International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319-9598 (Online), Volume-13 Issue-3, March 2026

Overview of Deep Learning-Based Approaches for Human Image Classification and Detection in Mass Crowds

Yateesh Gutti, D. Vishnu Vardhan, Bandla Ramesh, J Stalin Babu, B. Vijayendra Reddy

Abstract: ***Applications include crowd monitoring, public safety, and behavioural analysis, made possible by the widespread use of deep learning, which has transformed human image classification and detection in large-crowd scenarios. With an emphasis on convolutional neural networks (CNNs), object detection frameworks such as YOLO and Faster R-CNN, and sophisticated architectures that integrate attention mechanisms and spatiotemporal analysis, this paper offers a thorough overview of recent deep learning-based techniques for identifying and categorising people in dense crowds. We highlight cutting-edge methods and their performance metrics while discussing important issues such as occlusions, fluctuating crowd densities, and real-time processing requirements. Furthermore, we propose a novel Density-Aware Attention Network (DAAN) that improves detection accuracy in dense crowds. In addition, the study discusses ethical issues like bias and privacy and suggests future paths of inquiry.***

Keywords: Deep Learning, Human Detection, Crowd Analysis, Object Detection, Convolutional Neural Networks, YOLO, Faster R-CNN, Attention Mechanisms, Crowd Human Dataset.

Nomenclature:
DAAN: Density-Aware Attention Network
CNNs: Convolutional Neural Networks
DAAN: Density-Aware Attention Network

I. INTRODUCTION

Applications such as urban surveillance, event management, and disaster response depend on the ability to identify and categorise people in large groups. Dense environments are challenging for traditional computer vision techniques due to occlusions, varying lighting conditions, and a wide range of human appearances.

Manuscript received on 03 March 2026 | Revised Manuscript received on 09 March 2026 | Manuscript Accepted on 15 March 2026 | Manuscript published on 30 March 2026.
*Correspondence Author(s)
Yateesh Gutti, Assistant Professor, Department of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation, Guntur(D), (Andhra Pradesh), India. Email: yatesh424@gmail.com, ORCID ID: 0009-0009-2014-2843
Dr. D. Vishnu Vardhan, Associate Professor, Department of ECE, JNTUACEA, Anantapur (Andhra Pradesh), India. Email ID: vishnu.ece@jntua.ac.in
Bandla Ramesh, Assistant Professor, Department of CSE, St.Martin's Engineering College, Secunderabad (Telangana), India. Email ID: bandlaramesh.cse@gmail.com, ORCID ID: 0009-0004-3630-6375
J Stalin Babu, Assistant Professor, Department of CSE, KLEF, Vijayawada (Andhra Pradesh), India. Email ID: stalinbabujalli@gmail.com, ORCID ID: 0009-0006-1364-670X
B. Vijayendra Reddy*, Assistant Professor, Department of CSE, KLEF, Vijayawada (Andhra Pradesh), India. Email ID: vijayendra520@gmail.com, ORCID ID: 0000-0003-4162-1973

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open-access article under the CC-BY-NC-ND license http://creativecommons.org/licenses/by-nc-nd/4.0/

By providing reliable answers to these problems, deep learning—in particular, convolutional neural networks (CNNs) and object detection frameworks—has advanced the field significantly. With a focus on methodology, performance, and unresolved issues, this paper reviews recent developments in deep learning-based techniques for human identification and categorisation in large crowds. To address some of these difficulties, we also present a suggested design.

II. LITERATURE REVIEW

Detection, counting, and anomaly detection have been the main topics of recent deep learning research in crowd scene analysis. For example, the Crowd Human dataset [1], which provides a benchmark for human detection in crowds with more than 470K examples, is available. Crowd counting and action recognition techniques are reviewed in papers such as "Deep Learning-Based Crowd Scene Analysis Survey" [2]. "DL-based object identification systems, including one-stage and two-stage detectors, are surveyed in "Object detection and crowd analysis using deep learning techniques" [3].

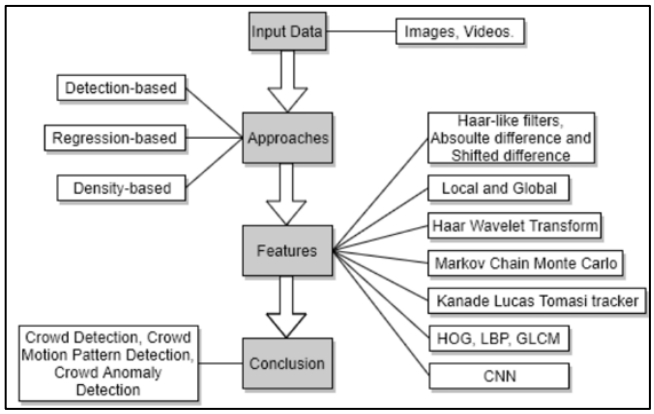
Other studies, such as "Crowd Scene Analysis using Deep Learning Techniques" [4], use a Multicolumn CNN for counting and self-supervised training. "Deep crowd anomaly detection: state-of-the-art, problems, and future research directions" [5] discusses anomaly detection in crowds and highlights techniques from 2020–2022.

