ARTIFICIAL INTELLIGENCE IN MEDICAL SCIENCE: EARLY LUNG CANCER CELL DETECTION USING DEEP LEARNING

Abstract

Artificial intelligence is currently playing a key and important part in medical science. The medical industry is undergoing a significant transformation due to evolution. This chapter mostly contributes to the advancement of lung cancer research. Lung cancer is the leading cause of death worldwide; due to cancer's extremely low survival rate, it accounts for roughly 18% of all fatalities. The development of artificial intelligence (AI) and machine learning (ML) techniques, as well as their applications in a variety of disciplines, have been extremely beneficial in revealing new developments in the fight against cancer. Deep learning is a crucial and developing AI approach for the creative change in the healthcare domain. A layered approach is used in deep learning, a sort of machine learning.

Keywords: Artificial intelligence, Cancer, Medical science, ML

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I. INTRODUCTION

1. **Artificial Intelligence:** A key element of modern healthcare, artificial intelligence (AI) has recently achieved tremendous advancements in computer science and informatics. In clinical settings and contemporary research, medical practitioners are helped by AI algorithms and other technologies. Artificial intelligence-enhanced computer systems are widely used in the medical sciences. Common applications include patient diagnosis, prescription transcribing, enhancing doctor-patient communication, remote patient treatment, and pharmaceutical discovery and development from start to finish. Even while computer systems usually complete tasks faster than people do, modern computer algorithms have recently reached accuracy levels in the field of medical sciences that are comparable to those of human experts. Some believe that humans will soon be fully replaced by machines. The goal of this essay is to examine how artificial intelligence is altering the field of medical science and to distinguish marketing hype from fact. AI is a broad concept that lacks a clear definition. In order to forecast or categorize items, an AI program analyzes past data [8]. The training dataset, pretreatment method, prediction model-generating algorithm, and pre-trained model—which expedites modeling and includes past knowledge—are the essential elements The study of developing methods to resolve problems without being explicitly programmed, such as decision trees (DTs), support vector machines (SVMs), and Bayesian networks (BNs), is known as machine learning (ML), a subfield of artificial intelligence (AI). A further kind of machine learning known as deep learning uses multiple layers of ML to simultaneously select features and fit models [9].

Lung Cancer: Cancer is still viewed as a hazardous disease with high mortality rates. Comparing all cancers, lung cancer has the greatest mortality rate or death rate [1, 2], and it is thought to be the deadliest carcinoma globally [3]. As a result, numerous researchers are concentrating on approaches for exploiting digital pictures, particularly Computed Tomography (CT), to detect lung cancer nodules. The use of X-rays in CT scans produces many pictures, making it difficult for radiologists to identify minute nodules from these images [4]. The fundamental task carried out by the radiologist for the diagnosis of lung cancer is the analysis and interpretation of nodules.

Numerous scientists and researchers are developing automated medical procedures that will save time and money [5–9]. The size and form of nodules, which can be classed as benign or malignant, usually provided the first indication of cancer in the majority of instances. Lung nodules less than 3 cm in diameter are typically regarded as benign nodules, but those greater than 3 cm are thought to be malignant or lung masses.

Genomic instability is a trait of lung cancer, a malignant tumour of the lungs. among 2020, 1.8 million individuals died from lung cancer worldwide [1], making it the second-most prevalent cause ocancer- related mortality among me

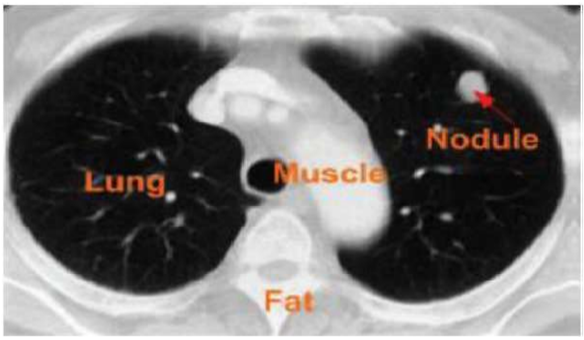

Figure 1: Lung Cancer Cell

Cancer risk can be calculated based on nodule classification and other data. The primary level identification and categorization of distinct cancer kinds is where AI approaches play a significant role [10–14]. In recent years, deep learning (DL) models have been applied in a variety of industries, such as games, agriculture, and medical [15]. DL models perform admirably in each of these areas, especially in particular applications like picture segmentation, object recognition, and image classification [16–17[DL] is an area of artificial intelligence that uses interconnected nodes to carry out challenging tasks. DL algorithms are able to learn from training data rather than using preprogrammed instructions [13]. Deep learning has previously been used by many researchers to identify cancer [18–20].

