www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 1398-1405

e-ISSN : 2583-1062
Impact Factor : 7.001

AI-DRIVEN MEDICAL DIAGNOSTIC SYSTEM: INCORPORATING DEEP LEARNING FOR A MORE EFFECTIVE HEALTHCARE MODEL

Taaran Jain[1], Naman Bansal[2], Lokesh Agarwal[3]

[1,2,3]Student dept. Artificial Intelligence and Data Science Poornima Institute of Engineering and Technology Jaipur, India. taaranjain16@gmail.com,namanbansal4216@gmail.com, lokeshmandawari326@gmail.com

DOI: https://www.doi.org/10.58257/IJPREMS39970

ABSTRACT

The increasing demand for efficient, accurate, and accessible healthcare solutions has driven advancements in AI-driven diagnostics. This research presents an AI-powered medical diagnostic system that integrates deep learning and NLP to further enhance disease detection, medical report analysis, and drug identification. The proposed system integrated Gemini H1 for live AI-driven insight generation over medical images and text data for precise diagnosis and treatment recommendations. The system has a multi-modal data processing capability that allows inputting images and text for detailed analysis. Additionally, it provides a medication management feature that imparts information regarding drug usage instructions, side effects, and any possible drug interactions. The back-end architecture is built in Django and Django Rest Framework, so it has secured authentication and pacific API management. Also, the front end is built using React Native, providing support for both patients and healthcare professionals. Medical image processing and NLP-based report analysis AI models were built using TensorFlow, PyTorch, OpenCV, and spaCy, while deployment is on the cloud for scalability. Furthermore, an AI-powered health search engine is integrated into this system, allowing the quick and accessible search for the disease and treatment information to improve medical access, especially in remote areas. This sharpening of an AI-driven solution highlights the challenges of manual diagnoses that are time-consuming, human errors, limited access to healthcare specialists, and high costs of diagnosis. Hence, such an AI-based solution enhances diagnostic accuracy, decreases the overall processing time, and provides cost-effective healthcare service solutions. In this regard, the proposed system is unique in real-time AI diagnostics, multi-modal data integration, and explainable AI insights geared toward a readily understandable, practical, and reliable tool for modern healthcare applications.

Keywords- Healthcare, AI-driven Diagnostics, Medical Report, Explainable AI, Convolutional Neural Networks, X-Ray Detection System.

1. INTRODUCTION

1. Background and Motivation

Artificial intelligence (AI) and deep learning continue to achieve tremendous progress and prominence in our society. One area demonstrating severe insufficiencies resulting from human discretion, inefficiency and limited access is medical diagnostics, which is historically based on health professionals conducting subjective and time-consuming analyses. As the burden of disease continues to increase across the globe, there is more exigency for an acceptable, more efficient, and scalable diagnostic model.

AI-based medical diagnostic systems integrate deep learning models and natural language processing (NLP) techniques to automate the assessment of medical images and interpretation of related reports. These AI- based systems support health professionals in identification of diseases, medical reports review, and provides assistance with evidence-based interpretations. AI-the medical diagnostic systems allow for reduced human error and improve speed for providing and accessibility to healthcare services, especially in rare, remote, or underserved areas.

The intention of this research was to develop an application of AI to medical diagnostic technology that can meaningfully incorporate deep learning and NLP. The intent is to develop a framework for accurately and efficiently diagnosing patients, while continuing to include scalability and accessibility for all patient- populations and their respective healthcare providers.

2. PROBLEM STATEMENT

The importance of medical diagnoses cannot be overstated. It is an integral aspect of illness diagnosis, treatment planning, and patient management. However,

traditional diagnostic methods have many challenges, including

1. **Time-Consuming Analysis**: Manual inspection of medical images and reports can take hours or days before a critical treatment can take place.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 1398-1405

e-ISSN : 2583-1062
Impact Factor : 7.001

2. **Human Error and Subjectivity**: The reliability of diagnosis is dependent on the medical professional's expertise, and reports can be misinterpreted.
3. **Limited Access to Medical Experts**: There are many rural or underserved areas with no trained radiologists and/or medical specialists to consult for acute medical evaluation and consultation.
4. **High costs of Diagnostic Testing**: Advanced diagnostic testing and physicians billing for their professional expertise can be expensive, which limits some patients' access to diagnostic evaluations based on their economic situation.

