

# The Role of Artificial Intelligence in the Medical Field

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**Abstract.** Artificial intelligence is the fast growing field of science, technology, and engineering. Artificial intelligence tries to mimic human intelligence capabilities such as understanding, learning, inferring, logic, problem solving, decision making and install these capabilities into machines, software, computer applications and computer programs. Artificial intelligence is used and implemented in many science, engineering and medical fields. The *aim* of this research paper is to investigate and introduce the role of the artificial intelligence in the medical field. Artificial intelligence is used in different sections in the medical field such as offering more accurate medical diagnoses, discovering new drugs, better medical data analysis, better patient care, better healthcare systems, electronic health records, clinical trial medicine, and diagnostic imaging analysis. The *methodology* used in this research paper was to identify and select research and technical papers related to the used of artificial intelligence in the field of medicine. The selected papers then were systematically reviewed. The findings of the paper showed that artificial intelligence is increasingly used in many areas of the medical field.

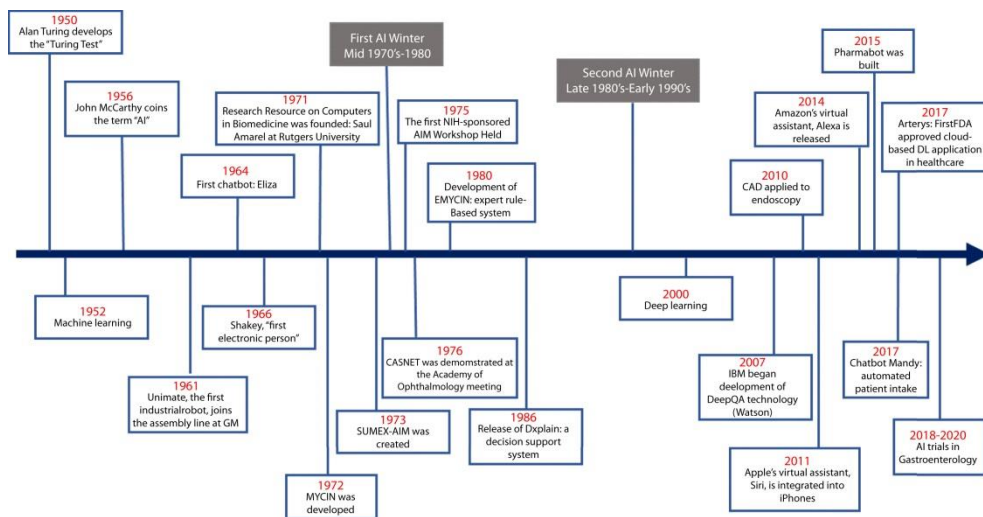
## 1 Introduction

Since the invention of computers, there has been always an attempt to replace human efforts and expertise with machines run by computers. In advance of all these efforts is the attempt of simulating human intelligence capabilities. These efforts are best known by the name of Artificial Intelligence. Human intelligence capabilities include understanding language, apply logic, learn from experience, accumulate knowledge, have memory, recognize patterns, solve problems, plan, make decisions sometimes complex ones, retain information and communicate. The science of artificial intelligence tries to develop systems that can think like humans and act like humans. These systems are known by the name of artificial intelligence systems [1].

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The first person to introduce the concept of using machines to do work like humans was Alan Turing in the 1950. He developed the concept of programming machines to do tasks like humans automatically. The first person to describe the term Artificial Intelligence was John McCarthy in 1956 as the science of making machines which are intelligent. Since then artificial intelligence has gone through many stages in development until reached the advanced stage of modern applications especially in medical field as it is shown in the figure 1 [1].



**Fig. 1.** AI History Time Line [1]

Since the invention of artificial intelligence, it has developed into many branches that can be used to develop software and applications that can be characterized as smart or intelligent. The main technology that is used to simulate human thinking is what is known as artificial neural network which mimics the structure of human brain. Human brain utilizes billions of biological cells known as neurons which are connected and used to think and make decisions. Artificial neural networks use similar structure known neurons which are connected in layers and can be trained by adjusting weights and using different functions. This ANN structure led to developing machines that can be trained in recognizing patterns in data and then used to classify fresh sets of data. This revolutionary concept led to new AI concepts such as Machine Learning (ML) and Deep Learning (DL) [1, 2].

