International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING

ISSN:2147-6799 www.ijisae.org Original Research Paper

Lung Cancer Detection and Recognition using Deep Learning Mechanisms for Healthcare in IoT Environment

Anna Shalini[1], Dr. A. Pankajam[2], Dr. Veera Talukdar[3], Dr. S. Farhad[4], Mr. Gokul Talele[5], Elangovan Muniyandy[6], Dharmesh Dhabliya[7,*]

Submitted: 24/10/2023 **Revised**: 17/12/2023 **Accepted**: 25/12/2023

Abstract: The use of machine learning in IoT-based healthcare applications has emerged as a prominent field of study, particularly in the realm of predicting chronic diseases. There is a general consensus among individuals that melanoma is regarded as most lethal illnesses. In order to enhance the probability of achieving a cure prior to the onset of cancer, a meticulous classification of lung lesions at their first stages might potentially facilitate the deliberation of therapeutic interventions. Body parts that are often exposed to the deleterious effects of direct sunlight have an elevated susceptibility to the development of lung cancer. However, it may also appear in places of your body that are seldom exposed to air and light, such as your hands, feet, and other areas. To provide algorithms for detection and classification, deep learning has been widely employed as a subfield of machine learning. In this investigation, the deep learning approach is being examined as a way to identify Lung cancer more quickly and accurately. Accuracy metrics including recall, precision, and f1-score were enhanced using hybrid deep learning models, while compression operations were applied to boost speed. People living in the Internet of Things era may benefit from constant, real-time Lung health monitoring. Lung cancer detection and identification inside the IoT has tremendous potential for improving healthcare and preventative methods as ML algorithms continue to advance and acquire access to huge datasets.

Keywords: *IoT, Machine learning, Lung cancer, Accuracy, Performance, CNN, F1 score, recall, precision.*

1. Introduction

Breast cancer is a formidable health concern that primarily affects women but can also occur in men. This form of cancer originates in the cells of the breast and can manifest as a malignant tumor. The disease is marked by uncontrolled growth and division of abnormal cells within the breast tissue, often forming a lump or mass.

Breast cancer is a complex and diverse condition, with various subtypes that may behave differently and require tailored approaches to diagnosis and treatment. Early detection through regular screenings, such as mammograms, plays a crucial role in improving outcomes, as treatment options are more effective in the initial stages. Beyond its physical impact, breast cancer also carries significant emotional and psychological challenges for individuals and their families. Research and awareness campaigns continue to drive progress in understanding, preventing, and treating breast cancer, emphasizing the importance of comprehensive healthcare strategies to address this widespread public health issue.

The convergence of deep learning mechanisms and IoT in realm of healthcare has ushered in a new era of innovation, particularly in domain of lung cancer detection and recognition. A subset of artificial intelligence, demonstrates a remarkable ability to analyze intricate patterns within vast datasets, making it an ideal candidate for enhancing the accuracy and efficiency of medical diagnostics. In the context of an IoT environment, where medical devices and sensors seamlessly communicate and share real-time health data, the potential for revolutionizing lung cancer detection is substantial. This integration allows for continuous monitoring through wearable devices and smart sensors, creating a dynamic ecosystem that can significantly contribute to early detection and personalized treatment strategies. As we navigate the evolving landscape of healthcare, the fusion of deep learning mechanisms with IoT holds great promise for improving the precision and timeliness of lung cancer diagnosis, ultimately leading to enhanced patient outcomes and more effective healthcare

[1]Research Scholar, Department of English, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India Email: 193240011@kluniversity.in

[2]Associate Professor, Department of Business Administration, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India Email: ambipankaj@gmail.com

[3]Professor, Department of Computer Science, D Y Patil International University, Akurdi Pune, Maharashtra, India Email: bhaskarveera95@gmail.com

[4]Associate Professor, Department of English, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India Email: farhad.anu21@gmail.com

[5]Research Scholar, Department of Data Science, IIIT Banglore, Karnataka, India Email: gokul.talele@iiitb.net

[6]Department of Biosciences, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India Email: muniyandy.e@gmail.com

[7]Professor, Department of Information Technology, Vishwakarma Institute of Information Technology, Pune, Maharashtra, India Email: dharmesh.dhabliya@viit.ac.in

** Corresponding Author Email: dharmesh.dhabliya@viit.ac.in*

delivery.

