International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319-9598 (Online), Volume-13 Issue-4, April 2026

The Evolution of Image Processing: A Critical Overview of Modern Trends and Key Technologies

Shakir Amjad, Umar Daraz

Abstract: ***Image processing has emerged as a critical tool across diverse domains, including agriculture, healthcare, industrial automation, and robotics. This review highlights the major technologies employed in image analysis and explores their methodologies, strengths, and practical applications. Approaches range from traditional image processing techniques to advanced machine learning and deep learning frameworks, as well as specialised modalities such as hyperspectral and 3D imaging. Each method provides distinct advantages, from simple filtering and segmentation to real-time object detection and high-precision phenotyping, enabling more accurate and efficient analysis across various fields.***

Keywords: Image Processing, Image Analysis, Machine Learning, Technology Review

Nomenclature:
SVMs: Support Vector Machines

I. INTRODUCTION

Image processing is a straightforward method for analysing various image qualities using different techniques, as described by Trigka (2025). [1], Previously, the human brain was considered a traditional method for image analysis; however, today, machine learning has accelerated image processing, allowing us to analyse complex images and obtain valuable results and data, as reported by Wang et al. [2]. Many advancements in image processing leverage artificial intelligence in agriculture, integrating aspects of agricultural machinery, chemical applications, medical analysis, and biomass utilisation, all supported by high-quality image acquisition and analysis (Song et al. [3]). Using image processing techniques, we can easily analyse complex results and identify high-quality images, thereby improving crop production. Automated feature learning has greatly advanced accuracy and adaptability in image processing.

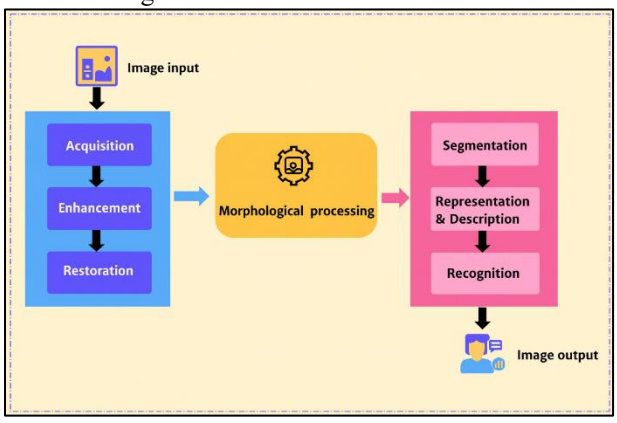
In recent years, imaging technologies, particularly deep learning and convolutional neural networks, have changed how images are analysed and classified for different purposes, and they can automatically learn complex data patterns and features from large datasets and become highly accurate at image recognition and predicting good values.

Manuscript received on 29 March 2026 | Revised Manuscript received on 04 April 2026 | Manuscript Accepted on 15 April 2026 | Manuscript published on 30 April 2026.
*Correspondence Author(s)
Shakir Amjad*, Department of Bionic Engineering, College of Biological and Agricultural Engineering, Jilin University, China. Email ID: shakiramjad595@yahoo.com, ORCID ID: 0009-0007-6621-617X
Umar Daraz, College of Agronomy, Gansu Agricultural University, Lanzhou, China. Email ID: umardaraz@gsau.edu.cn

The integration of advanced imaging processing with traditional image processing techniques has led to powerful hybrid systems that deliver improved performance, effectiveness, and scalability.

II. IMAGE PROCESSING TECHNOLOGIES

Image processing is a useful method for enhancing digital images, and tools are used to improve their quality and make them more informative. They are widely used in fields like advanced engineering, farming systems, medical imaging, remote sensing, robotics, and computer vision. There are several techniques based on image processing technologies, as shown in Figure 1.



[Fig.1: Image Processing Techniques [4]]

III. CLASSICAL IMAGE PROCESSING

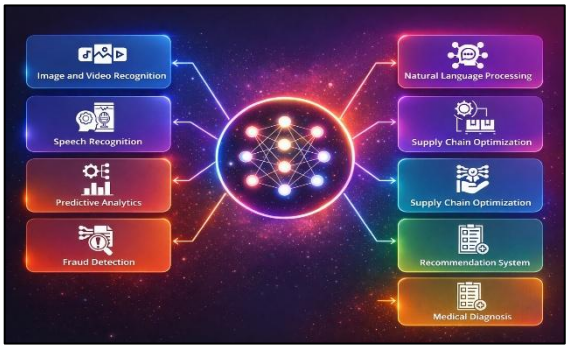
Image processing techniques can classify images and easily identify their size, shape, texture, and structure, as well as large edge objects, for different tasks by using methods such as filtering, edge detection, thresholding, and morphological operations (Unal et al. [5]).