Table 1: Cancer Cases

S. No.	Type of Cancer	Total cases (in millions)
1	Breast	2.26
2	Lung	2.21
3	Colon and rectum	1.93
4	Prostate	1.41
5	skin (non-melanoma)	1.20
6	stomach	1.0

Due to evolution and different treatments lung cancer is classified in 2 categories:

- **Non Small Cell Carcinoma (NSCC):** Most of the people who are having lung cancer have NSCC. Peoples having more than 65 years age and who smoke or who breathe a lot of smoke are most likely to get non small cell carcinoma.
- **Small Cell Carcinoma (SCC):** In small cell carcinoma cells of the lung start growing rapidly in an uncontrolled manner

Standard medical images are used as part of a multi-stage procedure called radiomics that aids in clinical diagnosis and prognosis. High-throughput quantitative feature extraction was defined by Gillies et al. [21] as "the conversion of images into mineable data and the subsequent analysis of these data for decision support." To identify or track a problem, radiologists and doctors might use a tool called computer-aided diagnosis (CAD) to analyze diagnostic imaging data. Imaging techniques like computed tomography (CT) scans, magnetic resonance imaging (MRI), positron emission tomography (PET), X-rays, and others are used in both radiomics and CAD. On the other hand, radiomics, a branch of computer-aided design (CAD), uses high-dimensional features collected from medical pictures to interact with clinical outcomes, build models for testing hypotheses and decision-making[22].

Despite the fact that radiomics can be utilized for any ailment, the National Cancer Institute (NCI) and the Quantitative Imaging Network (QIN) have sponsored the development of radiomics in the field of cancer. In the Radiomics workflow, patient images are gathered, regions of interest are found and recovered (Segmentation), high-dimensional features are created from the segmented area, and machine learning models are then used for classification or prediction. We gather medical images that adhere to a patient's standard of care. From the patient imaging, one or more areas of interest (ROI) are chosen. The ROI may very well be represented by the main tumor or a tiny tumor within it (referred to as a habitat). The ROI can subsequently be used to derive high-dimensional, deep radiomics, or semantic attributes..

Shape, size, margin, speculation, boundary, and external characteristics, such as pleural attachment and fissure attachment, all appear to be characterised in terms of semantic elements; shape characteristics include lobulation, concavity, and the like; size characteristics include long-axis diameter and short-axis diameter. An expert radiologist described semantic features of the ROI that provide important details about tumour characteristics [23].

2. Identification of Lung Carcinoma

The identification of lung cancer is made in the following ways:

- History and Physical examination
- Diagnostic tests
- Staging tests

  - chest X-ray It is the first imaging technique to look for lung cancer. Nodules greater than 1 cm are frequently visible on X-ray images. In the event that the chest X-ray exhibits any irregularities, patients may be advised to undergo staging testing.
  - X-rays X-rays are produced by the radiation emitted by electromagnetic waves. As the images are being created, X-rays are used to highlight interior body regions. Radiation varies in different places of the body because different tissues absorb radiation in different ways.
  - Computed tomography, or CT Computed tomography, commonly known as CAT or computerised axial tomography (CT), is frequently used in image processing techniques. The benefits of CT are numerous.
  - Radiography Similar to X-rays, radiography is a highly general term. The two radiographic image types employed in medical imaging are fluoroscopy and projection radiography. This imaging technique, the first one offered in modern medicine, takes pictures using a wide x-ray beam.

The amount of metastases is evaluated via a PET scan, commonly referred to as positron emission tomography. The term "metastasis" refers to the initial malignancy spreading from one organ to another. PET scanning is a recent technological advancement.

