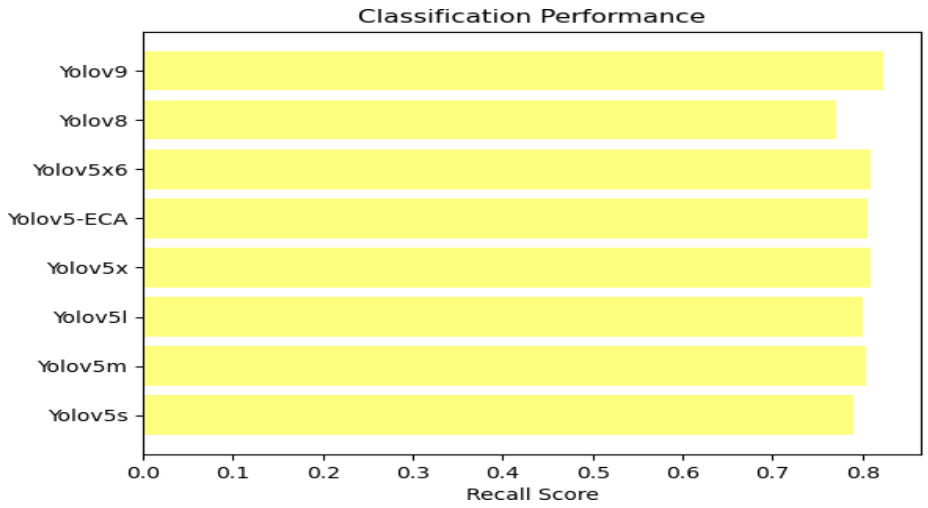
An important development in the identification of standard helmet wearing behaviour in industrial settings, especially in industries like manufacturing and construction, is the YOLO-ESCA model. Through the utilization of several YOLO models, such as YOLOv3, YOLOv5 variations, and the most recent YOLOv8 and YOLOv9 models, this system is able to determine appropriate helmet usage with high accuracy and efficiency. The YOLOv5x model's feature extraction is improved by the incorporation of the Efficient Channel Attention (ECA) module, which also increases sensitivity to important visual cues that signify adherence to safety regulations. This all-encompassing strategy guarantees that the model can efficiently adjust to different circumstances, offering trustworthy monitoring and enhancing general workplace safety.



Comparison Graphs:







Feasibility Study: In project management, a feasibility study is a thorough examination carried out to ascertain the viability and practicality of a suggested project. It evaluates a number of factors, including operational, legal, financial, technological, and scheduling viability to determine whether the project can be effectively finished within the specified parameters. Based on the risks, expenses, advantages, and possible results, the research assists stakeholders in making well-informed decisions on whether to move forward with the project or look into other options.

Types of Feasibility Study:

Technical feasibility: A technical feasibility assessment examines your project's technological resources. This analysis establishes whether you possess the necessary tools, sufficient tools, and technical know-how to accomplish your project's goals. For instance, This project isn't physically possible if your project plan calls for producing 50,000 products per month but your factories can only manufacture 30,000 products per month.

Financial feasibility: Your project's financial viability is determined by its financial feasibility. A cost-benefit analysis of the project is part of a financial feasibility report. It also lists any financial concerns and projects an anticipated return on investment (ROI). Understanding the project's potential economic benefits is the aim of the financial feasibility study.

Market feasibility: The market feasibility study is an evaluation of how your team expects the project's deliverables to perform in the market. This section of the research contains sales forecasts, a market analysis, and a breakdown of market competition.

Operational feasibility: Your organization's ability to finish this project is assessed via an operational feasibility analysis. This covers organizational structure, workforce needs, and any relevant legal requirements. Your team will know at the conclusion of the operational feasibility study if you have the resources, competencies, and abilities necessary to finish this activity.

Legal feasibility: An evaluation of the project's legal viability determines whether it conforms with all applicable laws and rules. This entails looking at regulatory and legal obstacles, required licenses, permits, or certificates, possible legal hazards or liabilities, as well as issues related to intellectual property. The project may be finished without breaking any laws or exposing the company to unnecessary legal risk thanks to the legal feasibility assessment.

