IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Special Issue 1, March 2024

1st International Conference on Machine Learning, Optimization and Data Science

Organized by

Department of Computer Science and Engineering, Baderia Global Institute of Engineering and Management, Jabalpur, India

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 || Monthly Peer Reviewed & Refereed Journal |

| "1st International Conference on Machine Learning, Optimization and Data Science"|

Organized by

| Department of Computer Science and Engineering, Baderia Global Institute of Engineering and Management, Jabalpur|

|| Volume 12, Special Issue 1, March 2024 ||

Study On Evolution in Image Processing Using Deep Learning

Neha Thakre[1], Nidhi Pateriya[2], Kuldeep Soni[3]

Assistant Professor, Dept. of Computer Science, BGIEM, RGPV University, Madhya Pradesh, India [1].

Assistant Professor, Dept. of Computer Science, BGIEM, RGPV University, Madhya Pradesh, India [2].

Assistant Professor, Dept. of Computer Science, BGIEM, RGPV University, Madhya Pradesh, India [3].

ABSTRACT: The amount of data we create and use is going to be huge, around 180 zettabytes by 2025, causing big challenges for companies and society. The data is not only getting bigger but also more complicated, making it harder to understand and process. In the last 20 years, tools for studying this data, called data science tools, have become really popular because they are good at handling complex information with high accuracy. Dealing with pictures is even tougher because as pictures get better, there's more data to handle. While traditional ways of teaching computers (machine learning) are still used a lot, scientists are excited about new ways using artificial intelligence (AI), especially neural networks, to understand and work with images. Our study looked at how AI is getting better and how we can make it work even more efficiently with pictures. Even though we've made progress, there are still many challenges ahead. We talk about the recent improvements and suggest what future research could look like in this rapidly changing field.

KEYWORDS: artificial intelligence; deep learning; reinforcement learning; image processing.

I. INTRODUCTION

Pictures have always been crucial for human communication, allowing us to grasp information from the visible spectrum. While our eyes are limited to this range, computers can handle a much broader spectrum, from gamma to radio waves. Image processing, born in 1964 during the analysis of lunar surface images, involves computational techniques for analyzing, enhancing, compressing, restoring, and extracting data from digital images. From mid of twentieth century, the image processing technology is continuously evolving in which machine learning is playing a significant role. As we know machine learning technology is a subset of Artificial Intelligence, which ultimately is focusing on creating intelligent machines capable of making decisions independently. This has revolutionized image recognition, enabling advancements in facial recognition, object detection, image generation, restoration, and retrieval.
Machine learning in image processing brings numerous benefits, making processes more efficient and opening new possibilities. By using advanced algorithms and neural networks, we can now accurately identify objects, recognize patterns, and analyze images, particularly impactful in fields like medicine. Automation is a key advantage, as machine learning can swiftly and precisely identify defects in products, eliminating manual inspections and reducing errors in production lines. It also aids in tasks such as facial recognition for public safety and analyzing images in areas like astronomy or medicine. The paper encourages exploring new techniques and challenges in machine learning for image processing, aiming to guide future researchers and offer a contemporary perspective on the subject. The document covers research methodology, technical background, image processing developments, challenges, and future directions.

II. METHODOLOGY

To conduct this review, we looked at many scientific papers in the field of machine learning, especially those where image processing is done using deep learning (DL) and reinforcement learning (RL).

2.1. Validation of Source of Information

To ensure the reliability of information's, we have considered trustworthy journals and university repositories for our review. We aimed to cover various areas and topics in image processing research, with the help of keywords that are

relevant to image processing on search engines such as Springer, and Science Direct. We have chosen these search engines because of their ability to provide comparable searches and filter results by research area.
As of February 2023, most of the searches for "image processing using AI" provide lots of written documents, research papers and articles which majorly focuses on three areas: "Medicine," "Computer Science," and "Engineering". The results were consistent across different research aggregators. Some topics may have more research available, leading to a higher prevalence in the cases described.

2.2. AI Models Used in Image Processing

Internet and social media has contributed in the increase of digital images as it enables you to express your feeling and share information with the known ones. This collected information has capability to support various applications. In this whole, the part where we have to focus more is recognizing and interpreting the digital image and understand how different techniques are used for the extraction the information from the same.