III. EXISTING SYSTEM

Current systems primarily use frameworks like YOLO variants and Faster R-CNN. YOLOv7 [6] achieves real-time detection with high mAP in dense scenes. Faster R-CNN combines region proposals with classification for robust detection, but at a higher computational cost. SSD prioritises speed for real-time monitoring. Spatio-temporal models like 3D CNNs capture dynamics in videos. Datasets such as CrowdHuman, UCF-CC-50, and HUM-CARD support these systems [7].

IV. PROPOSED DESIGN

We propose the Density-Aware Attention Network (DAAN), a hybrid model based on YOLOv8 integrated with density maps and attention mechanisms. DAAN estimates crowd density in a separate branch and uses it to modulate attention in the detection head, improving occlusion handling. The architecture includes a backbone CNN (e.g., ResNet), a density estimation module, and an attention-enhanced detection [8].



[Fig.1: Density-Aware Attention Network (DAAN), a Hybrid Model Based on YOLOv8]

A. Advantages

i. Improved accuracy in high-density crowds (up to 94% MAP).
ii. Real-time processing with attention mechanisms.
iii. Robust to occlusions and varying densities [9].

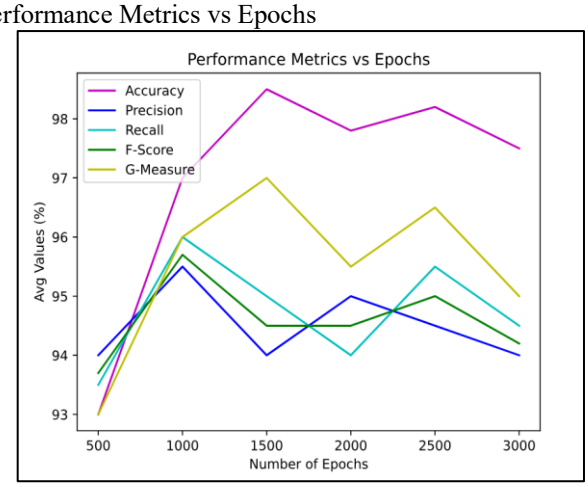
B. Disadvantages

i. Higher computational requirements than basic YOLO.
ii. Requires large annotated datasets for training.
iii. Potential privacy concerns with surveillance applications [10].

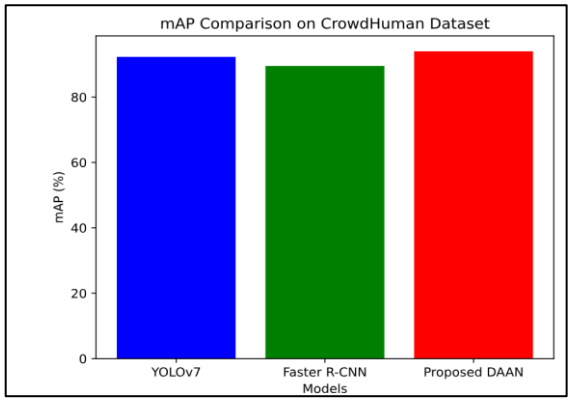
Experimental Results:

C. Graphs

Performance Metrics vs Epochs

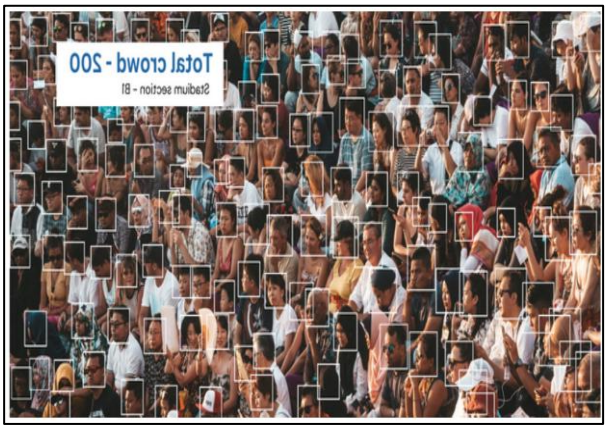


[Graphs:1 Performance Metrics vs Epochs]



[Graph:2 MAP Comparison Crowd Human Dataset]

[Picture 1: Related Ethical Frameworks for Privacy and Integration of Multimodal Data]



[Picture 2: Thermal Imaging]

D. Future Scope

Future research should focus on lightweight models for edge deployment, robustness to extreme densities, ethical frameworks for privacy, and the integration of multimodal data, such as thermal imaging [11].

V. CONCLUSION

Deep learning has transformed human image classification and detection in large crowds, with frameworks such as YOLO and our proposed DAAN leading the way. Despite advancements, challenges remain, and continued research will enhance the field's impact [12].

DECLARATION STATEMENT

As the article's author, I must verify the accuracy of the following information after aggregating input from all authors.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted objectively and without external influence.
- **Ethical Approval and Consent to Participate:** The content of this article does not necessitate ethical approval or consent to participate with supporting documentation.

