Augmented AI in Health Diagnostics: Enhancing Medical Decision Making through Artificial Intelligence

Dhivya Sudeep

Application Architect, IBM Corporation, Healthcare Membership and Enrollment IT, Richmond, Virginia, USA
Email: *teddudivu86[at]gmail.com*

Abstract: ***The integration of Artificial Intelligence (AI) in Health Diagnosis presents a transformative approach in improving Health outcomes. According to a Harvard Medical school study, the estimated market for AI is expected to be around $21.74 Billion by 2032 compared to $1.07 Billion in 2022[1]. The world Economic Forum also predicted that AI could help with improved health outcomes with its ability to use data from diverse and concealed sources that have been existed across healthcare.[6] This paper explores various AI diagnostic models that can improve diagnosis and inspect real-life use cases of AI for medical diagnosis. By integrating vast amounts of medical data, including electronic health records, imaging records, and genomic information, Augmented AI facilitates a more comprehensive understanding of patient conditions. This review paper further highlights the promising future of Augmented AI as a vital tool in the evolution of medical diagnostics, aiming to enhance both clinician performance and patient outcomes.***

Keywords: Artificial Intelligence, Augmented AI, Natural Language Processing (NLP), Large language Models (LLM), machine learning, medical diagnosis, lung cancer detection, diabetic retinopathy, breast cancer detection

1. Introduction

Medical health diagnosis is one of the most critical roles played by healthcare professionals. Medical diagnostics is not just about diagnosing health conditions; it also helps clinicians monitor treatment progress, validate the effectiveness of the treatment, and deduct health issues before they become serious. With the increase in patient medical data, it has become impossible for healthcare professionals to keep up with the multitude of data. The healthcare industry generates about 19 terabytes of clinical data annually, equivalent to 4,750 movies or 5.89 million photos [2]. It includes data from various sources, including Electronic Health records, radiology data, claims-related data, wearables, health tracking devices, data from hospitals and clinics, diagnostic information, and genomics data.

Understanding the data and deriving insights from that data is yet another challenging task. With the increased complexity of diseases, overlapping symptoms have challenged even the most experienced clinicians. Clinicians end up spending a lot of time analyzing the data and keeping up with the trends. As a result, practitioners are not able to spend quality time with the patients and focus on what is really required.

Healthcare professionals spend almost 70% of their time collecting patient data, including medical health history and medical reports like blood pressure, radiology, etc., and the remaining 30% of their time validating the data and talking to patients. Clinicians also spend a lot of time doing administrative tasks like filling outpatient health records, which reduces the overall facetime clinicians could have given to their patients.

The number of skilled clinicians in the US is way less than the demand. For example, there are about active 50,000 Radiologists in the United States, and we need five times more radiologists to meet the current healthcare demand [3].

2. Solution

The Healthcare sector is undergoing a remarkable transformation, especially in the health diagnosis area driven by advancements in artificial intelligence (AI) and machine learning technologies. Among these developments, Augmented AI has emerged as a potential tool that can help improve the efficiency and accuracy of medical diagnosis. We have often heard the term Generative AI, but what is Augmented AI? Augmented AI is an approach that combines human expertise with machine learning capabilities. Augmented AI is often referred to for healthcare, the approach here is not to replace humans but to use AI to assist doctors/physicians in making informed decisions. While generative AI learns from existing data, Augmented AI uses digital information and experiences to complement reality.

AI driven Healthcare diagnostics algorithms consist of the following key components.

2.1 Natural Language Processing:

Natural Language Processing (NLP) is a technique that helps analyze and understand unstructured data from medical records and clinical research papers and returns valuable insights from unstructured data. NLP can help identify medical conditions that were previously missed, create a structured patient database from unstructured medical notes, help identify patients' conditions to make improved decisions, help predict patient outcomes in critical care, help detect early-stage illness, help extract helpful information from patient records and put into a format readable by clinicians by organizing data into flowcharts or in tabular form and can also auto-assign ICD 10 codes to diagnosis.

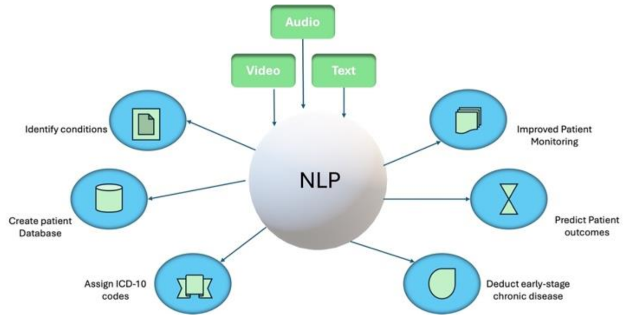

Figure 1: Natural Language Processing (NLP)

2.2 Machine Learning

Machine Learning (ML) uses algorithms and statical models to analyze and draw inferences from patterns in data without having to explicitly program the computer to perform the required task. In Medical diagnosis, machine Learning can be used for disease detection by analyzing medical images such as MRIs and X-rays, the patterns of which are difficult for humans to see. ML can also help with assessing the risk of a patient developing a disease and help create customized treatment plans for patients. Machine Learning can use predictive analytics to help forecast disease outbreaks and diagnose rare diseases by analyzing patient photos to detect rare genetic diseases.ML powered chatbots can help identify patterns in patient symptoms and recommend treatment options. Apart from the above, ML can help doctors around the world in the field of pathology, oncology and Dermatology. Below is a summary of the different machine learning models and their training algorithms.

Supervised Learning	Uses Input, output and feedback provided by data scientists to build models
Un-Supervised Learning	Uses deep learning on unlabeled training data to arrive at patterns and conclusions
Semi-Supervised Learning	Uses both labeled and unlabeled data to build models
Reinforcement Learning	Uses Trail and Error for self-interpreting data based on a system on rewards and punishments

Figure 2: AI Key components

3. Use Cases of AI in Medical Diagnosis

AI has evolved from being a +AI, where AI is used as a tool in addition to the core process, to AI+, where AI is the core product. Below are some critical real-time use cases where AI is used for medical diagnosis.

3.1 Cancer Detection

By analyzing MRIs, CT scan results and mammography, AI can help with detecting cancer cells in the early stages. Examples of Health organizations currently using AI for cancer detection includes

- The FDA is using AI assistants that can help detect cancer relating to brain, skin, lung, thyroid, breast and skin cancer.[12]
- Ipswich Hospital in the UK uses AI to review radiology reports for Lung cancer.[13]
- Massachusetts general Hospital uses AI to predict if a person will develop Lung cancer in the next one year.[14]
- Murray Hill Radiology in NYC uses AI to review mammograms to detect breast cancer.[15]

3.2 Ophthalmology

AI can help to detect Diabetic Retinopathy which is a complication of diabetes which can lead to vision loss if not treated early. AI can detect signs of vision loss by analyzing retinal images. The university of IOWA Hospitals and Clinics are using an AI based diagnostic tool that diagnoses diabetic retinopathy.[16]

The below Figure 3 shows how an AI model using a hierarchical organization of AI, machine learning and deep learning can be created and trained to detect diabetic retinopathy. The key concept of machine learning is its ability of learn with the large amounts of data fed to it as Input. For the algorithm to learn, the input data used must be labeled. The labels are often created by expert clinicians and are the ground truth which the model uses to learn from iterative feedback. The model learns to perform a task to get as close to the ground labels as possible.

The model shown in the Figure 3 is trained on an example dataset of 500 images. Each image is put into deep learning algorithms to generate a prediction, and the prediction is compared with the label to calculate a loss. The calculated loss is then used to update the weights of the Deep learning model. In this example, the process has been repeated for about 1000 cycles in which the model is fed with the entire set of 500 images.[17]

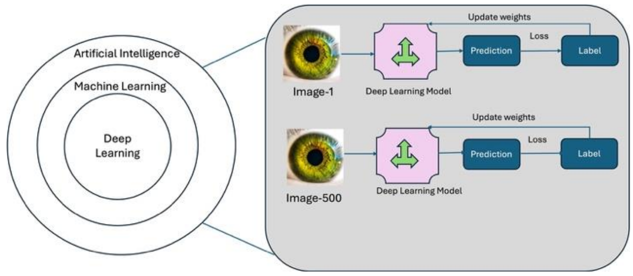

Figure 3: Diabetic Retinopathy training model

3.3 Cardiology

AI can help analyze heart scans to detect potential issues like coronary artery diseases or cardiovascular value problems. Diagnosing such problems is usually a complex task.[18]

Mayo Clinic has applied AI techniques to develop a tool for those with a specific type of heart problem with no natural or apparent symptoms. The condition is described as left ventricular dysfunction. The tool found people at risk of this condition about 93% of the time. In addition, Mayo Clinic has also developed a tool that is used in Apple Watch to detect weak heart pumps [19]

Currently, ventricular dysfunction which is a weak heart pump is usually identified today through echocardiogram, MRI or CT scan but these methods are expensive, time consuming and at times inaccessible. The ability to diagnose a weak heart pump through an ECG that a person records from his wearable device allows timely detection of this potentially life-threatening disease in a massive scale.

Within 30 days after logging an ECG from the apple watch, approximately 420 participants had an echocardiogram which is a standard test that uses sound waves to produce images of the heart. Of those, 16 had low ejection fraction confirmed by echocardiogram which provided a comparison for accuracy.[20]

3.4 Neurology

A potential use case of AI is to analyze brain scans to identify abnormalities in Alzheimer's, dementia, and brain tumors. AI can help automate complex image analysis tasks such as recognizing brain regions, calculating changes in brain volume over time, and detecting abnormalities in brain scans.

Methodist Manifest Hospital uses RAPID-AI technology by analyzing CT scan images to find abnormalities in the brain. The medical team is notified if there are any abnormalities. A neuroradiologist then determines if there is a need for further medical treatment.[21]

3.5 Bone Fracture detection

Fractures have an annual frequency of 9.4 million cases in the United States and missed fractures account for about 80% of the misdiagnosis in emergency department. The workload for on-call radiologists have substantially increased and the growing workload contributes to misdiagnosis or incorrect diagnosis resulting in radiologist burnout.AI driven tools can help detect subtle fractures that can be otherwise ignored by a radiologist. Deep learning models have been used for detection on fracture and there are two broad categories of approach that are considered – weekly and strongly supervised [22]

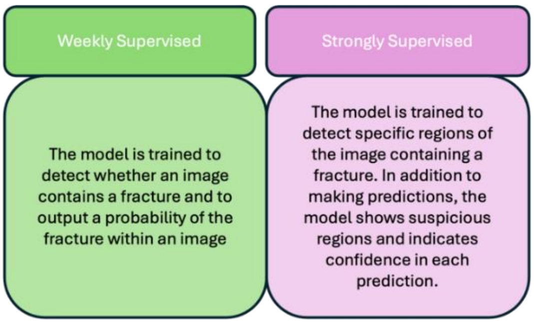

Figure 4: Weekly/Strongly supervised model for fracture detection

4. Conclusion

The integration of Augmented AI in health diagnostics offers a promising future for improving the accuracy and efficiency of medical decision making. By combining human expertise with advanced machine learning algorithms, AI can process vast amounts of data, assist in early detection of diseases, and enhance clinical outcomes. Rather than replacing healthcare professionals, Augmented AI supports them in providing more comprehensive care to patients. As AI technologies continue to evolve, the collaboration between AI and healthcare professionals will play a vital role in transforming the medical diagnostics landscape, improving both patient care and overall healthcare efficiency.

References

[1] Havard Medical School, "AI in Health care: From Strategies to Implementation", Nov 2024 https://execonline.hms.harvard.edu/artificial-intelligence-in-health-care-from-strategies-to-implementation?utm_source=Google&utm_network=g&utm_medium=c&utm_term=using%20ai%20in%20healthcare&utm_location=9052847&utm_campaign_id=21212474098&utm_adset_id=160845325906&utm_ad_id=697082031060&gad_source=1&gbraid=0AAAAADDa9X28jrYg5toEmkzfNE77I7zs8&gclid=Cj0KCQjwsc24BhDPARIsAFXqAB3szSw4M2InDOBE9qUP9_WLrKvW2ig1KL4Hbyf7C3bG4_Svb_fF4HcaApr0EALw_wcB

[2] Stephanie Trunzo, Senior Vice President and GM, Oracle Health "Data in the past fuels the future",May 3, 2023 https://www.oracle.com/health/clinical-suite/electronic-health-record/data-in-the-past-fuels-the-future/

[3] RamSoft ,"Solving the Radiologist shortage for healthcare facilities", Aug 2023 https://www.ramsoft.com/blog/radiologist-shortage#:~:text=The%20number%20of%20practicing%20radiologists,and%20stress%20in%20the%20profession.

[4] "Six steps to prevent readmission Denials"; March,2023 https://php8.allzonems.com/tag/improve-patient-outcomes/

[5] Alastair Majury, Chartered MCSI, "AI Case Study Saturday: AI in Healthcare Diagnostics-IBM Watson", July 2024 https://www.linkedin.com/pulse/ai-case-study-saturday-healthcare-diagnostics-ibm-alastair-bwk2e

[6] Dan Reiss and Antonio Spina, "Patient-First Health with Generative AI: Reshaping the Care Experience",Jan 2024, Page 9 https://www3.weforum.org/docs/WEF_Patient_First_Health_with_Generative_AI_2024.pdf

[7] Saskia Locke, Anthony Bashall, Sarah Al-Adely, John Moore, Anthony Wilson, Gareth B. Kitchen, "Trends in Anesthesia and Critical care"Volume38,June2021, Pages 4-9 https://www.sciencedirect.com/science/article/abs/pii/S2210844021000411#:~:text=Chatbots%20are%20a%20fast%20growing,of%20patient%20mortality%20is%20routine.

[8] Angelina Leigh, "6 uses of Natural Language processing in healthcare" https://global.hitachi-solutions.com/blog/nlp-in-healthcare/#:~:text=Clinical%20Entity%20Resolver:,determine%20the%20outcome%20of%20care.

[9] Machine Learning and Medical Diagnosis: An Introduction to How AI Improves Disease Detection https://kili-technology.com/data-labeling/machine-learning/machine-learning-and-medical-diagnosis-an-introduction-to-how-ai-improves-disease-detection#

[10] Isabelle, D., Isabelle, D., & Westerlund, M. (2022). A Review and Categorization of Artificial Intelligence-Based Opportunities in Wildlife, Ocean and Land Conservation. Sustainability, 14(4), 1979.

[11] 7 most crucial uses cases of Generative AI in Healthcare https://nextgeninvent.com/blogs/use-cases-

of-generative-ai-in-ealthcare/#:~:text=To%20identify%20and%20diagnose%20various,touchpoint%20when%20time%20is%20limited.
[12] Patrick Boyle, "Is it cancer: Artificial Intelligence helps Doctors get a clearer picture", March 2024 https://www.aamc.org/news/it-cancer-artificial-intelligence-helps-doctors-get-clearer-picture#:~:text="It's%20another%20tool%20to%20help,'"
[13] Rachael McMenemy, "Ipswich Hospital uses AI to detect lung cancer in new research project" https://www.bbc.com/news/uk-england-suffolk-67993386#
[14] BerkeleyLovelace,Jr., JohnTorres, M.D., MarinaKopf and PatrickMartin "Promising new AI can detect early signs of lung cancer" ,Apr 2023 https://radarhealthcare.sdli.es/2023/04/12/promising-new-ai-can-detect-early-signs-of-lung-cancer/
[15] "NYC Hospital embracing AI to help breast cancer in mammograms" https://www.youtube.com/watch?app=desktop&v=AhtjKZ3BBMs#:~:text=Murray%20Hill%20Radiology%20in%20NYC%20is%20using,http://abc7ny.com/%20Find%20us%20on%20social%20media:%20FACEBOOK:
[16] Using Artificial intelligence to diagnose diabetic retinopathy before it causes blindness https://www.youtube.com/watch?app=desktop&v=reYQusRXecE#:~:text=Artificial%20intelligence%20(AI)%20is%20now%20being%20used,IDx%2DDR%20%2D%20a%20technology%20that%20uses%20artificial
[17] Artificial Intelligence and Diabetic Retinopathy: AI Framework, Prospective Studies, Head-to-head Validation, and Cost-effectiveness,*Diabetes Care* 2023;46(10):1728–1739 https://diabetesjournals.org/care/article/46/10/1728/153626/Artificial-Intelligence-and-Diabetic-Retinopathy#
[18] Joshi, M., Sodhi, K. S., Pandey, R., Singh, J., & Goyal, S. (2017). Duxorubicin-induced cardiotoxicity. https://core.ac.uk/download/543134009.pdf
[19] AI Transforms Smartwatch ECG Signals Into a Diagnostic Tool for Heart Failure, Dec 1, 2022 https://radarhealthcare.sdli.es/2022/12/01/ai-transforms-smartwatch-ecg-signals-into-a-diagnostic-tool-for-heart-failure/
[20] AI transforms smartwatch ECG signals into a diagnostic tool for heart failure**,** November 2022 https://newsnetwork.mayoclinic.org/discussion/ai-transforms-smartwatch-ecg-signals-into-a-diagnostic-tool-for-heart-failure/Methodist Mansfield Hospital uses AI tools for brain mapping, August 2024 https://www.keranews.org/health-wellness/2024-08-14/methodist-mansfield-hospital-finds-success-using-ai-tools-to-assist-medical-staff#
[21] JohnR. Zech, MD,MA, Samantha M. Santomartino, BA,and PaulH. Yi, MD "Artificial Intelligence (AI) for Fracture Diagnosis: An Overview of Current Products and Considerations for Clinical Adoption, From the *AJR* Special Series on AI Applications", Volume 219, Issue 6 https://ajronline.org/doi/10.2214/AJR.22.27873

Author Profile

Dhivya Sudeep, With over 17 years of experience in the IT healthcare industry, Dhivya Sudeep has a diverse skill set across various roles and industry verticals. She has extensive expertise in the analysis, design, development, customization, and implementation of software applications, adeptly translating business requirements into technical specifications and architectural solutions. Throughout her career, Dhivya Sudeep has successfully led and managed teams, taking on multiple roles. Her strong database skills and sound experience in Z/OS application development, along with related interfaces, have positioned her as a key contributor in delivering innovative solutions within the healthcare domain. A co-author of a published book by SPRINGER on High Performance Big Data Analytics, Dhivya Sudeep has keen interest in cloud technologies, IBM Watson, and Big Data, complementing her work with IBM Mainframes. Known for excellent communication and interpersonal skills, she is a self-motivated, quick learner and a vital team player.