iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: VIII Month of publication: August 2025

DOI: https://doi.org/10.22214/ijraset.2025.73449

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VIII Aug 2025- Available at www.ijraset.com

A Historical Review of X-Ray Imaging: Advancements from Film-Based Techniques to Artificial Intelligence Integration

Riyanshi Verma[1], Zahid Ahmad Rather[2], Danish Nabi[3]
[1, 2, 3]*Department of Radio-Imaging Technology, Maharishi Markhandeshwar (Deemed to be University), Mullana, Haryana, India*

Abstract: Since Wilhelm Conrad Roentgen's groundbreaking discovery of X-rays in 1895, the field of radiology has witnessed remarkable technological progress.
This review traces the evolution of X-ray imaging from traditional film-based methods to the incorporation of artificial intelligence (AI). It highlights key advancements such as computed and digital radiography, the implementation of PACS (Picture Archiving and Communication Systems), and the rise of AI-driven tools in diagnostic imaging. These developments have significantly enhanced diagnostic speed, accuracy, and safety. Additionally, the article discusses the opportunities and challenges posed by AI in radiology, focusing on its ethical, practical, and clinical implications. By analyzing both historical and current trends, this paper provides a comprehensive understanding of how X-ray technology continues to evolve and shape modern healthcare.

I. INTRODUCTION

The discovery of X-rays by Wilhelm Roentgen in the late 19th century transformed medical diagnostics by allowing clinicians to visualize internal structures non-invasively [1].
Initially, X-ray imaging relied on analog film and manual processing, requiring skilled interpretation without digital enhancements. Over the decades, technological innovations have transitioned X-ray imaging into the digital era, culminating in the integration of artificial intelligence. This review examines the historical trajectory of X-ray technology and explores how AI is redefining radiological practices today.

II. THE ERA OF FILM-BASED RADIOGRAPHY

For much of the 20th century, radiographic imaging was performed using analog film. These systems captured images on photographic plates, which required chemical processing in darkrooms [2,3].

- Strengths: Excellent image resolution and long-term archiving.
- Limitations: Time-consuming development, limited image editing capabilities, and bulky storage needs.

Radiologists relied entirely on manual interpretation without the aid of digital enhancement tools, which sometimes limited diagnostic efficiency in critical care settings

III. DIGITAL TRANSFORMATION: CR AND DR SYSTEMS

The shift from analog to digital began in the 1980s with the development of Computed Radiography (CR), which utilized reusable phosphor imaging plates to digitize X-ray images [4]. This was followed by Digital Radiography (DR), offering faster and more efficient imaging using flat-panel detectors.

A. Key Benefits

- Instant image preview
- Enhanced image quality through post-processing
- Lower radiation doses
- Integration with digital storage systems

These systems revolutionized how radiologic data was captured, stored, and interpreted.

IV. PACS AND RIS INTEGRATION

The implementation of Picture Archiving and Communication Systems (PACS) and Radiology Information Systems (RIS) marked another leap in efficiency. These platforms streamlined data storage, retrieval, and sharing across departments and hospitals [5].

1) Enabled centralized access to radiographic data
2) Facilitated remote consultations and teleradiology
3) Improved patient care coordination

V. THE RISE OF ARTIFICIAL INTELLIGENCE IN RADIOLOGY

The incorporation of AI into radiology began gaining momentum in the 2010s, especially with the emergence of deep learning techniques.

AI now contributes to:

1) Detecting abnormalities (e.g., lung nodules, fractures)
2) Prioritizing urgent cases
3) Enhancing image interpretation accuracy

Several studies have demonstrated that AI algorithms can match or exceed human performance in tasks such as detecting pneumonia on chest X-rays [6,7].

VI. CLINICAL APPLICATIONS OF AI TOOLS

Numerous AI-powered platforms such as qXR (Qure.ai), Aidoc, and Zebra Medical Vision are now used in clinical environments [8].

1) These tools assist radiologists by:
   - Highlighting abnormal findings
   - Automating routine measurements
   - Reducing reporting delays
2) Advantages: Faster workflows, improved diagnostic confidence, and reduced variability in interpretations.

VII. LIMITATIONS AND ETHICAL CONSIDERATIONS

Despite its benefits, AI integration in radiology presents several challenges [9]:

1) Bias in algorithms due to non-representative training data
2) Lack of transparency in decision-making processes
3) Legal and ethical accountability in case of errors
4) Skepticism among professionals about job security and over-reliance on technology. It is important to recognize that AI is a tool meant to support—not replace—the expertise of trained radiologists.

VIII. FUTURE PERSPECTIVES

The future of X-ray technology is likely to include:

1) Radiomics: Advanced image analysis techniques that extract quantitative features for predictive diagnostics.
2) AI-enabled mobile imaging units for field and rural use.
3) Autonomous systems for initial reporting of routine radiographs.
4) Personalized diagnostics powered by AI and big data analytics [10].