CONCLUSION

To sum up, the YOLO-ESCA model is a major step forward in identifying the typical wearing behaviour of safety helmets in industrial settings, especially in industries like manufacturing and construction. By utilizing the With the use of several YOLO models, such as YOLOv3, YOLOv5 variations, and the most recent YOLOv8 and YOLOv9, this system is able to determine appropriate helmet usage with great accuracy and efficiency. The YOLOv5x model's feature extraction is improved by the incorporation of the Efficient Channel Attention (ECA) module, which also increases sensitivity to important visual cues that signify adherence to safety regulations. This all-encompassing strategy guarantees that the model can efficiently adjust to different circumstances, offering

trustworthy monitoring and enhancing general workplace safety. creation of an intuitive Flask-based frontend, replete with secure authentication, makes user engagement and testing smooth and improves the system's usefulness even more. By increasing the effectiveness of helmet detection, YOLO- ESCA hopes to drastically lower the number of incidents brought on by incorrect helmet use, promoting a safer workplace and guaranteeing compliance with industry standards. All things considered, this cutting-edge detection technology establishes a new benchmark for workplace safety compliance and monitoring. In order to expand its use in workplace safety monitoring, the YOLO-ESCA model will eventually be able to identify additional personal protective equipment (PPE), such as safety vests and goggles. Furthermore, Over time, incorporating real-time analytics and reporting capabilities may yield insightful information on patterns in safety compliance. Investigating the application of sophisticated deep learning strategies, like ensemble methods and transfer learning, may enhance detection robustness and accuracy even more. Furthermore, the system can be deployed on edge devices for real-time processing, which can enable prompt notifications in dangerous circumstances and greatly improve safety procedures in a variety of industrial settings.

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. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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.
14. Lavanya, P. (2024). In-Cab Smart Guidance and support system for Dragline operator.
15. Kovoor, 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.
16. Rao, N. R., Kovoor, 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).
17. Madhuri, K. (2023). Security Threats and Detection Mechanisms in Machine Learning. *Handbook of Artificial Intelligence*, *255*.
18. 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*.

19. 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.
20. Reddy, P. R. S., & Ravindranadh, K. (2019). An exploration on privacy concerned secured data sharing techniques in cloud. *International Journal of Innovative Technology and Exploring Engineering*, *9*(1), 1190-1198.
21. 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.
22. 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.
23. Yakoob, S., Krishna Reddy, V., & Dastagiraiah, C. (2017). Multi User Authentication in Reliable Data Storage in Cloud. In *Computer Communication, Networking and Internet Security: Proceedings of IC3T 2016* (pp. 531-539). Springer Singapore.
24. Sukhavasi, V., Kulkarni, S., Raghavendran, V., Dastagiraiah, C., Apat, S. K., & Reddy, P. C. S. (2024). Malignancy Detection in Lung and Colon Histopathology Images by Transfer Learning with Class Selective Image Processing.
25. Dastagiraiah, C., Krishna Reddy, V., & Pandurangarao, K. V. (2018). Dynamic load balancing environment in cloud computing based on VM ware off-loading. In *Data Engineering and Intelligent Computing: Proceedings of IC3T 2016* (pp. 483-492). Springer Singapore.
26. Swapna, N. (2017). „Analysis of Machine Learning Algorithms to Protect from Phishing in Web Data Mining". *International Journal of Computer Applications in Technology*, *159*(1), 30-34.
27. Moparthi, N. R., Bhattacharyya, D., Balakrishna, G., & Prashanth, J. S. (2021). Paddy leaf disease detection using CNN.
28. Balakrishna, G., & Babu, C. S. (2013). Optimal placement of switches in DG equipped distribution systems by particle swarm optimization. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, *2*(12), 6234-6240.
29. Moparthi, N. R., Sagar, P. V., & Balakrishna, G. (2020, July). Usage for inside design by AR and VR technology. In *2020 7th International Conference on Smart Structures and Systems (ICSSS)* (pp. 1-4). IEEE.
30. Amarnadh, V., & Moparthi, N. R. (2023). Comprehensive review of different artificial intelligence-based methods for credit risk assessment in data science. *Intelligent Decision Technologies*, *17*(4), 1265-1282.
31. Amarnadh, V., & Moparthi, N. (2023). Data Science in Banking Sector: Comprehensive Review of Advanced Learning Methods for Credit Risk Assessment. *International Journal of Computing and Digital Systems*, *14*(1), 1-xx.
32. Amarnadh, V., & Rao, M. N. (2025). A Consensus Blockchain-Based Credit Risk Evaluation and Credit Data Storage Using Novel Deep Learning Approach. *Computational Economics*, 1-34.
33. Shailaja, K., & Anuradha, B. (2017). Improved face recognition using a modified PSO based self-weighted linear collaborative discriminant regression classification. *J. Eng. Appl. Sci*, *12*, 7234-7241.
34. Sekhar, P. R., & Goud, S. (2024). Collaborative Learning Techniques in Python Programming: A Case Study with CSE Students at Anurag University. *Journal of Engineering Education Transformations*, *38*.
35. Sekhar, P. R., & Sujatha, B. (2023). Feature extraction and independent subset generation using genetic algorithm for improved classification. *Int. J. Intell. Syst. Appl. Eng*, *11*, 503-512.
36. Pesaramelli, R. S., & Sujatha, B. (2024, March). Principle correlated feature extraction using differential evolution for improved classification. In *AIP Conference Proceedings* (Vol. 2919, No. 1). AIP Publishing.
37. Tejaswi, S., Sivaprashanth, J., Bala Krishna, G., Sridevi, M., & Rawat, S. S. (2023, December). Smart Dustbin Using IoT. In *International Conference on Advances in Computational Intelligence and Informatics* (pp. 257-265). Singapore: Springer Nature Singapore.
38. Moreb, M., Mohammed, T. A., & Bayat, O. (2020). A novel software engineering approach toward using machine learning for improving the efficiency of health systems. *IEEE Access*, *8*, 23169-23178.
39. Ravi, P., Haritha, D., & Niranjan, P. (2018). A Survey: Computing Iceberg Queries. *International Journal of Engineering & Technology*, *7*(2.7), 791-793.
40. Madar, B., Kumar, G. K., & Ramakrishna, C. (2017). Captcha breaking using segmentation and morphological operations. *International Journal of Computer Applications*, *166*(4), 34-38.
41. Rani, M. S., & Geetavani, B. (2017, May). Design and analysis for improving reliability and accuracy of big-data based peripheral control through IoT. In *2017 International Conference on Trends in Electronics and Informatics (ICEI)* (pp. 749-753). IEEE.
42. Reddy, T., Prasad, T. S. D., Swetha, S., Nirmala, G., & Ram, P. (2018). A study on antiplatelets and