The use of AI in the medical field has advanced rapidly in the last five decades. With the improvements in machine learning and deep learning algorithms, AI has become an integral part of all medical technologies from disease diagnosis such as cancer diagnoses to personalize treatment, medical data analysis, better healthcare and many more areas of offering healthcare to patients [1, 2]. The advancement in computer technology such as processing power and bigger storage capacity has helped tremendously in the application of AI technology in the medical field. These advances and the better algorithms and programs used in the medical field led to a higher trust in these technologies from all interested parties such as doctors, nurses, health administrators, as well as patients [1, 2].

The aim of this research paper is to present and overview of the role that artificial intelligence technologies play in the medical field. This research paper is an attempt to offer the reader a summary of the areas in the medical field that are benefiting from the used of artificial intelligence technology and advancements.

The rest of the paper is organized in a way that covers the artificial intelligence applications in the medical field based on medical areas that are identified from the reviewed papers. Section two represents major medical areas utilizing artificial intelligence applications.

## **2 AI Applications in the Medical Field**

Artificial Intelligence has been used widely in the medical field. It ranges from medical diagnosis to treatment. It even helped sometimes in replacing the traditional medical procedures because it avoids the basic errors that can be made by humans. The following sections are the summery offered by this research in the major medical areas that can benefit from the application of artificial intelligence.

### **2.1 AI Medical Diagnosis**

Disease or illness diagnosis is the process of determining what is the cause of illness of a patient using medical history, clinical evaluations, symptoms, lab tests results, and X-ray results. The purpose of this process is to determine the best course actions in terms of treatment in order to make the patient become well. This process can be improved greatly in terms of time and accuracy by using computer programs or medical technology that uses artificial intelligence [3, 4].

In the process of illness diagnosis, doctors collect large amount of data about their patients. The data collected comes from patient and family medical history, large range of clinical observations of symptoms, wide range of medical imaging from 2D X-rays, MRI, and CT scans 3D imaging, patient vital signs such as temperature and blood pressure, and a wide range of lab test results of patient blood and bodily fluids. Doctors make decisions based on this data about the illness of the patient and how to treat it. This process can be prone to errors because it is based on the knowledge and experience of humans like doctors and nurses. This process can be improved greatly by building data matrices from all the data collected and analysed by powerful algorithms using machine learning and deep learning technology [3, 4].

Large amounts of clinical data are a great source for training medical diagnostic systems to diagnose illnesses accurately and quickly. It helps in monitoring the progress of the patient condition especially in the chronic diseases. Another benefit of using AI in analysing large amount of medical data is to detect future illnesses earlier. The combination of multiple sources of clinical data provides a complete picture of the health of the patient, thus reducing the chance of misdiagnoses and errors which leads to faster recovery and saving time and money [3, 4].

Medical diagnosis system using AI has been used in detecting many diseases. Among the most known diseases that benefit from AI based systems are [5]:

1. Cancerous Diseases Such as
  - Lung Cancer.
  - Breast Cancer.

- Brain Cancer.
  - Gastric and Colon Cancer.
  - Skin Cancer.
2. Non-Cancerous Diseases Such as:
- Cardiology.
  - Ophthalmology.
  - Dentistry.
  - Diabetes.
  - Psychiatric and Neurological Conditions.

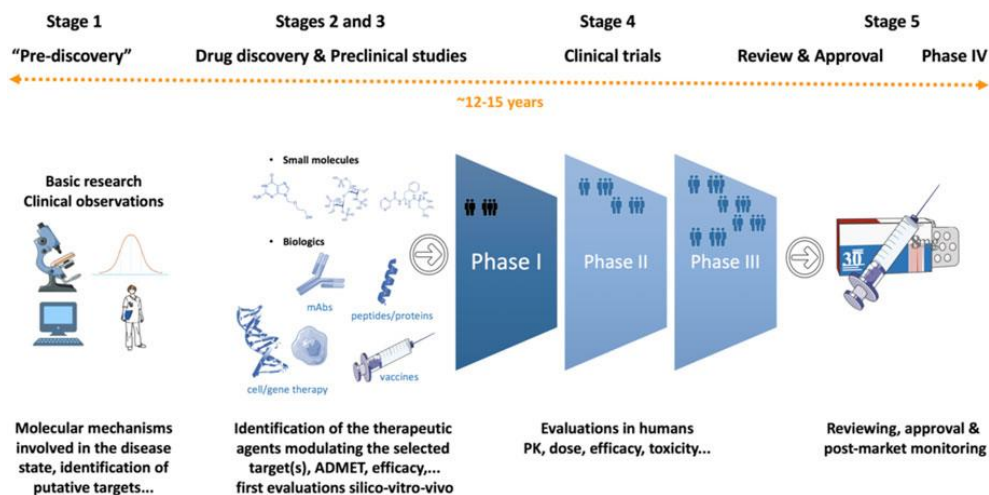
Another major area that uses AI algorithms in treatment is robotic surgery. Robotic Surgery is used by surgeons to operate on patients in minimally invasive surgeries. This process includes making tiny incisions and inserting tiny cameras and a mechanical arm with surgical instrument attached to it. The surgeon will have control of the camera and the inserted arm through a computer system that provides a video feed through a monitor and also provide control tools for the arm in order to perform the required surgical intervention on the patient. Robots can be used to help in the patient care especially with handicap people who require assistance [6].

## **2.2 AI New Drug Discovery**

New drug discovery and development is a very long and costly process because it involves a lot of required scientific and administrative steps until the new drug reaches the human trials stage. The process of new drug discovery goes through several stages which is long, tedious, costly and sometimes fruitless process. This process is explained in the following stages [7]

1. Initial Research Step: In this step, research is conducted to discover how a certain disease is possible in the human body. It is crucial to understand the mechanism.
2. Initial drug discovery stage: in this stage scientists try to find the molecules that can treat the disease.
3. Preclinical stage: In this stage all the tests on the newly discovered drug is done to determine the safety and effectiveness of the drug in terms of dose and other factors.
4. Clinical Trials: In this stage the drug is tested on selected group of people.
5. Post review process: in this stage a continuous process of review is conducted and data is collected to monitor the success of the drug and discover any problems.

This process is explained in the following diagram in figure 2.



**Fig. 2.** New Drug Discovery Process [7]

Since the traditional approach to the process of new drug discovery is long and costly, new approaches had to be introduced. Artificial intelligence is a novel approach for discovering and developing new drugs. Because AI can process large amount of data, it is the ideal technology to handle the large amount of data that is related to drug discovery. The large amount of data that related to drugs contains human genetic data, different protein data, and different combinations of molecules, large clinical trials data, and all the large amount of review data [8].

The pharmaceutical industry invested a lot of resources in developing AI based systems to make the process of developing new drugs faster, cheaper, and more accurate in results. Pharmaceutical companies in the USA and China have spearheaded the efforts in using artificial intelligence in the process of discovering and developing new drugs. With the advancement of machine learning and deep learning algorithms, these pharmaceutical companies developed systems that can benefit patients and even other drug companies in the process of identifying and developing new drugs [8].

Among most known companies in China, (Insilico Medicine) is famous company based in Hong Kong. It is known for its AI technology for researching and developing new drugs and use the data in testing instead of animal trials. This company uses big data of genomics and drug data in their deep learning technology for the drug discovery process. They share technology with other drug developers [8].

The other renowned pharmaceutical company is the US (Pfizer) company. Pfizer is known for its efforts in discovering and developing many new drugs which are known in the entire world. Pfizer has adopted AI based systems in the process of discovering new drugs. The have developed advanced machine learning algorithms that can process huge amount of data and lead to new drug discovery faster, more effectively, and less costly. Pfizer is known for their efforts in rapidly developing vaccines for COVID-19 pandemic and also in developing some of the best anti-viral medicines [8].