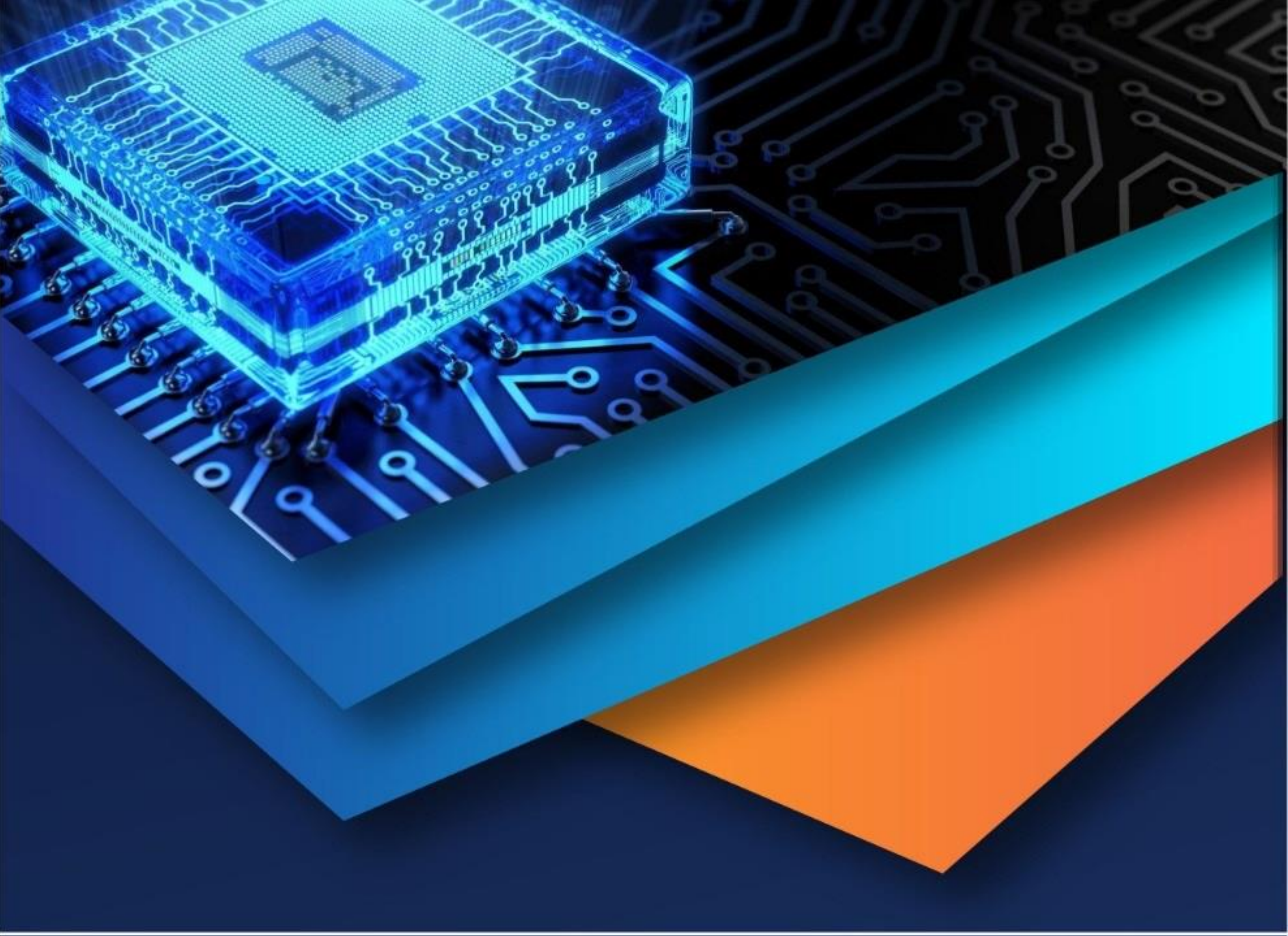
Such developments will further bridge the gap between technology and clinical decision-making.

IX. CONCLUSION

The evolution of X-ray imaging technology from film-based radiographs to AI-assisted diagnostics illustrates the dynamic nature of medical imaging. Each phase of development—from analog to digital, and now intelligent automation—has brought about improved efficiency, safety, and accuracy. While AI holds great promise in enhancing radiological workflows, its implementation must be carefully managed to ensure ethical use and clinical effectiveness. Continued innovation and collaboration between radiologists, technologists, and AI developers will be key in shaping the future of radiology.

REFERENCES

[1] Glasser O. Wilhelm Conrad Röntgen and the Early History of the Roentgen Rays. Norman Publishing; 1993.
[2] Hendee WR, Ritenour ER. Medical Imaging Physics. Wiley-Liss; 2002.
[3] Bushberg JT, Seibert JA, Leidholdt EM, Boone JM. The Essential Physics of Medical Imaging. Lippincott Williams & Wilkins; 2012.
[4] Seeram E. Computed Radiography: Physical Principles, Image Quality, and Image Formation. Saunders; 2001.
[5] Huang HK. PACS and Imaging Informatics: Basic Principles and Applications. Wiley; 2010.
[6] Rajpurkar P, Irvin J, Zhu K, et al. CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning. arXiv preprint arXiv:1711.05225. 2017.
[7] Lakhani P, Sundaram B. Deep Learning at Chest Radiography: Automated Classification of Pulmonary Tuberculosis by Using Convolutional Neural Networks. Radiology. 2017;284(2):574-582.
[8] McBee MP, Awan OA, Colucci AT, et al. Deep learning in radiology. Acad Radiol. 2018;25(11):1472-1480.
[9] European Society of Radiology (ESR). ESR white paper on artificial intelligence. Insights Imaging. 2019;10:1-8.
[10] Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJ. Artificial intelligence in radiology. Nat Rev Cancer. 2018;18(8):500-510.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

SJIFactor TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY