

ARTIFICIAL INTELLIGENCE IN HEALTHCARE: A BRIEF REVIEW

Chiguruvada Ramakrishnan Punith Kumar^{*}, Ramalakshmi Natarajan, Kumar Padma and Amuthalakshmi Sivaperuman¹

Received: March 05, 2021; Revised: March 25, 2021; Accepted: June 14, 2021

Abstract

Artificial intelligence is the major upcoming technology in various fields, particularly in the medicinal field. It utilizes machines to mimic human intelligence to solve various problems that remain unsolved by humans. This article studies about the history of Artificial intelligence in the medicinal field and also its current applications in drug discovery and various diagnostic aids in major diseases such as Cancer, Alzheimer's Disease, Arthritis, Hepatitis B, Urinary tract infection, Tuberculosis, and so on. This article also summarizes about the future directions of Artificial intelligence in the medicinal field.

Keywords: Artificial Intelligence, Healthcare, Drug discovery, Diagnosis, Future

Introduction

Artificial intelligence is the ability of a digital system or a computer that is controlled either by humans or robotic systems which are programmed to think like humans and mimic their actions to carry out several research works which is difficult to carry out by humans. Artificial intelligence was carried out to perform various programs such as Learning, reasoning, problem solving, perception, and using language (Copeland, 2020). The use of Artificial intelligence in medicinal field in diagnosing various diseases had created an evolution in the healthcare industry among people. For instance, robotic surgeries perform complicated surgeries with great accuracy and lesser time of recovery. This review article gives detailed information about the applications of Artificial Intelligence in medicinal field such as diagnosis and also gives a glimpse on the future of Artificial intelligence in the healthcare industry. The aim of this study is to increase the use of Artificial intelligence to the utmost level in

various fields, especially in the healthcare field so that the use of technology be spread all over the world including developing countries. This study was reviewed by the electronic databases (Google scholar, PubMed, etc). for different diagnostic aids and developments in the healthcare industry. A brief

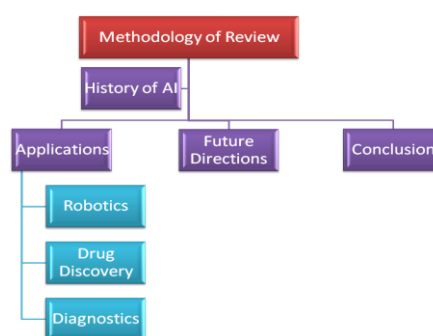


Figure 1. (A) Methodology of Review procession.

Department of Pharmaceutical Chemistry C.L. Baid Metha College of Pharmacy Thoraiappakam, Chennai-600097, E-mail: punith2408kumar@gmail.com

^{*} Corresponding author

methodology process of the review is described in Figure 1.

History

The concept of using computers to simulate intelligent behavior and critical thinking was first described by Alan Turing in 1950. He developed a “turning test” to determine whether computers can mimic human intelligence. The field of AI research was developed at a workshop at Dartmouth College in 1955, where the term “Artificial Intelligence” was coined by John McCarthy (Kaul *et al.*, 2020). Research in the 1960s and 1970s gave the first problem-solving program or expert system Dendral designed for applications in organic chemistry which is used for automated decision-making and problem-solving system for organic chemists (Wikipedia contributors, 2021). Dendral formed the basis for a subsequent system Mycin. It is one of the most significant early uses of artificial intelligence in medicine which determines the bacteria causing severe infections by artificial intelligence (Wikipedia contributors, 2020a).

Applications

Robotic systems

The term robot is derived from the Czech word Robota which means biosynthetic machines used as forced labour. The robotic systems are used in the medicinal field as robotic surgical units. Robotic surgery is a type of minimally invasive surgery. “Minimally invasive” means that instead of operating on patients through large incisions, we use miniaturized surgical instruments that fit through a series of quarter-inch incisions. Da Vinci robotic surgical system is the first unit developed to perform surgeries in the year 2000. This is the most widely used system which performed over 1,037,000 surgical procedures in over 67 countries. The robotic system has a high-resolution 3D image viewing capacity with a motion control and a physician console. It has four robotic arms similar to the shape of the human fingers which can alter in any angle up to 360°. The controls operated in the console are translated by the arms of the system. It has a high precision in performing surgeries. All the surgical maneuvers are under the direct control of the physician. The physician console has a sensor in which the system stops working when the physician loses the point of contact with the console (Hamet and Tremblay, 2017).

Drug Discovery

Machine Learning (ML) coupled with Natural Language Processing (NLP) was found to be very helpful in reducing the time and cost required for drug discovery. The goal of drug discovery is

to identify small molecules that selectively modulate the functions of target protein. Artificial intelligence can perform this without any Lead molecule by Trial or Error method. “Machine Vision System” is a newer image analytical technique, it allows predicting which molecule might be effective for which biological targets and simultaneously it analyzes chemical interactions and determines the efficacy of the drug. AI can not only aid quick and hassle-free hit compound identification but also contribute to the suggestions of synthesis routes of these molecules along with the prediction of the desired chemical structure and an understanding of drug-target interactions and their SAR (Paul *et al.*, 2020).

Diagnostic Aids

Prostate cancer

Machine and deep learning have been used for long time to determine a procedure to diagnose cancer. Deep learning with Deep learning neural network is compared with Non-Deep Learning for the treatment of prostate cancer and prostate benign conditions by Scale Invariant feature transform (SIFT). The results showed that deep learning with neural networks is superior in SIFT image feature method in diagnosing cancer which can be further extended to MRI, CT, and PET scans for other organs (Huang *et al.*, 2020).

Lung cancer

Pneumoconiosis X-Ray Diagnosis Expert System is an expert system that is used to diagnose lung diseases. It takes a picture of the lungs from the upper side of the body which exactly looks like a shadow. The shadow is used to determine the type and degree of lung cancer. This system includes three modes: Knowledge base, Explanation interface, and Knowledge acquisition. Knowledge base mode represents the data of X-ray representation of various stages of disease. Explanation interface determines the conclusion whereas knowledge acquisition allows medical experts to add or change information in the system (Skillville, 2021).

Dxplain

Dxplain is a clinical decision support system (CDDS) that helps clinicians to diagnose various diseases based on the signs and symptoms of the patients. The Dxplain method uses Pseudo-probabilistic algorithm method in diagnosis. The system differentiates between common and rare diseases using the information stored for a particular disease. The system also acts as a clinical reference with a searchable database of various diseases and conditions (Wikipedia contributors, 2020b).

Germ watcher

Germ watcher is an expert system that is designed to support infection control especially in detecting, tracking, and investigating the hospitalized patients. It can also monitor the microbiology culture data from the hospital laboratory system. The AI system uses some rules to determine whether the positive cultures are potential nosocomial infections. The system sends the reports directly to the Center for Disease Control and Prevention (Nazira, 2021).

Skin Cancer

Artificial Neural network systems are used in screening skin cancer by automatic early detection system. In this method, digital image processing technique is used in different dermoscopic images that are fed into the system as input. The system separates the cancerous part of the skin from the healthy part of the skin in the image by segmentation. These segments are extracted by 2D Wavelet transform which identifies the cancerous part easily. This method is considered to be a better one than the conventional bioscopy method (Jaleel *et al.*, 2012).

Breast Cancer

Diagnosis of breast cancer by mammography done by radiologists is compared with the artificial intelligence systems. Artificial intelligence provided a decision support system. Breast Imaging Reporting, Data System score, and probability of malignancy were used as input into the system which analyses and reports the results. Radiologists found to have improved in the cancer detection by mammography when using artificial intelligence system for support, without requiring any additional reading time (Rodríguez *et al.*, 2019).

Diabetic Retinopathy

Machine and deep learning are used to develop algorithms for the automated detection of diabetic retinopathy. The fundus photographs of the diabetic retinopathic eyes are collected and it is used as the input into the expert system. The fundus photographs should be taken in different angles. When these photographs act as the input source based on these inputs, the patient's eyes are tested whether they are prone to get diabetic retinopathy. The patients with diabetes are tested with the automatic detection of diabetic retinopathy so that it will help diagnose the disease earlier. Screening of diabetic retinopathy using artificial intelligence might help in the prevention of blindness due to diabetes (Grzybowski *et al.*, 2020).

Rheumatoid Arthritis

In diagnosing arthritis, imaging techniques of the radiographs are carried out where convolutional neural network (CNN) is used. It is a deep learning method. In this method, hands of arthritis affected are fed as input to the system and training by deep learning method is done. The network is trained with different training datasets of more number of radiographs with normal and arthritis radiographs. The accuracy of the network was found to be 73.33% and the error rate was found to be 0.0167. The accuracy, specificity, sensitivity, and precision shows it as a better diagnostic tool for rheumatoid arthritis (Üreten *et al.*, 2020).

Alzheimer's disease

Alzheimer's disease (AD) is a neurodegenerative disease caused by dementia. AD can be diagnosed in the early stage by artificial intelligence method by using multi-modality imaging data for diagnosis and prognosis of AD at early stages. According to various studies, it is found out that mild cognitive impairment (MCI) is the starting stage of AD. Classical machine learning algorithms and deep learning-based algorithms are used in AD diagnosis and prognosis by detecting the earlier MCI stage of Alzheimer's disease and so that the transformation of MCI to AD can be stopped (Liu *et al.*, 2018).

Liver Disease

Liver diseases are more common nowadays, but early diagnosis of liver disorders is lacking. Artificial intelligence systems such as classification and regression tree (CART) and case-based reasoning (CBR) are used in diagnosis. In these systems, CART provides classification accuracy and it also provides a set of rules to obtain target variables in the diagnosis. CBR helps in the identification of the type of liver disease. The model can be used as a support system in decision making and helps physicians in decreasing the errors in diagnosis and effective treatment. CART provides a greater classification capacity when compared to CBR hence it is preferred much in the classification of diagnosis (Lin, 2009).

Neonatal Diseases

The neonatal period is an important phase in the development of a child. Children born nowadays have low birth weights and are prone to many diseases and have high neonatal mortality. These can be accurately diagnosed using artificial intelligence by artificial neural network (ANN) in disease diagnosis and also in the prediction of

mortality risk of babies. The neural networks help the physicians in decision making and it is considered to produce good results than other prediction methods. The study proves that the neural network system accurately diagnosed about 75% of cases with great stability (Chowdhury *et al.*, 2011).

Corona Virus

Coronavirus (Covid 19) is tested by reverse transcriptase-polymerase chain reaction kits. This test may take up to 2 days and in some cases the test gave false results, therefore rapid testing by artificial intelligence is used. In this method, CNN algorithms which are an 18-layer residual network are used in which computed tomography (CT) findings with clinical symptoms, exposure history, and laboratory testing are used to rapidly diagnose patients. The AI system was found to have an improved detection rate of Covid-19 positive cases in diagnosing the disease with the help of CT scans. The system correctly tested about 68% of cases using chest CT scans (Mei *et al.*, 2020).

Urinary Tract Infection

Urinary tract infection (UTI) is caused by the inflammation of urinary tract. The infection can be diagnosed using artificial intelligence by four major methods such as decision tree (DT), support vector machine (SVM), random forest (RF), and ANN. UTI can be diagnosed by testing with different UTI datasets. The ANN method is found to have the highest accuracy with 98.30% with high sensitivity and specificity. This proposed model is a successful medical decision support system for UTI with complex symptoms. The usage of this artificial intelligence method has its advantages of lower diagnosis cost, lower diagnosis time and there is no need for invasive methods (Ozkan *et al.*, 2018).

Hepatitis B

Hepatitis B is a common liver disorder caused by the Hepatitis B virus which may lead to hepatocellular carcinoma (Liver cancer). In the diagnosis of Hepatitis B by artificial intelligence, ANN is used to determine the severity of the disease in the patient. The intelligent system with multi-layer perceptron (MLP) structures with the back-propagation (BP) algorithms is used to diagnose the disease. MLP shows good classification accuracy of different types of hepatitis. From this, it is concluded that ANN can be used effectively in the diagnosis of Hepatitis B (Ghumbre and Ghatol, 2010).

Thyroid

Artificial neural networks is the most commonly used intelligence method in disease

diagnosis. In this method, thyroid disease dataset are collected and converted into input datasets which classifies it into testing and training data. A neural network MLP is created and is trained based on the BP algorithm. The final output layer provides the results. By selecting an appropriate hidden layer and a particular Logsig function for it and six neurons in that layer shows classification accuracy in diagnosis of thyroid disease can be up to 98.6% (Gharehchopogh *et al.*, 2013).

Tuberculosis

Tuberculosis is an infectious disease caused by the microorganism *Mycobacterium tuberculosis*. The disease is diagnosed by artificial intelligence system by using multi-layer neural network (MLNN) with two hidden layers and also by the general regression neural network (GRNN) model. The MLNN networks are trained using back propagation with momentum (BPwM) and Levenberg-Marquardt (LM) algorithms in which LM algorithm was found to be better than the BPwM algorithms in training. The MLNN structures with two hidden layers trained by LM algorithm were found to be good in disease diagnosing. The GRNN was also found to be good in diagnosing Tuberculosis (Er *et al.*, 2010).