A. Machine Learning-Based Image Analysis

Machine learning can automate the detection of plant diseases from images by leveraging models and algorithms. Several techniques, such as support vector machines (SVMs) and ensemble methods like random forests, are commonly used to classify plant diseases from extracted images (Botero-Valencia et al. [6]).

B. Deep Learning Approaches

Deep learning is a specialised approach to using neural networks to automate image processing. This can easily improve imaging accuracy by leveraging autonomous vehicles, medical imaging, and precision agriculture models, as well as by Zualkernan et al. [7]. As shown in Figure 2.

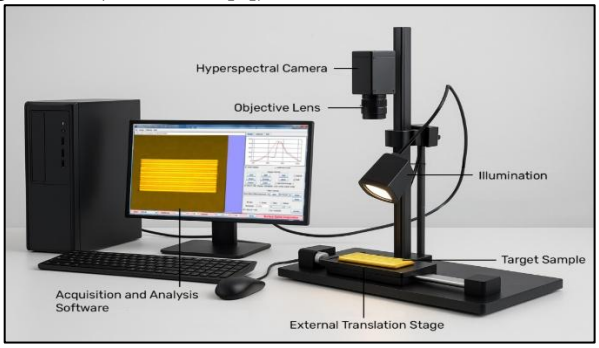


[Fig.2: Proposed Model Architecture, Deep Learning-Based Image Processing Techniques for Classification]

IV. SPECIALIZED IMAGING TECHNOLOGIES

A. Hyperspectral Imaging

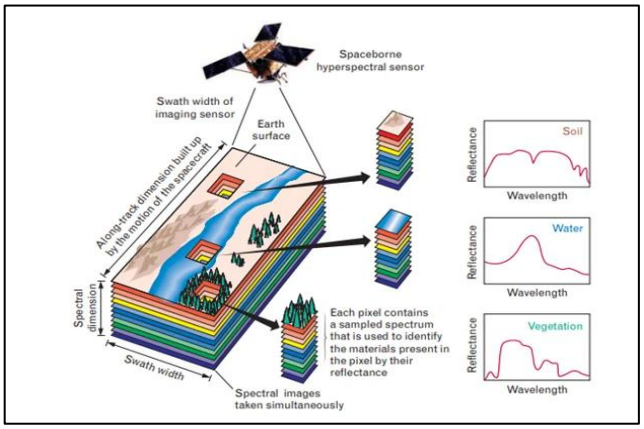
Hyperspectral imaging is an advanced image processing technology that identifies different types of crops, internal and external, and modern places, even when they are not visible to the human eye and require examination of hyperspectral imaging data, alongside conventional machine algorithms (Chen et al. [8]).



[Fig.3: Hyperspectral Imaging System: Dark Room with Camera Setup (Left) and Computer for Image Acquisition (Right) (with Permission https://surfaceoptics.com/hyperspectral-camera-price) [9].

B. Multispectral Imaging

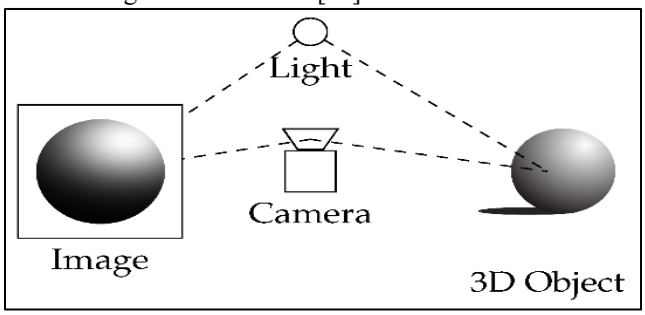
The advanced imaging technique captures image data at specific points across different wavelength bands within the electromagnetic spectrum. It is commonly used for crop analyses, monitoring, and quality valuation in farming systems (Walsh et al. [10]).



[Fig.4: Multispectral Imaging—a Space System Captures a Swath of Earth; each Pixel Records a Spectrum to Identify Materials. Reproduced with Permission from (https://innoter.com/en/articles/multispectral-imaging/)] [11]

C. 3D Imaging

Types of imaging technologies that can provide clear evidence of autonomous navigation and can be evaluated automatically, clearly shown in the image as a 3D form, as shown in Figure 3. Kim et al. [12].



[Fig.5: Proposed Model Architecture: Imaging Analysis on Lighting Systems in 3D]

D. X-ray Imaging

Advanced imaging techniques, fast and cost-effective, can easily detect diseases, broken bones, and other abnormalities using various image processing methods. These days, they work by exploring different types of data, as Ait Nasser et al. [13] do.