## **2.3 AI Medical Records Systems**

Large amount of data has been collected about patients in the medical field as well as large amount of data from the healthcare systems. Data from the healthcare systems include patient information and demographics, patient history, illnesses, diagnosis, lab results, X-ray and other imaging, treatment plans, drugs prescribed, surgery information, results and outcome of the process. All this data and information could be stored in large computer systems run by hospitals and clinics. Major hospitals and clinics have developed system to run the daily operations in their facilities and departments. Systems developed for hospitals are known as Hospital Management Systems (HMS). These systems contain all the information about all parts of the hospital from patient clinics, laboratories, Imaging facilities, pharmacies, operation rooms, and administrative offices. It includes information about all doctors, nurses, medical personal as well as patient information. Managing these systems represents a daunting task and faces a lot of problems daily in terms of the size of the data, safety of the data, privacy of the data, and the use of the data to improve the daily operations of the hospital and the health system [9, 10].

Great advancements in computer technology have occurred in terms of computer processing power, storage capacity, faster communication, faster and better displays, and smaller sizes of computers. These advancements made it possible to develop hospital management systems that are better, more robust, more reliable, easier to use, and cheaper. With the introduction of artificial intelligence technology, it is possible to make these systems as intelligent system that can provide smart functionalities to all the systems users like the doctors, nurses, administrators, and the patients. The use of artificial intelligence in managing medical records provides a lot of advantages. It helps system users to organize their time and tasks more efficiently, it provides better access to the services, it helps monitor patients and services more efficiently. The large amount of health records provides an opportunity for the hospital and healthcare providers to better manage costs have better healthcare plans [9, 10].

Knowledge based systems could be an example used to improve medical management systems. Knowledge based systems use reasoning which is based on logic and rule based systems in solving problem and accumulate knowledge, and then this knowledge could be the core for intelligent systems. Medical management systems can be dealt with like knowledge based systems because of the abundance of data and information. In this process, artificial intelligence models such as fuzzy logic, artificial neural network, and genetic algorithms could be the technology used to develop intelligent medical information systems. These intelligent medical systems could be used for many purposes in the healthcare systems such predicting disease pattern, community health risks, healthcare cost analysis, etc. [10, 11].

## **2.4 AI Medical Imaging**

Since the invention of X-ray machines and the medical use of it in 1896, medical imaging has become an essential part and most important diagnostic tool used by doctors for the diagnosis of many medical conditions such as musculoskeletal illnesses. Medical imaging technology has seen huge advancements and expanded from plain X-rays to computed tomography, mammography, ultrasound, CT scan, fluoroscopy, PET scan, and nuclear medicine. Artificial Intelligence has introduced a new era of possibilities in using medical

imaging in diagnosing diseases and medical conditions more accurately and in a shorter time [12, 13].

Artificial intelligence technology such as machine learning and deep learning offers great tools for medical researchers to analyze medical images and discover abnormalities more accurately which helps the prospect of treating patients better. Medical imaging technology generates huge amount of data that requires a lot of expertise in the analysis and diagnosis of abnormalities which is difficult sometimes to be done by doctors and is prone to errors. Deep learning models which are based on artificial neural network models can provide robust algorithms to train computer models and be able to work on large amount of medical images. Artificial intelligence provides new methods for image segmentations and object detection by using sophisticated algorithms which can be used to detect objects inside medical images such as cancer tumors, blood vessels, or different abnormalities in the image. Artificial intelligence algorithms can be used to detect early signs of different types of cancer such as breast cancer, brain cancer, or lung cancer from MRI or CT scans. Another benefit of using artificial intelligence, machine learning, or deep learning in the analysis of medical images is to develop personalized treatment plan tailored specifically for a patient which helps enhances the treatment effectiveness and minimizes the risks of side effects which in return can lead to a better quality of life for patients [14, 15].

### 3 Discussion

This research paper conducts a systematic review of scientific and technical papers that covers the use of artificial intelligence applications in the medical field. The aim of the paper is to introduce the important role that artificial intelligence plays in the medical field. Artificial intelligence applications are increasingly used in many fields to benefit people. People involved in the medical field such as doctors, nurses, healthcare managers as well as patients stand to benefit tremendously from using artificial intelligence. In section two major studies that cover medical fields were presented and reviewed. Table 1 presents a comparisons of the papers reviewed in this study.