Future Directions

The first non-man made drug is developed by AI for treating obsessive compulsive disorder. The molecule is DSP-1181; it has entered Phase-1 clinical trial. The molecule is a long-acting potent Serotonin 5-HT_{1A} receptor agonist. It was designed and developed in just 12 months, whereas normal procedure takes up to 5 years. The drug is created using Algorithms, which made it faster to develop (European Pharmaceutical review, 2021). In the year 2016, Pfizer partnered with IBM and worked on Immuno-oncology. It used Machine learning to better identification of new drug targets, and for the selection of patients for clinical trials (Pfizer, 2016). Roche partnered with GNS Healthcare to work on cancer therapy using Artificial intelligence. They converted cancer patient data into models that can identify new targets for cancer therapy (GNS healthcare, 2021).

By the year 2030, artificial intelligence will access multiple sources of data to provide patterns in disease and aid treatment and care. Healthcare systems will be able to predict an individual's risk of certain diseases and suggest preventative measures. Artificial intelligence will help reduce waiting times for patients and improve efficiency in hospitals and health systems (World economic forum, 2021). AI will support the future needs of medicine by analyzing the vast amounts and various

forms of data that patients and healthcare institutions record in every moment. AI will support and augment physicians by reducing their work hopefully and enabling them to spend more time with their patients and improving the human touch (Ahuja, 2019).

Conclusion

This study provides a brief knowledge about artificial intelligence and its applications in medical and healthcare systems. Artificial intelligence is widely used as a diagnostic aid or a diagnostic tool in the healthcare industry and also in drug discovery. Artificial intelligence methods are commonly used in various disease diagnoses by different methods such as ML, ANN, MLNN and DL. The use of artificial intelligence in various aspects in the healthcare industry in upcoming years is interpreted in Figure 2 of which Diagnosis and Robotic surgeries take a major part (Grand View Research, 2021). The study also provides an overview about the future of artificial intelligence in medicine field with leading pharmaceutical companies working on it. Artificial intelligence can also help physicians in suggesting drug combinations to a patient by CDDS. The use of artificial intelligence is considered to reduce the workload of many physicians and other healthcare professionals which could make a great impact in their performance and physicians may able to diagnose a disease in its early stage.

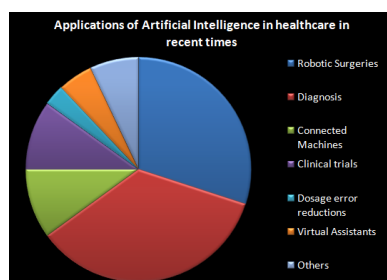


Figure 2. Applications of Artificial Intelligence in recent times.

Acknowledgment

The author sincerely thank the Librarian of C.L. Baid Metha College of Pharmacy helping him search different sources regarding the article and in completing the review in short period of time.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