V. CONCLUSION

In the study, we present different types of image processing based on new technological advances in fields such as agricultural farming systems, engineering at Technogym, and medical lineups. They deliver good production results in a short time. Now, researchers will develop new low-cost techniques for farmers, and advanced technology will deliver reliable, high-quality results through machine learning.

ACKNOWLEDGEMENTS

The Authors would like to express their sincere gratitude, supported by

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.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** Shakir Amjad performed the conceptualisation work; Umar Daraz conducted the literature search and data analysis. Shakir

Amjad did writing, original draft preparation; Umar Daraz did write review and editing, and did a critical review of the work.

REFERENCES

1. Trigka, M.; Dritsas, E. A Comprehensive Survey of Deep Learning Approaches in Image Processing. Sensors 2025, 25, 531. DOI: https://doi.org/10.3390/s2502053.
2. Wang L, Zhang S, Xu N, He Q, Zhu Y, Chang Z, Wu Y, Wang H, Qi S, Zhang L, Shi Y, Qu X, Zhou X, Song J. Role of artificial intelligence in medical image analysis. Chin Med J (Engl). 2025 Nov 20; 138(22):2879-2894. Epub 2025 Oct 24. PMID: 41131954; PMCID: PMC12634253. DOI: https://doi.org/10.1097/CM9.0000000000003824
3. Song, X.; Yan, L.; Liu, S.; Gao, T.; Han, L.; Jiang, X.; Jin, H.; Zhu, Y. Agricultural Image Processing: Challenges, Advances, and Future Trends. Appl. Sci. 2025, 15, 9206. DOI: https://doi.org/10.3390/app15169206.
4. V Srinivas Durga Prasad. (2022, December 15). Artificial Intelligence and Machine Learning-based Image Processing. Design & Reuse. https://www.design-reuse.com/article/61392/artificial-intelligence-and-machine-learning-based-image-processing.
5. Unal, C.; Cinar, I.; Saripinar, Z.; Koklu, M. Comparative Evaluation of YOLOv8 and YOLO11 for Image-Based Classification of Sugar Beet Seed Treatment Levels. Sensors 2026, 26, 2137. DOI: https://doi.org/10.3390/s26072137.
6. Botero-Valencia, J.; García-Pineda, V.; Valencia-Arias, A.; Valencia, J.; Reyes-Vera, E.; Mejía-Herrera, M.; Hernández-García, R. Machine Learning in Sustainable Agriculture: Systematic Review and Research Perspectives. Agriculture 2025, 15, 377. DOI: https://doi.org/10.3390/agriculture15040377.
7. Zualkernan, I.; Abuhani, D.A.; Hussain, M.H.; Khan, J.; ElMohandes, M. Machine Learning for Precision Agriculture Using Imagery from Unmanned Aerial Vehicles (UAVs): A Survey. Drones 2023, 7, 382. DOI: https://doi.org/10.3390/drones7060382.
8. Chen, L.; Wu, Y.; Yang, N.; Sun, Z. Advances in Hyperspectral and Diffraction Imaging for Agricultural Applications. Agriculture 2025, 15, 1775. DOI: https://doi.org/10.3390/agriculture15161775.
9. Hyperspectral Camera Price (2026 Cost Guide) Hyperspectral imaging system: dark room with camera setup (left) and computer for image acquisition (right) (with permission. https://surfaceoptics.com/hyperspectral-camera-price.
10. Walsh JJ, Mangina E, Negrão S. Advancements in Imaging Sensors and AI for Plant Stress Detection: A Systematic Literature Review. Plant Phenomics. 2023 Mar 1; 6:0153. PMID: 38435466; PMCID: PMC10905704. DOI: https://doi.org/10.34133/plantphenomics.0153
11. Multispectral imaging—a space system captures a swath of Earth; each pixel records a spectrum to identify materials. Reproduced with permission from [[https://innoter.com/en/articles/multispectral imaging/] (https://innoter.com/en/articles/multispectral-imaging.).
12. Kim, E.; Kim, S.-Y.; Lee, C.-H.; Kim, S.; Ryu, J.; Kim, G.-H.; Lee, S.-K.; Kim, G. Advanced 3D Depth Imaging Techniques for Morphometric Analysis of Detected On-Tree Apples Based on AI Technology. Agriculture 2025, 15, 1148. DOI: https://doi.org/10.3390/agriculture15111148.
13. Ait Nasser A, Akhloufi MA. A Review of Recent Advances in Deep Learning Models for Chest Disease Detection Using Radiography. Diagnostics (Basel). 2023 Jan 3;13(1):159. PMID: 36611451; PMCID: PMC9818166. DOI: https://doi.org/10.3390/diagnostics13010159