**Table 1:** Comparison of the reviewed papers

Paper Title	Year	Research Question	Methodology	Findings
History of artificial intelligence in medicine	2020	Historical perspective on the evolution of AI	Presentation of the evolution of AI from 1950 to 2020	Emphasized the importance of AI in the medical field
Application of artificial intelligence in medical technologies: A systematic review of main trends	2023	A systematic review of research into the used AI in the medical technologies.	Reviews 89 papers using PRISMA methodology.	Identified the current status of AI in the medical technologies.
Application of Artificial Intelligence in Medicine: An Overview	2021	A systematic review of research to identify the trends of AI in medicine.	Survey papers and identify major medical areas using AI	AI is used in major medical fields.
Artificial Intelligence for Medical Diagnostics- Existing and Future AI Technology	2023	A systematic review of research to define the present and future of AI in medicine	Survey papers and identify major medical areas using AI	AI is used in major medical fields.
Application of artificial intelligence in modern medicine	2023	A systematic review of research to identify the trends of AI in medicine.	The surveys identified the progress of AI in the medical field	Covered the use of AI in cancer diagnoses.
Applications of Artificial	2021	Explore and discuss the	Survey papers and	Presented major



Intelligence (AI) in healthcare: A review		various modern applications of AI in the health sector	identify major medical areas using AI	areas that use AI in medicine.
Drug discovery and development: introduction to the general public and patient groups	2023	Introducing drug discovery process to the general public	Presenting facts about how the drug discovery process work	Informative and useful study in drug discovery.
Artificial intelligence applications in medical sciences—Illustrations in pharmaceutical and medical imaging areas	2022	The Use of AI in the medical sciences especially in the pharmaceutical and imaging areas.	The surveys identified the progress of AI in the medical field	AI is used in major medical fields. Presenting major firms in US and China.
Artificial Intelligence for Health and Health Care	2017	How the systems that uses AI can assist in improving healthcare systems.	Comprehensive study of the US healthcare system	AI has a huge role in transforming healthcare system.
Knowledge and intelligent computing system in medicine	2009	Study Knowledge Bases and Intelligent computing system in Medicine.	Study of different papers from 1970 to 2008	Many methods are used in the diagnosis field.
Artificial intelligence in medicine	2004	Use of AI in analyzing complex medical data	Review of papers and medical applications	The used of AI has the potential to be used in every field of medicine.
How Artificial Intelligence Is Shaping Medical Imaging Technology: A Survey of Innovations and Applications	2023	Integration of AI in the field of medical imaging.	Study and survey of the applications of AI in the medical imaging field	AI has brought a paradigm shift in the medical imaging field.
Evaluation of Modified VGG16 Learning Model for Classifying Skin Cancer Lesions	2023	Application of deep learning methods in skin cancer classification	The use of special algorithm to classify skin cancer images.	The algorithm accurately identified skin cancer lesions.
The Role of Digital Technology and Artificial Intelligence in Diagnosing Medical Images: A Systematic Review	2021	Integration of AI in the field of medical imaging.	Study and survey of the applications of AI in the medical imaging field	Identify the major role of AI in medical imaging.
The Artificial Intelligence (AI) Application in Medicine: A Review	2022	Use of AI in medical applications	Review of papers and medical applications	The used of AI has the potential to be used in every field of medicine.

## 4 Conclusions

Artificial intelligence has become the most important field of science, engineering, and technology in recent years. AI has evolved rapidly and become more robust science and is used in many fields to solve problems and perform tasks that are difficult for humans. We see AI based applications and machines in everyday life from mobiles, to cars, websites, robots, etc. One of the important fields that benefit tremendously from using artificial intelligence technology is the medical field. Artificial intelligence is used in the medical field for diagnosis, advice treatment plans, analyse medical images, manage patient data, discover new drugs, and provide future assessment for healthcare. This research paper provided a comprehensive review for the areas that artificial intelligence is used in the medical field. It provided also the different artificial intelligence technologies and methodologies that are used in different areas in the medical field from cancer detection, illness diagnosis, medical imaging analysis, etc.

Future trends in this area of research involves identifying and cataloguing the major artificial intelligence applications in the medical field to be used as reference for researchers.



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