- Ahuja, A.S. (2019). The impact of artificial intelligence in medicine on the future role of the physician. *PeerJ*, 7:e7702.
- Chowdhury, D.R., Chatterjee, M., and Samanta, R.K. (2011). An artificial neural network model for neonatal disease diagnosis. *Int. J. of Artificial Intelligence and Expert Systems (IJAE)*, 2(3):96-106.
- Copeland, B.J. (2020) "Artificial intelligence". *Encyclopedia Britannica*. Available from: <https://www.britannica.com/technology/artificial-intelligence>. Accessed date: Feb 20, 2021.
- Er, O., Temurtas, F., and Tanrikulu, A.Ç. (2010). Tuberculosis disease diagnosis using artificial neural networks. *J. of medical systems*, 34(3):299-302.
- European Pharmaceutical review. (2021)., Available from: <https://www.europeanpharmaceuticalreview.com/news/112044/dsp-1181-drug-created-using-ai-enters-clinical-trials/>. Accessed date: Feb 20, 2021
- Gharehchopogh, F.S., Molany, M., and Mokri, F.D. (2013). Using artificial neural network in diagnosis of thyroid disease: a case study. *Int. J. on Computational Sciences & Applications (IJCSA) Vol.*, 3:49-61.
- Ghumbre, S.U. and Ghatol, A.A. (2010). An intelligent system for hepatitis b disease diagnosis. *Int. J. of Computers and Applications*, 32(4):455-460.
- GNS Healthcare. (2021). Cambridge. Available from: <https://www.gnshealthcare.com/gns-healthcare-announces-collaboration-to-power-cancer-drug-development/>. Accessed date: Feb 20, 2021.
- Grand View Research (2021). Available from: <https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-healthcare-market>. Accessed date: Feb 25, 2021.
- Grzybowski, A., Brona, P., Lim, G., Ruamviboonsuk, P., Tan, G. S., Abramoff, M., and Ting, D.S. (2020). Artificial intelligence for diabetic retinopathy screening: a review. *Eye*, 34(3):451-460.
- Hamet, P. and Tremblay, J. (2017). Artificial intelligence in medicine. *Metabolism*, 69:S36-S40.
- Huang, S., Yang, J., Fong, S., and Zhao, Q. (2020). Artificial intelligence in cancer diagnosis and prognosis: Opportunities and challenges. *Cancer letters*, 471:61-71.
- Jaleel, J.A., Salim, S., and Aswin, R.B. (2012). Artificial neural network based detection of skin cancer. *Int. J. of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 1(3).
- Kaul, V., Enslin, S., and Gross, S.A. (2020). The history of artificial intelligence in medicine. *Gastrointestinal endoscopy*, 92(4):807-812
- Lin, R.H. (2009). An intelligent model for liver disease diagnosis. *Artificial Intelligence in Medicine*, 47(1):53-62.
- Liu, X., Chen, K., Wu, T., Weidman, D., Lure, F., and Li, J. (2018). Use of multimodality imaging and artificial intelligence for diagnosis and prognosis of early stages of Alzheimer's disease. *Translational Research*, 194:56-67.

- Mei, X., Lee, H. C., Diao, K. Y., Huang, M., Lin, B., Liu, C., and Yang, Y. (2020). Artificial intelligence-enabled rapid diagnosis of patients with COVID-19. *Nature medicine*, 26(8):1,224-1,228.
- Nazira azwan., Prezi., (2021). Available from: <https://prezi.com/u8k9nf7cv06e/germwatcher/>. Accessed date: Feb 20, 2021
- Ozkan, I. A., Koklu, M., and Sert, I. U. (2018). Diagnosis of urinary tract infection based on artificial intelligence methods. *Computer methods and programs in biomedicine*, 166:51-59.
- Paul, D., Sanap, G., Shenoy, S., Kalyane, D., Kalia, K., and Tekade, R.K. (2020). Artificial intelligence in drug discovery and development. *Drug Discovery Today*, 26(1):80-93
- Pfizer., (2016). Available from: https://www.pfizer.com/news/press-release/press-release-detail/ibm_and_pfizer_to_accelerate_immuno_oncology_research_with_watson_for_drug_discovery. Accessed date: Feb 20, 2021
- Rodríguez-Ruiz, A., Krupinski, E., Mordang, J. J., Schilling, K., Heywang-Köbrunner, S. H., Sechopoulos, I., and Mann, R.M. (2019). Detection of breast cancer with mammography: effect of an artificial intelligence support system. *Radiology*, 290(2):305-314.
- SkillVille., (2021). Mumbai, Available from: <https://skillville.in/blog/ai-expert-systems-for-medical-sciences/>. Accessed date: Feb 20, 2021
- Üreten, K., Erbay, H., and Maraş, H.H. (2020). Detection of rheumatoid arthritis from hand radiographs using a convolutional neural network. *Clinical rheumatology*, 39(4):969-974.
- Wikipedia contributors. (2020a). Mycin. In Wikipedia, The Free Encyclopedia. Available from: <https://en.wikipedia.org/w/index.php?title=Mycin&oldid=994744850>. Accessed date: Feb 25, 2021.
- Wikipedia contributors. (2020b). DXplain. In Wikipedia, The Free Encyclopedia. Available from: <https://en.wikipedia.org/w/index.php?title=DXplain&oldid=990258043>. Accessed date: Feb 25, 2021.
- Wikipedia contributors. (2021). Dendral. In Wikipedia, The Free Encyclopedia. Available from: <https://en.wikipedia.org/w/index.php?title=Dendral&oldid=1002912884>. Accessed date: Feb 25, 2021.
- World economic forum (We forum) (2021). Available from: <https://www.weforum.org/agenda/2020/01/future-of-artificial-intelligence-healthcare-delivery/>. Accessed date: Feb 20, 2021.