- Magnetic-resonance imaging A big magnet is used in MRI scans to create 3-D images. Any region in particular that could not be well interpreted on a CT scan can be studied using MRI. Examining the participation of cancer cells with MRI is helpful. Brain tumour identification often involves the use of a magnetic resonance imaging technique. When a nuclear magnetic resonance (NMR)
- Sonographic images Medical imaging creates images by using high-frequency, wide-band sound waves in the Megahertz (MHz) range that are reflected differently by tissue.

Identification of the Lung Carcinoma Problem Radiologists retrospectively review lung scans for indications of cancer. The region of interest that is not suspicious enough to recall can be used to spot an anomaly in photos. When radiologists handle lung pictures, there are two basic issues that arise. The radiologist may have overlooked the symptom and not given it any attention, which is the first potential issue.

The second scenario involves looking at the indicator but deciding it is innocuous, typical, or not worrisome enough to warrant further investigation. In addition to these issues, there are further difficulties with mass detection.

They are listed as follows:

- The intensity levels in different lung areas vary substantially, making it challenging to define characteristics for segmentation.
  - The grey level segmentation is challenging due to subtle variations in grey level across the image.
  - Tumours are sometimes difficult to see.
  - The image's poor lighting and significant noise levels, which can range from 10-15% of the maximum pixel entity.

following breast cancer, the leading cause of cancer-related death in women. Annual low-dose computed tomography (CT) screening decreased lung cancer mortality by 20% compared to chest radiography, according to the National Lung Screening experiment (NLST), a randomised control experiment including more than 50,000 high-risk patients in the United States [1]. As a result, low-dose CT scanning initiatives have started to be implemented in the US and other countries. It's one of the most challenging features of CT for radiologists to evaluate so many images. There could be up to 600 slices in a CT scan. The analysis of such massive amounts of data presents a considerable problem for radiologists.

II. ROLE OF DEEP LEARNING

Artificial intelligence (AI) is the process of using computers and technology to mimic human-like intelligent behaviour and critical thought. The term was first used by John McCarthy in 1956 [1]. Additionally, it gives us the ability to assess and grasp complex medical data, aiding in diagnosis, management, and the prediction of treatment outcomes across a range of clinical presentations. The medical sector could undergo a fundamental transformation thanks to artificial intelligence. Because of the accessibility of digital data, machine learning, and computer infrastructure, AI applications have been able to expand into fields that were previously believed to be unachievable with Radiography is a key area for the early use of AI techniques in the medical industry, claims Tang. It is anticipated that the use of AI will considerably increase the breadth, quality, and value of radiology's contribution to patient care and public health over the coming ten years. Workflow for radiologists is anticipated to alter and evolve significantly. One class of representation learning methods called deep learning uses picture data to learn hierarchical feature representation. Deep learning has the benefit of being able to produce high level feature representations straight from the original image data.

Additionally, parallel architectural deep learning approaches have improved accuracy in many sectors recently, including image identification, object detection, and speech recognition, with the use of Graphic Processing Units (GPUs). For instance, current research indicates that CNNs deliver guaranteed performance in cancer diagnosis and detection [18].

1. **Deep learning Approaches:** The most popular unsupervised learning techniques in medical pictures are convolutional neural networks (CNN), deep convolutional neural networks (DCNN), and recurrent neural networks (RNN). Given that it requires minimal pre-processing, CNN architecture is one of the most used supervised deep learning algorithms for lesion segmentation and classification. Recently, medical image classification and segmentation have been carried out using CNN designs including Mask R-CNN, AlexNet, and VGGNet. DCNN designs often include more layers and complex nonlinear interactions, and they have been demonstrated to perform regression and classification with decent accuracy [44,45,46]. An RNN-designed higher-order neural network can support network output to re-input [20]. RNN applies the Elman network with feedback links from the buried layer to the reinforcement learning technique for the first time. Due to their exceptional performance, convolutional neural networks (CNNs) have lately grown in prominence in the machine learning sector.[22,23] Neurons with programmable weights and biases make up CNNs. This method is based on the artificial neural network (ANN) structure, which was modelled after the biological neuron. The fact that CNNs learn filters on their own gives them an advantage over conventional neural networks. The learnable filters that make up the CNN layer parameters enable the system to adapt to new problems. These filters use a convolutional method to extract spatial information from the incoming data. Because of this, CNNs excel at a variety of tasks, including object detection, video analysis, speech recognition, natural language processing, and medical image analysis. But in order to prevent overfitting,

2. **Convolutional Neural Networks:** A CNN has been arranged in the form of the layers.