anticoagulants utilisation in a tertiary care hospital. *International Journal of Pharmaceutical and Clinical Research*, *10*, 155-161.

43. Prasad, P. S., & Rao, S. K. M. (2017). HIASA: Hybrid improved artificial bee colony and simulated annealing based attack detection algorithm in mobile ad-hoc networks (MANETs). *Bonfring International Journal of Industrial Engineering and Management Science*, *7*(2), 01-12.
44. AC, R., Chowdary Kakarla, P., Simha PJ, V., & Mohan, N. (2022). Implementation of Tiny Machine Learning Models on Arduino 33–BLE for Gesture and Speech Recognition.
45. 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.
46. Nagaraj, P., Prasad, A. K., Narsimha, V. B., & Sujatha, B. (2022). Swine flu detection and location using machine learning techniques and GIS. *International Journal of Advanced Computer Science and Applications*, *13*(9).
47. Priyanka, J. H., & Parveen, N. (2024). DeepSkillNER: an automatic screening and ranking of resumes using hybrid deep learning and enhanced spectral clustering approach. *Multimedia Tools and Applications*, *83*(16), 47503-47530.
48. Sathish, S., Thangavel, K., & Boopathi, S. (2010). Performance analysis of DSR, AODV, FSR and ZRP routing protocols in MANET. *MES Journal of Technology and Management*, 57-61.
49. Siva Prasad, B. V. V., Mandapati, S., Kumar Ramasamy, L., Boddu, R., Reddy, P., & Suresh Kumar, B. (2023). Ensemble-based cryptography for soldiers' health monitoring using mobile ad hoc networks. *Automatika: časopis za automatiku, mjerenje, elektroniku, računarstvo i komunikacije*, *64*(3), 658-671.
50. Elechi, P., & Onu, K. E. (2022). Unmanned Aerial Vehicle Cellular Communication Operating in Non-terrestrial Networks. In *Unmanned Aerial Vehicle Cellular Communications* (pp. 225-251). Cham: Springer International Publishing.
51. Prasad, B. V. V. S., Mandapati, S., Haritha, B., & Begum, M. J. (2020, August). Enhanced Security for the authentication of Digital Signature from the key generated by the CSTRNG method. In *2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT)* (pp. 1088-1093). IEEE.
52. Mukiri, R. R., Kumar, B. S., & Prasad, B. V. V. (2019, February). Effective Data Collaborative Strain Using RecTree Algorithm. In *Proceedings of International Conference on Sustainable Computing in Science, Technology and Management (SUSCOM), Amity University Rajasthan, Jaipur-India*.
53. Balaraju, J., Raj, M. G., & Murthy, C. S. (2019). Fuzzy-FMEA risk evaluation approach for LHD machine–A case study. *Journal of Sustainable Mining*, *18*(4), 257-268.
54. Thirumoorthi, P., Deepika, S., & Yadaiah, N. (2014, March). Solar energy based dynamic sag compensator. In *2014 International Conference on Green Computing Communication and Electrical Engineering (ICGCCEE)* (pp. 1-6). IEEE.
55. Vinayasree, P., & Reddy, A. M. (2025). A Reliable and Secure Permissioned Blockchain-Assisted Data Transfer Mechanism in Healthcare-Based Cyber-Physical Systems. *Concurrency and Computation: Practice and Experience*, *37*(3), e8378.
56. Acharjee, P. B., Kumar, M., Krishna, G., Raminenei, K., Ibrahim, R. K., & Alazzam, M. B. (2023, May). Securing International Law Against Cyber Attacks through Blockchain Integration. In *2023 3rd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)* (pp. 2676-2681). IEEE.
57. Ramineni, K., Reddy, L. K. K., Ramana, T. V., & Rajesh, V. (2023, July). Classification of Skin Cancer Using Integrated Methodology. In *International Conference on Data Science and Applications* (pp. 105-118). Singapore: Springer Nature Singapore.