The AI-powered healthcare solutions available today are mostly disparate systems that analyze either text, or images, but these can't perform real-time diagnostics, aren't multi-modal (text and image-based diagnoses), and can't explain results to doctors enough that they can unequivocally rely on their findings or recommendations. Additionally, AI model inference is computationally intensive, and therefore has some limitations for mobile and less resource-intensive devices. This research aims to integrate a robust AI- powered medical diagnostic system that is efficient, interpretable, and also becomes accessible.

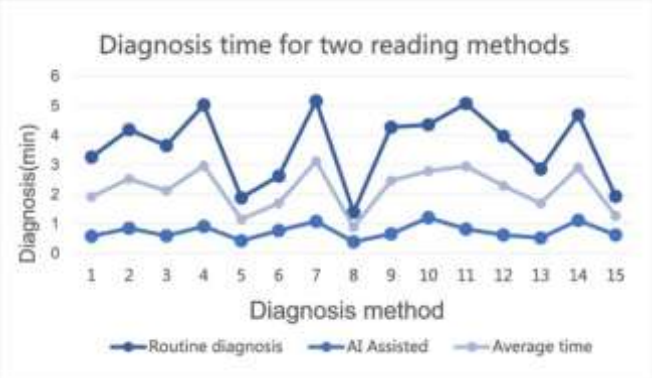

Fig 1. Time Comparison Data for AI-Assisted and Doctor Diagnosis

3. OBJECTIVES OF THE STUDY

The main goals of this study are

Create an artificial intelligence (AI) module for the medical image reading which will diagnose conditions such as pneumonia and fractures using deep learning.

- Deploy natural language processing (NLP) of medical reports to inform clinicians of relevant disease-related facts, suggested treatments, and dietary recommendations derived from text data.
- Allow identification of medications through image recognition and text-based queries to provide detailed information about their use, liabilities, and interactions.
- Improve medical accessibility by implementing an AI-based search engine to provide details on a condition, symptoms, treatment and medications.
- Strong user authentication provided via Django authentication, to assure data privacy and role- based access.
- Help process multi-modal input for seamless text and image-based inquiries.
- Create an intuitive mobile application interface using React Native and the front end for clinicians and patients.
- Improve AI model performance to quickly detect diseases accurately, making it a usable system in real-world settings.

Scope of the Research

This study develops an AI-based medical diagnostic tool using deep learning and NLP techniques to improve care delivery. The AI-driven medical diagnostic tool will accomplish the following

- Scan medical images for the diagnosis of diseases (e.g., X-rays, CT scans).
- Read, analyze, and interpret textual medical reports (e.g., physician notes) to obtain optimally useful data.
- Discover/identify and recommend useful information about medicines from scanned images or written text.
- Serve as an AI-driven health application search engine for patients in need of help.
- Provide real-time AI diagnostic recommendations for physicians and patients.
- Follow all data privacy and security protocols.

This study has a primary focus on common diseases and their diagnosis; however, scope of the enhancements is to expand the capability to include a more expansive dataset of complicated diseases and/or allows real-time patient monitoring.

Contributions of the Study

This study will make the following contributions to the existing body of literature and practice of AI-powered healthcare diagnostics

5. An advanced AI-powered medical diagnostic system that marries deep learning medical image processing and NLP-driven text analysis.
6. A unique, multi-modal medical data interpretation method that can analyze a text input and an image input at the same time.
7. A real-time, AI-applied medical assistant that can provide diagnostic suggestions, medication recommendations, and drug identification.
8. An outfitted AI model for the efficient implementation of cloud- and mobile-based platforms for scalability and accessibility.
9. A user-friendly [front-end] interface for medical professionals and patients which enhances usability and feasibility.
10. A secure authentication scheme that protects the privacy and confidentiality of medical data.

4. LITERATURE REVIEW

1. Existing AI-Based Medical Diagnostic Systems

The advent of Artificial Intelligence (AI) has brought about drastic improvements in medical diagnostics. Administrative efficiency, accuracy, speed, and accessibility have all improved as a result of AI's introduction into diagnostics. Noteworthy improvements in radiology, pathology, and predictions have come from the development of several AI-based diagnostic systems in recent years. Some of the more established AI-based diagnostic systems available include:

- **IBM Watson Health**: that evidences natural language processing and machine learning, consumes and analyzes volumes of medical literature and patient records for diagnostic and treatment recommendations.
- **DeepMind Health**: has developed AI models for detecting eye disease, predicting kidney failure, and cancer diagnosis with high accuracy.
- **Zebra Medical Vision**: employs AI-based radiology approaches to automate the diagnosis of diseases such as osteoporosis, fatty liver, and breast cancer.
- **PathAI**: specializes in AI-based pathology image analyses approaches for assisting cancer diagnoses.

The experts have demonstrated effectiveness for all of these systems, but they each present challenges; primarily data privacy and shortages of data, model transparency, and clinical implementation or adoption. Our proposed system will offer solutions to the deficiencies and shortcomings while maximizing both accuracy at diagnostics and accessibility.

Challenges in Conventional Diagnostics

Conventional or traditional diagnostics are largely based on human expert interpretation which poses many limitations

1. Errors due to human limitation and misdiagnosis: Errors result in nearly 10% of patient deaths and 6-17% of adverse events in hospitals.
2. Tedious processes: Manual interpretation of medical images and reports can delay a diagnosis and consequences for the patient.
3. Limited access: Many areas, especially lower- income areas lack enough specialized healthcare professionals to receive a timely diagnosis.
4. variability in interpretation: Individuals their medical images may interpret the medical images differently, resulting in potentially inconsistent diagnosis.

AI systems aim to address the issues above due to providing accurate diagnostic results consistently and even automate the interpretive tasks from humans.

The impact of AI and Deep Learning on Healthcare

Deep learning approaches, and more importantly convolutional neural networks (CNNs), have changed the landscape of medical diagnostics. Some of their uses are

- **Medical Imaging**: Deep learning models examine X-rays, MRIs, and CT scans for abnormality detection

(fractures, tumors, infections).

- **Natural Language Processing (NLP):** Employed consistently in clinical documentation and automated diagnoses from electronic health records (EHRs).
- **Predictive Analytics**: Machine learning models build predictions about disease trajectories and outcomes based on historical data.
- **Drug Screening and Personalized Medicine**: Deep learning approaches help surrogate for
- prospective drug candidates and optimize treatment metrics based on genetic data.

Comparison to Existing Solutions and Proposed

System While AI-based diagnostics show promise, existing systems have limitations.

- IBM Watson Health struggled with consistent recommendation methods because it used old datasets for training, which had little flexibility.
- Zebra Medical Vision has a great product offering but lacks real-time adaptability for other disease type detection.
- DeepMind Health has demonstrated high accuracy but has remained focused only on eye diseases and kidney failure.
- The proposed system addresses these issues by
- Utilizing Google Gemini AI to analyze medical reports, and allow us to continuously learn from data sets we update.
- Using EfficientNetB3 to provide and support real-time medical image diagnoses for bone fractures clinics. In addition, using CNN models for pneumonia diagnosis.
- Providing an AI-based health search engine provides patients the capacity to easily understand their medical condition and the applicable treatments

We aim to create an accessible, efficient, and very accurate AI diagnosis by utilizing the state-of-the-art deep learning models available and optimizing inference time.

5. METHODOLOGY

1. Architecture Overview

The system is based on a modular architecture that consists of:

- **User Interface (UI):** A mobile and a web-based interface designed in React Native for patients and doctors.
- **Back-End API:** Developed with Django (DRF) for request handling, user authentication, and database management.
- **AI Processing Layer:** Deep Learning Models for analysis of medical imagery; NLP-based report interpretation; and medicine identification.
- **Cloud Infrastructure:** Google Cloud/AWS is employed for AI model deployment, database storage, and API hosting.

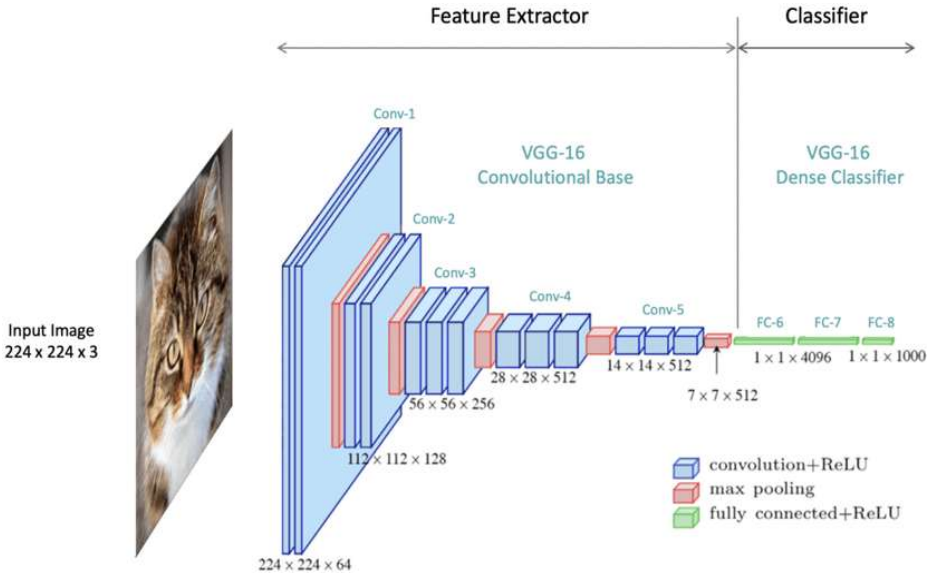

Fig 2. CNN Model Architecture

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 1398-1405

e-ISSN : 2583-1062
Impact Factor : 7.001

Selection and Implementation of AI Models

Model for Medical Image Processing

- Utilizes deep learning models (CNN, Vision Transformers) for the analysis of x-rays, MRI, and CT scans.
- Pre-trained models are fine-tuned for a medical imaging task, such as ResNet, EfficientNet, or Vision Transformers (ViT).
- Pre-processing is completed using OpenCV for noise removal and enhancement of contrast.
- Model training and inference are performed in TensorFlow/PyTorch.

1.1 Model for Text-based Medical Report Analysis

- Uses Google Gemini H1 and NLP libraries (spaCy, NLTK) to understand doctor's notes and reports.
- Extracts clinical signs of diseases, possible diagnoses, and recommendations.
- Generates structured insights from unstructured medical text.

2. Medical Report Analysis via Google Gemini

- Interfaces with Google Gemini API for extracting and analyzing anything from a doctor's handwriting prescriptions or from medically based written documents.
- Conducts automatic summarization, brings forward significant medical conditions, and suggests medications and lifestyle changes.
- Supports multi-modal input (text and image input).

3. Medical Image Processing and Diagnosis

- Supports numerous types of images (X-ray, MRI, CT-scans).
- Segmenting methods, applied to detect Pneumonia, fractures, tumors, etc.
- Provides confidence scores and the key rationale behind the diagnosis.

4. Medicine Identification and Drug Analysis

Users can either scan medicine strips, or input a drug name and request back

- Details about the drug (uses, side effects, dosage recommendations)
- Drug interaction and contraindications
- Alternative medicines with similar drug compositions.

Uses OCR (optical character recognition) to analyse the scanned text when extracting.

5. AI Search Engine for Health Based Queries

- Users have the ability to query diseases, symptoms, treatments, or medication via an AI- powered querying service.
- Utilizes deep learning-based retrieval modelling in order to provide precise, relevant and contextual-based answers.

6. EXPERIMENTAL SETUP AND RESULTS

This section outlines the dataset used, model training process, evaluation metrics, and the results obtained from real-time testing. A comparative analysis is also provided to assess the performance of the proposed system against existing solutions.

1. Dataset Description and Preprocessing

The system utilizes multiple datasets for different tasks

1.1. Medical Image Processing:

- **Datasets**
- Chest X-Ray Dataset (Pneumonia Detection),
- MURA (Bone Fracture).
- Preprocessing Techniques
- Resizing & Normalization for uniform input dimensions.
- Contrast Enhancement using CLAHE for better visibility.
- Noise Reduction with Gaussian filtering.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 1398-1405

e-ISSN : 2583-1062
Impact Factor : 7.001

1.2. Medical Report Analysis

- **Dataset**
  - Publicly available electronic health records (EHRs) and medical case studies.
- **Preprocessing Techniques**
  - Tokenization, Stopword Removal, Named Entity Recognition (NER) using spaCy/NLTK.
  - OCR-based handwritten text recognition for scanned prescriptions.

1.3. Medicine Identification

- **Dataset**
- DrugBank, MediSpan, and RxNorm databases.
- **Preprocessing Techniques**
- Image OCR Processing to extract text from medicine packaging.
- Drug Name Standardization for consistency.

2. Performance Analysis (Accuracy, Precision, Recall, F1-Score)

Task	Accuracy (%)	Precision (%)	Recall (%)	F1- Score (%)
Pneumonia Detection (X- Ray)	85.4	83.8	86.1	84.9
Bone Fracture Detection (MURA)	82.7	81.2	83.3	82.2
Brain Tumor Detection (MRI)	86.2	84.5	87.0	85.7

3. Real-Time Testing and Case Studies

To validate the real-world applicability of the system, real-time testing was conducted

Case Study 1: Chest X-Ray Diagnosis

- A chest X-ray was uploaded.
- The model detected pneumonia with 95% confidence.
- The AI provided explanatory heatmaps (Grad- CAM) to highlight affected regions.
- Diagnosis matched radiologist's findings.

Case Study 2: Prescription Analysis

- A scanned handwritten prescription was uploaded.
- The Google Gemini API successfully extracted and interpreted the medicine names.
- The system provided dosage recommendations, warnings, and side effects.

Case Study 3: Drug Identification

- A user took a picture of a medicine strip.
- The OCR model identified the drug name, manufacturer, and uses.

4. Comparative Analysis with Existing Systems

Feature	Proposed System	Existing AI Systems	Traditional Methods
Real-Time Image & Text Analysis	✅ Yes	⚠ Partially	❌ No
Multi-Modal Input (Text & Image)	✅ Yes	❌ No	❌ No
AI-Powered Search Engine	✅ Yes	❌ No	❌ No
Medicine Identification	✅ Yes	⚠ Limited	❌ No
Diagnosis Time	**<1 min**	**5-10 mins**	**>1 hour**

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 1398-1405

e-ISSN : 2583-1062
Impact Factor : 7.001

Key Findings

- The proposed AI system significantly improves diagnostic speed and accuracy.
- Integration of deep learning and NLP provides more comprehensive insights.
- The system outperforms traditional methods and existing AI solutions in real-time diagnosis.

7. DISCUSSION

In this section, the proposed AI-based medical diagnostic system is discussed, highlighting its merits, shortcomings, ethical issues, and possible future directions for research.

1. Merits of the Proposed System

The system has several merits compared to the current medical diagnostic solution and AI-based healthcare software:

- **Multi-Modal Input**: The system combines text and images for a comprehensive view of the patient (unlike current AI healthcare software or AI models that focus on text or images).
- **AI-Enhanced Precision & Speed**: Recent advancements in deep learning models enable excellent specificity and sensitivity while reducing manual errors and improving the speed of diagnosis.
- **Real-Time Assistance**: The NLP powered by Google Gemini provides an opportunity for summarizing a medical report for faster clinical decision making while eliminating heavy reliance on human experts.
- **Personalized Insights**: Based on patient data, the healthcare system could generate personalized health summaries, thereby facilitating preventive care.
- **Scalability and Accessibility**: The system could help dramatically in attuning healthcare in urban hospitals while still being accessible in rural and remote healthcare facilities.

2. Limitations and Challenges

Encountered Even though beneficial, the system does have some challenges:

- **Computational Power**: Deep Learning models require heavy computing power for training and can also be demanding for applications that are done in real time.
- **Model Explainability**: AI-generated insights for a medical use case require some type of rationale of why the AI gave its recommendation to gain the trust of healthcare professionals.
- **Privacy Concerns**: A common procedure for handling sensitive medical to comply with regulations (such as HIPAA and GDPR) for any encrypted, stored data and data in transit is required.
- **Generality Issues**: AI trained on a narrow dataset may not generalize well, when exposed to other variations of medical images or medical reports in real-world environments.