2.2.1 Image Processing

Images, for humans, is a visual representation which he classifies into regions and objects that coveys a sensible meaning. Advances in image processing have many practical applications in our daily lives, which involve techniques like image compression, image enhancement, noise removal, and image regeneration. When we provide image to computer for classification, it transforms the image into millions of pixels which further makes the data processing more difficult. Further segmentation process the computer divides the image into constituent parts which we some time refer to as region of interest (ROI) which is done with the help of descriptors such as color, texture and edges of an object. Image processing techniques play a significant role in the medical domain, involving:

- Computer vision
- Pattern recognition
- Image mining

When using ML models for image processing challenges, reducing data entries is often necessary to quickly extract valuable information. To simplify this process of reducing the data entries, computer can transform images applying an operation into a reduced set of features. This operation will only select and measure essential data properties thereby representing the original data up to a certain degree of precision. For an instance Zeng [1], used deep convolutional neural network to extract the essential features of images and to reduce the set feature they applied principal component analysis(PCA).

2.2.2 Machine Learning

Machine learning (ML) is like a smart computer that learns from examples and helps with things like recognizing patterns, processing images, and making decisions in businesses. It's becoming more popular in environmental science and engineering because it's flexible and precise. Deep learning, a type of ML, can figure things out on its own with little help from humans. There are two main types of ML:

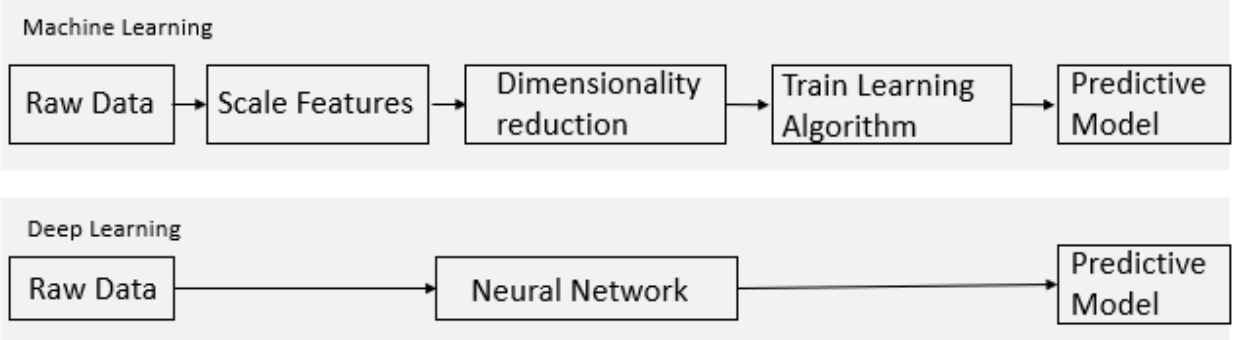
- In **supervised learning**, the computer learns from examples that already have labels or answers. It's great for tasks like predicting and classifying data.
- **Unsupervised learning** tries to find patterns in data that doesn't have labels. It's like sorting things without knowing what each thing is.

Machine learning helps a lot in different areas, like predicting diseases or managing resources efficiently. It's like having a smart helper that learns from lots of information. There are challenges, though, like biased predictions, but scientists are working on making ML even better. Overall, machine learning is like a helpful tool that's getting smarter every day.

2.2.3 Deep Learning Concepts

Deep Learning (DL) is a subset of Machine Learning (ML) where artificial neurons known as perceptrons are used to recognize patterns in images or data. DL algorithms, like multilayered perceptrons (MLP), Convolutional Neural Networks (CNN), and recurrent neural networks (RNNs), are helpful for tasks such as image recognition. DL is different from traditional ML in how it handles training, uses activation functions like the Sigmoid, and tackles issues like overfitting with regularization techniques.
In recent years, people have studied probability stats, wavelet analysis, and partial differential equations for flexible image modeling. Image processing, which deals with large images, benefits from DL, especially autoencoders, for tasks like image segmentation. CNNs, a type of DL model, are widely used for powerful image processing, improving image recognition and resolution. They find practical use in real-world scenarios like surveillance systems, airports,

and mobile phones. Object detection, made possible by high-powered computers, is crucial for tasks like human activity recognition and marine surveillance.



Differences in the progress stages between traditional ML methods and DL methods

Image-processing techniques, especially in surveillance tools like CCTV cameras, have diverse applications. Human operators can miss important actions on screens after few minutes of intensive monitoring. For tasks like identifying pedestrians and detecting weapons object detection plays an important role.

2.2.4 Reinforcement Learning

Reinforcement Learning (RL) is a way computers learn by making decisions and getting rewards or penalties in different situations. It's like teaching a computer to figure out the best actions on its own. RL is used in many areas like robots, games, biology, driving, and healthcare, where it learns from feedback to maximize rewards. Deep Reinforcement Learning (DRL) is a smart way of learning without needing labeled data, and it's used in complex tasks like playing video games.

In RL, a computer interacts with an environment, takes actions, and gets rewards or penalties based on its decisions. DRL, combining deep neural networks, faced challenges until 2015 when breakthrough research showed success in tasks like playing video games. RL is now applied to solve real-world problems, like finding optimal strategies during the COVID-19 pandemic. It's also used in computer vision for tasks like detecting objects and tracking images, making computers smarter in various applications.

III. RELATED WORK

Developments inImage Processing

In the past seven years (2017–2023), many studies have explored machine learning (ML) in different areas like medicine, engineering, and biology. Recently, deep learning (DL) is significantly used for image processing. There has been tremendous increase in the number of published articles on this topic, ultimately convening message that more and more people are paying attention to DL methods. Especially in the medical field, researchers are working on challenges like having limited data and improving the performance of models. They use techniques like model pruning or compression to make models like Convolutional Neural Networks (CNNs) work better and cost less.

3.1. Domain

Research on image processing covers various areas like monitoring infrastructure, analyzing road pavement, and detecting diseases in plants. Machine learning, especially deep learning, is widely used in medicine for tasks like infection monitoring and disease diagnosis. Traditional machine learning methods are still relevant, seen in engineering studies using models like SimpleCV. Another application gaining attention is image super-resolution, which addresses challenges in image processing. In the automotive industry, intelligent vehicles and driver assistance systems rely on image processing methods, including traditional machine learning approaches.

Studies also focus on blood cell analysis using image processing, revealing differences in cell types. Common methods include Neural Networks, Decision Trees, and SVM. Image-based recognition systems are valuable tools in medical analysis, showcasing the diverse use of image processing techniques in research and industry.

3.1.1. Research in Image Processing Using Deep Learning

In DL research, there's a strong focus on making Deep Neural Networks (DNN) work better. One study looked at a technique called algorithm unrolling, connecting signal processing methods with DNNs to improve their performance in recognition tasks. Another study introduced a model called Boundary Regulated Network (BR-Net) using high-resolution satellite images, showing a 15% improvement in performance and 20% faster recognition speed. However, concerns were raised about its ability to work well with large datasets. Another research explored teaching a CNN model to drive safely using data from a front-facing camera, showing promise but facing challenges in real-world deployment due to the need for a substantial amount of training data.

With modern research, the practical applications of DL have immensely increased in the field of image processing:

1. A DL model inspired by natural language processing which uses a recurrent long and short term memory network (LSTM) which you can consider as a special brain of computer is used for video prediction. With the help of LSTM the computer can predict the future images by encoding the sequence of images learned during video processing [2].
2. Salahzadeh [10] has created as a smart system that analyze the way people stand or move. In this smart system they have integrated three complex components which includes a mechanical structure with the camera, a smart program to collect and analyze data and at last a network that will send this information to a DL sever. They claim this smart device to be cost-effective, user friendly, offering stable postural assessment for patient rehabilitation.
3. Tremendous work has been done in creating the search engine for pictures that would conveniently retrieve the images based the given content in real-time. These systems can find images effectively, showing a clear similarity between the input (what you search for) and the output (what you get), both in terms of meaning and appearance [3].In their review Latif [5] identify that representing feature of an image using just one method is almost impossible instead, several low-level features must be combined to represent different part of the images.
4. Rani [13] conducted a literature review where the found that researchers are using ML techniques in the field of microbiology to recognize the image of bacteria, algae, protozoa, and fungi. Kasinathan and Uyyala [4] improved machines applying computer vision and knowledge-based approaches to identify and detect insect in crowded images.

They processed images to find important details, then built models using ML to tell different insects apart.
In the medical field, Deep Learning (DL) is being widely used for image processing to make automatic classifiers for various medical subjects. These classifiers show promising results and save time compared to human inspection, and some researchers, like Luis et al. in 2023, are adding explainable artificial intelligence (xAI) to better understand and interpret the model results. Melanthota [12]. looked into DL-based image processing in optical microscopy, especially for smartphone-based microscopy, finding that CNN-based DL networks are really good for improving image resolution in medical contexts.

A significant focus in the medical field is using DL for brain image segmentation to diagnose cancer, helping differentiate between cancer cells and healthy ones. Devunooru [11] suggested a system named *data image segmentation processing and viewing* (DIV) for tumor brain diagnosis using DL models, stressing the importance of considering data, image segmentation, and "view" factors. There's a need to make image segmentation more efficient and handle large volumes of medical images. Yedder [9] also reviewed that DL method works well compared to conventional method when it comes to image reconstruction for medica diagnosis. They also noticed that more and more types of medical images are being reconstructed using DL, and there's a growing trend towards using methods that don't need as much supervision, especially because it can be hard to get realistic training data.

3.1.2. Research in Image Processing Using Reinforcement Learning

Scientists have been using reinforcement learning (RL), often combined with deep learning, in various areas like robotics, design automation, energy management for hybrid vehicles, parameter estimation in biology, facial motion learning, and even in games. In image processing, researchers have applied deep reinforcement learning (DRL) for different purposes, introducing novel applications. For instance, a 2022 study by Dai [7] explored healthcare strategies using DRL methods to simulate human bodies, particularly focusing on tongue images and body constitution types. Another noteworthy study by Laskin [8] in 2020 addressed challenges in computer vision by incorporating a reinforcement learning module with augmented data, aiming to enhance the overall performance of RL systems without significant changes to the underlying algorithm.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 || Monthly Peer Reviewed & Refereed Journal |

| "1st International Conference on Machine Learning, Optimization and Data Science"|

Organized by

| Department of Computer Science and Engineering, Baderia Global Institute of Engineering and Management, Jabalpur|

|| Volume 12, Special Issue 1, March 2024 ||

Additionally, researchers have successfully employed RL in retrieving ancient images from Arabic manuscripts, reducing data dimensionality for better image classification and retrieval accuracy. Ren et al. [6] proposed a system for image stereo-matching algorithms using DRL, demonstrating quick convergence and high accuracy. In 2022, Le [14] conducted a comprehensive review of DRL methodologies in computer vision, categorizing them into seven applications, such as landmark localization, object detection, and image segmentation. The authors discussed the potential benefits and limitations of DRL in computer vision research and highlighted promising approaches like inverse DRL, multi-agent DRL, meta DRL, and imitation learning.

IV. DISCUSSION AND FUTURE DIRECTION

Despite the undeniable success of ML, particularly in digital image processing, there are crucial limitations in its operation and design. Most algorithms are trained for specific tasks, lacking the ability to solve diverse problems. The generalization capacity is restricted, making it challenging to use these models beyond their original training purpose. Another limitation involves the efficiency of ML, especially deep learning, which demands substantial data and computational resources. This can be impractical in certain scenarios, requiring techniques like model compression and pruning to reduce costs and training time. Additionally, interpreting deep learning models is challenging due to their complexity, necessitating techniques for explaining their functioning and results. Ethical concerns also arise, demanding techniques to ensure privacy, security, transparency, justice, and accountability in ML's societal impact. Techniques like homomorphic encryption and algorithmic auditing can address these concerns and mitigate potential negative effects.

V. CONCLUSION

In this review, we looked at recent developments in image processing systems usingdeep learning (DL) and reinforcement learning (RL) methods, or a combination of both. The researchin image processing and AI has immensely been increased in disciplines such as medicine, computer science, and engineering. Traditional ML methods are still being used in areas such ascomputational biology and predicting diseases. On other hand, DL methods are now being used for image processing which is sometimes far better than conventional ML methods. Researchers are nowadays focusing on increasing the application on ML at the same time limiting the computational resources required.The medical field, autonomous driving, and graphical search engines are among the areas receiving significant attention. Applications combining DL and RL models show promise, leveraging DL's data processing ability and RL's historical feedback for fine-tuning.

REFERENCES

1. Zeng, Y.; Guo, Y.; Li, J. Recognition and extraction of high-resolution satellite remote sensing image buildings based on deep learning. Neural Comput. Appl. 2022, 34, 2691–2706.
2. Zhang, L.; Cheng, L.; Li, H.; Gao, J.; Yu, C.; Domel, R.; Yang, Y.; Tang, S.; Liu,W.K. Hierarchical deep-learning neural networks: Finite elements and beyond. Comput. Mech. 2021, 67, 207–230.
3. Jardim, S.; António, J.; Mora, C.; Almeida, A. A Novel Trademark Image Retrieval System Based on Multi-Feature Extraction and Deep Networks. J. Imaging 2022, 8, 238.
4. Kasinathan, T.; Uyyala, S.R. Machine learning ensemble with image processing for pest identification and classification in field crops. Neural Comput. Appl. 2021, 33, 7491–7504.
5. Latif, A.; Rasheed, A.; Sajid, U.; Ahmed, J.; Ali, N.; Ratyal, N.I.; Zafar, B.; Dar, S.H.; Sajid, M.; Khalil, T. Content-Based Image Retrieval and Feature Extraction: A Comprehensive Review. Math. Probl. Eng. 2019, 2019.
6. Ren, J.; Guan, F.; Li, X.; Cao, J.; Li, X. Optimization for image stereo-matching using deep reinforcement learning in rule constraints and parallax estimation. Neural Comput. Appl. 2023, 1 –11.
7. Dai, Y.; Wang, G.; Muhammad, K.; Liu, S. A closed-loop healthcare processing approach based on deep reinforcement learning. Multimed. Tools Appl. 2022, 81, 3107–3129.
8. Laskin, M.; Lee, K.; Stooke, A.; Pinto, L.; Abbeel, P.; Srinivas, A. Reinforcement Learning with Augmented Data. In Proceedings of the 34th Conference on Neural Information Processing Systems 2020, Vancouver, BC, Canada, 6–12 December 2020; pp. 19884–19895.
9. Yedder, H.B.; Cardoen, B.; Hamarneh, G. Deep learning for biomedical image reconstruction: A survey. Artif. Intell. Rev. 2021, 54, 215–251.

10. Salahzadeh, Z.; Rezaei-Hachesu, P.; Gheibi, Y.; Aghamali, A.; Pakzad, H.; Foladlou, S.; Samad-Soltani, T. A mechatronics data collection, image processing, and deep learning platform for clinical posture analysis: A technical note. Phys. Eng. Sci. Med. 2021, 44, 901–910.
11. Devunooru, S.; Alsadoon, A.; Chandana, P.W.C.; Beg, A. Deep learning neural networks for medical image segmentation of brain tumours for diagnosis: A recent review and taxonomy. J. Ambient Intell. Humaniz. Comput. 2021, 12, 455–483.
12. Melanthota, S.K.; Gopal, D.; Chakrabarti, S.; Kashyap, A.A.; Radhakrishnan, R.; Mazumder, N. Deep learning-based image processing in optical microscopy. Biophys. Rev. 2022, 14, 463–481.
13. Rani, P.; Kotwal, S.; Manhas, J.; Sharma, V.; Sharma, S. Machine Learning and Deep Learning Based Computational Approaches in Automatic Microorganisms Image Recognition: Methodologies, Challenges, and Developments. Arch. Comput. Methods Eng. 2022, 29, 1801–1837.
14. Le, N.; Rathour, V.S.; Yamazaki, K.; Luu, K.; Savvides, M. Deep reinforcement learning in computer vision: A comprehensive survey. Artif. Intell. Rev. 2022, 55, 2733–2819.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

doi crossref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details