58. LAASSIRI, J., EL HAJJI, S. A. Ï. D., BOUHDADI, M., AOUDE, M. A., JAGADISH, H. P., LOHIT, M. K., ... & KHOLLADI, M. (2010). Specifying Behavioral Concepts by engineering language of RM-ODP. *Journal of Theoretical and Applied Information Technology*, *15*(1).
59. Prasad, D. V. R., & Mohanji, Y. K. V. (2021). FACE RECOGNITION-BASED LECTURE ATTENDANCE SYSTEM: A SURVEY PAPER. *Elementary Education Online*, *20*(4), 1245-1245.
60. Dasu, V. R. P., & Gujjari, B. (2015). Technology-Enhanced Learning Through ICT Tools Using Aakash Tablet. In *Proceedings of the International Conference on Transformations in Engineering Education: ICTIEE 2014* (pp. 203-216). Springer India.
61. Reddy, A. M., Reddy, K. S., Jayaram, M., Venkata Maha Lakshmi, N., Aluvalu, R., Mahesh, T. R., ... & Stalin Alex, D. (2022). An efficient multilevel thresholding scheme for heart image segmentation using a hybrid generalized adversarial network. *Journal of Sensors*, *2022*(1), 4093658.
62. Srinivasa Reddy, K., Suneela, B., Inthiyaz, S., Hasane Ahammad, S., Kumar, G. N. S., & Mallikarjuna Reddy, A. (2019). Texture filtration module under stabilization via random forest optimization methodology. *International Journal of Advanced Trends in Computer Science and Engineering*, *8*(3), 458-469.

63. 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.
64. Sirisha, G., & Reddy, A. M. (2018, September). Smart healthcare analysis and therapy for voice disorder using cloud and edge computing. In *2018 4th international conference on applied and theoretical computing and communication technology (iCATccT)* (pp. 103-106). IEEE.
65. Reddy, A. M., Yarlagadda, S., & Akkinen, H. (2021). An extensive analytical approach on human resources using random forest algorithm. *arXiv preprint arXiv:2105.07855*.
66. Kumar, G. N., Bhavanam, S. N., & Midasala, V. (2014). Image Hiding in a Video-based on DWT & LSB Algorithm. In *ICPVS Conference*.
67. Naveen Kumar, G. S., & Reddy, V. S. K. (2022). High performance algorithm for content-based video retrieval using multiple features. In *Intelligent Systems and Sustainable Computing: Proceedings of ICISSC 2021* (pp. 637-646). Singapore: Springer Nature Singapore.
68. Reddy, P. S., Kumar, G. N., Ritish, B., SaiSwetha, C., & Abhilash, K. B. (2013). Intelligent parking space detection system based on image segmentation. *Int J Sci Res Dev*, *1*(6), 1310-1312.
69. Naveen Kumar, G. S., Reddy, V. S. K., & Kumar, S. S. (2018). High-performance video retrieval based on spatio-temporal features. *Microelectronics, Electromagnetics and Telecommunications*, 433-441.
70. Kumar, G. N., & Reddy, M. A. BWT & LSB algorithm based hiding an image into a video. *IJESAT*, 170-174.
71. 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.
72. 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.
73. 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.
74. 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.
75. 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.
76. 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.
77. 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.
78. 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.
79. 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.
80. Praveen, R. V. S. (2024). *Data Engineering for Modern Applications*. Addition Publishing House.