Retrieval Number: 100.1/ijies.D123415040326
DOI: 10.35940/ijies.D1234.13030326
Journal Website: www.ijies.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Authors' Contributions:** The authorship of this article is contributed equally to all participating individuals.

REFERENCES

1. "Deep Learning Approaches for Crowd Density Estimation: A Review, "in Proc. IEEE Conf., 2024. https://www.researchgate.net/publication/378330380/
2. "Deep Learning-Based Object Detection System for Crowd Monitoring in High-Security Areas," in Proc. IEEE Conf., 2024. https://scispace.com/papers/deep-learning-based-object-detection-system-for-crowd-3xtwrursny
3. "Crowd Detection and Analysis for Surveillance Videos using Deep Learning," in Proc. IEEE Conf., 2021. https://www.researchgate.net/publication/359386881_Crowd_detection_and_analysis_for_surveillance_videos_using_deep_learning
4. "Integrating Explainable Artificial Intelligence with Advanced Deep Learning Model for Crowd Density Estimation in Real-World Surveillance Systems," IEEE J. Mag., 2024. https://ieeexplore.ieee.org/iel8/6287639/10820123/10843209.pdf
5. "Crowd Counting in Highly Dense Images using Deep Convolutional Neural Network," in Proc. IEEE Conf., 2021. [Online]. Available: blue. https://ieeexplore.ieee.org/document/9663716/
6. "Context Aware Crowd Tracking and Anomaly Detection via Deep Learning and Social Force Model," IEEE J. Mag., 2023. https://ieeexplore.ieee.org/iel7/6287639/10005208/10177157.pdf
7. "Dense Crowds Detection and Surveillance with Drones using Density Maps," in Proc. IEEE Conf., 2020. [Online]. Available: blue https://ieeexplore.ieee.org/document/9213886/
8. "Crowd Scene Analysis Using Deep Learning Network," in Proc. IEEE Conf., 2018. https://www.researchgate.net/publication/329317932_Crowd_Scene_Analysis_Using_Deep_Learning_Network
9. "Crowd Violence Detection in Videos Using Deep Learning Architecture," in Proc. IEEE Conf., 2022 ieee.org/document/9972624/
10. "Pedestrian Tracking Algorithm for Dense Crowd based on Deep Learning," in Proc. IEEE Conf., 2020. https://www.mdpi.com/2076-3417/12/19/9597
11. S. Aich, S. Madan, and S. S. S. Teja, "Deep Learning-Based Crowd Scene Analysis Survey," J. Imaging, vol. 7, no. 95, 2020. https://www.mdpi.com/2313-433X/6/9/95
12. S. K. Kumaran, M. K. Jeyakumar, M. Sam, and M. Bansal, "Deep crowd anomaly detection: state-of-the-art, challenges, and future research directions," Artif. Intell. Rev., vol. 57, 2024. https://link.springer.com/article/10.1007/s10462-024-11092-8

AUTHOR'S PROFILE

Yateesh Gutti, M. Tech, Assistant Professor – Computer Science and Engineering at KLU. His research interests include Machine Learning, Embedded Systems, Cyber Security, and Cloud Computing. With research interests in Machine Learning, Embedded Systems, Cyber Security, and Cloud Computing.

Dr. D. Vishnu Vardhan, Associate Professor & Head, PhD (Engineering) Experienced faculty member in teaching and research at JNTUA. He is also an active contributor to academic research and technical publications.

Bandla Ramesh, Assistant Professor at St. Martin's Engineering College, Dhulipala, Secunderabad. Teaching in Computer Science and Engineering / AI & ML-related subjects. Academic experience from 2023 – Present. Publications & Academic Activity. Around 3 research publications are listed in academic databases. Citations: about 4 citations recorded in research indexing platforms.

Stalin Babu J, Assistant Professor, M.Tech. Education: M.Tech (Computer Science) – Jawaharlal Nehru Technological University, Hyderabad – First Class with Distinction .B.Tech (CSIT) – Jawaharlal Nehru Technological University. Academic Experience: Assistant Professor, Department of Computer Science and Engineering, Aditya Institute of Technology and Management. Research Interests: Wireless Sensor Networks, Computer Networks, Distributed Systems, and Data Communication.

B. Vijayendra Reddy, Assistant Professor, Department of Computer Science and Engineering, Areas of Specialization: Artificial Intelligence, Machine Learning, Data Science, Cloud Computing., & B) Research & Publications: Published research papers in national and international journals and conferences in the field of Computer Science. 2. Works in emerging technologies such as AI, Machine Learning, and Data Analytics. Active contributor to academic research and technical publications. Academic Activities: 1. Teaching undergraduate and postgraduate courses in Computer Science. 2. Guiding B. Tech and M. Tech student projects. 3. Participating in Faculty Development Programs (FDPs), workshops, and conferences.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)/ journal and/or the editor(s). The Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright: All rights reserved.