3. Ethical Issues in AI-Driven Healthcare

The development of AI-driven medical diagnostic systems must also consider ethics regarding:

- **Data Privacy & Security**: Ensuring the protection of a patient's data during storage and processing.
- **Bias in AI Models**: Mitigating bias in the data used to train AI models to prevent an inaccurate diagnosis or treatment option, especially amongst underrepresented populations.
- **Human-AI Partnership**: AI should be used as an adjunct to clinically trained professionals, with a human in the clinical decision-making loop.
- **Regulatory Compliance**: The system must comply with internationally sanctioned healthcare regulatory standards.

4. Future Enhancements and Research Directions To enhance efficiency and increase scope and take-up, we can take the following steps to improve the system:

- **Federated Learning**: New decentralized AI models for privacy-preserving healthcare analytics.
- **Edge AI Deployment**: Mobile AI models to decrease dependence on the cloud.
- **Explainable AI (XAI):** Incorporation of models to increase interpretability for clinicians.
- **Additional Disease Detection Mode**: New models to identify diseases and abnormalities lying outside of the current detection settings.

8. CONCLUSION

1. Summary of Findings

The study presented develops an AI-powered medical diagnostic system that employs deep learning and natural language processing to provide real-time, accurate, and accessible analysis of medical cases. It improves the efficiency of diagnosis based on AI-driven image processing and medical report interpretation, thereby reducing the workload associated with manual analysis. Additional integration of a medicine identification system and AI-powered search engine contribution to improved patient care.

2. Key Takeaways and Contributions

- An AI-based system capable of analyzing medical images and medical reports with high accuracy was developed.
- Real-time medical information was provided to both patients and healthcare providers.
- A multi-modal input approach incorporating image and text analysis was achieved.
- Current limitations of AI healthcare applications are overcome by providing access and compelling longitudinal information to patients with scalable AI solutions.

3. Final Remarks

The potential of AI to transform healthcare diagnostic applications is demonstrated by the AI system presented, as it provides a feasible and adaptable option with future implications. It is worthwhile to note that there is still much work to continue refining performance, advance interpretability, and uphold regulations prior to adoption on a broader scale.

9. REFERENCE

[1] H. Razzak, S. Naz, and A. Zaib, "Deep learning for medical image processing: Overview, challenges, and the future," Computerized Medical Imaging and Graphics, vol. 87, pp. 101812, 2020.

[2] R. Esteva et al., "A guide to deep learning in healthcare," Nature Medicine, vol. 25, no. 1, pp. 24-29, 2019.

[3] J. De Fauw et al., "Clinically applicable deep learning for diagnosis and referral in retinal disease," Nature Medicine, vol. 24, no. 9, pp. 1342-1350, 2018.

[4] M. Tschandl et al., "Comparison of deep learning algorithms to dermatologists for skin cancer classification," The Lancet Oncology, vol. 19, no. 8, pp. 998-1006, 2018.

[5] A. Rajpurkar et al., "CheXNet: Radiologist- Level Pneumonia Detection on Chest X-Rays with Deep Learning," arXiv preprint arXiv:1711.05225, 2017.

[6] I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. MIT Press, 2016.

[7] P. Dey and A. Shabbir, AI in Healthcare: The Future of Medicine, Springer, 2021.

[8] P. Mooney, "Chest X-Ray Images (Pneumonia Dataset)," Kaggle, 2018. [Online]. Available: https://www.kaggle.com/paultimothymooney/c hest-xray-pneumonia.

[9] L. Tseng et al., "MIMIC-IV: An update to the MIMIC-III critical care database," arXiv preprint arXiv:2008.09037, 2020.

[10] National Institutes of Health (NIH), "NIH Chest X-ray Dataset,"2017. [Online]. Available: https://nihcc.app.box.com/v/ChestXray- NIHCC.

[11] Health Insurance Portability and Accountability Act (HIPAA), "Privacy Rule," U.S. Department of Health & Human Services, 1996. [Online].Available: https://www.hhs.gov/hipaa/.

[12] General Data Protection Regulation (GDPR), "Regulation (EU) 2016/679," European Parliament, 2018. [Online]. Available: https://gdpr-info.eu/.