   - ReLU layers

- Convolutional layers
- Pooling layers
- a Fully connected layer

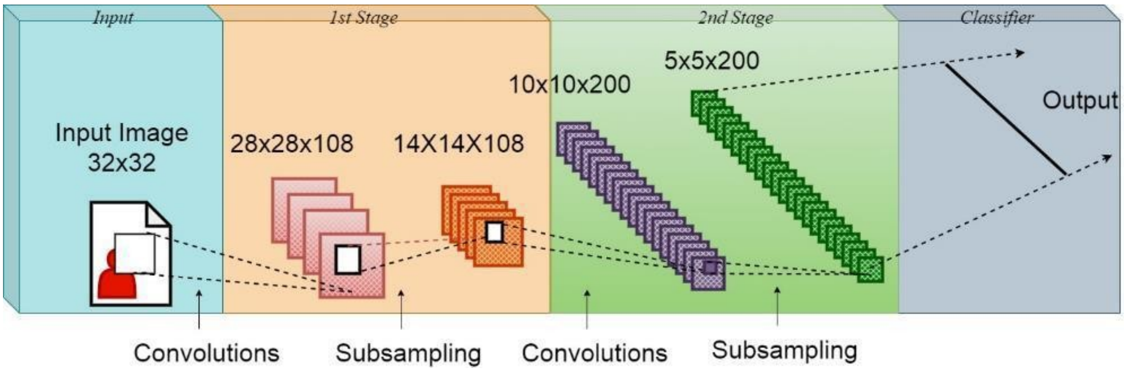

Figure 2: Convolutional Neural Networks

- **Convolutional Layer:** The primary goal of this convolution phase is to concentrate the highlights in the data image. Consistently, CNN starts with the convolutionary layer. The features are extracted from the input image in this procedure, and a feature map is created.
- **ReLU:** The straight redressed unit layer comes after the convolution layer. Here, the feature maps are used to implement the enactment function, which increases the non-linearity in the network and makes it simple to remove negative values.
- **Pooling Layer:** The size of the input can gradually be decreased by the pooling process. The pooling stage can reduce overfitting. By increasing the amount of parameters required, it will quickly identify the necessary ones.[24]
- **Fully Connected Layer:** Here are all the traits and their matched attributes. It is possible to use the classification approach with significant percentile imprecision. The primary methods of measuring and recording the inaccuracy
- **Softmax Layer:** To convert the abnormal network activity over expected performance groups to a probability distribution in neural grids, softmax is also used. The Softmax has been used to solve numerous problems in numerous academic domains. The decimal's probability will imply 1.0. Consider the related Softmax versions, such as Full Softmax, which has the ability to determine the chance of each potential class. To categorise the images, CNN employs successive convolutional and pooling layers.

The CNN's pooling layer decreases the dimension and categorises the object without respect to its spatial information, or where the object is actually situated in the image. The benefit and the disadvantage of CNN's pooling feature are both present. Some crucial information that is crucial for object detection and image segmentation is lost during the pooling operation[25].

CNN is having pretrained networks and transfer learning which again improves the system performance in terms of accuracy, precision, recall, F1 score.

III. CONCLUSION

This chapter covers the importance of AI in medical science related to detecting lung nodule in early stages. The traditional methods for lung cancer cell detection and their pitfalls.The advancement of AI like Machine learning, Deep Learning how these approaches helping the radiologist, doctors and finally to the patients to survive. Deep Learning approaches like Convolutional Neaural Networks, Recurrent Neural Network, LSTM has a great impact in medical field. CNN is preferred most for lung cancer cell detection and classification process, whether the cell is benignant or malignant.

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