Breast cancer is malignant form of cancer that is well recognised as a significant worldwide health issue [1-3]. Enhancing the probability of achieving a cure for cancer may be facilitated by accurately classifying lung lesions at their first stages, hence impeding their development. This is due to the potential for reliable classification of early-stage lung lesions. There is an increased propensity for the development of lung cancer in regions of the body that often encounter the detrimental consequences of direct sunlight exposure [4-9]. Males exhibit the presence of hair follicles on their heads, faces, lips, and ears, while females possess them on their chests, arms, and hands. Both genders share the characteristic of having hair follicles on their legs. Nevertheless, it may also manifest in obscure and concealed regions, such as the hands, which experience little air circulation and light exposure, as well as the feet and several other bodily regions. If an individual often conceals certain regions of their physique, it is plausible that this phenomenon may occur [10-15]. This presents a potential scenario. The objective of study is to investigate potential of DL techniques in enhancing efficiency and precision of lung cancer diagnosis, as compared to existing methodologies. Previous studies shown use of compression procedures has potential to enhance performance. Additionally, the utilisation of hybrid deep learning models has been found to improve accuracy measures as indicated by many references [16, 17, 18, 19].

Breast cancer is a pervasive and complex disease that affects the cells in the breast tissue, predominantly in women but also, albeit rarely, in men. It is characterized by the uncontrollable growth of abnormal cells that form a lump or mass within the breast. Breast cancer is not a singular entity; rather, it encompasses a spectrum of subtypes, each with unique characteristics and behaviors. The condition can originate in different parts of the breast, such as the milk ducts or lobules, and may have varying levels of aggressiveness. Early detection is pivotal in the management of breast cancer, and routine screenings, including mammograms, play a crucial role in identifying the disease at its earliest and most treatable stages. Beyond the physical implications, a breast cancer diagnosis often has profound emotional and psychological impacts on individuals and their support networks. Ongoing research and awareness initiatives strive to enhance our understanding of breast cancer, improve prevention strategies, and advance treatment options, underscoring the collective effort to combat this significant public health challenge.

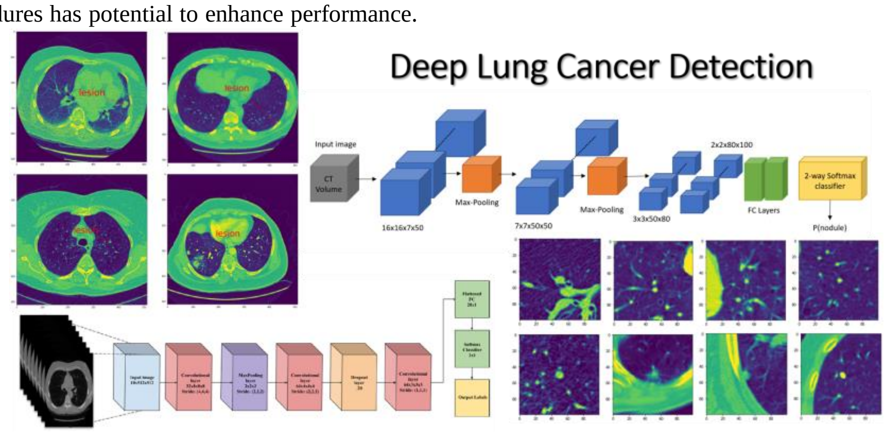

Fig. 1. Lung Cancer Detection and Recognition using deep learning

The application of deep learning in the detection and recognition of lung cancer represents a promising frontier in medical research and technology. With its ability to analyze complex patterns and vast datasets, deep learning, a subset of artificial intelligence, offers innovative solutions to enhance the accuracy and efficiency of lung cancer diagnosis. Deep learning algorithms can be trained on diverse medical imaging data, such as computed tomography (CT) scans and X-rays, enabling them to identify subtle anomalies indicative of lung cancer at early stages. This early detection is critical for improving patient outcomes, as timely intervention and treatment significantly impact survival rates. The integration of deep learning models in lung cancer recognition not only expedites the diagnostic process but also reduces the likelihood of false negatives and positives. As the field of medical imaging continues to evolve, the synergy between deep learning and lung cancer detection holds great promise in revolutionizing how we identify and address this formidable disease, contributing to more effective and personalized healthcare interventions.

Intricate patterns and characteristics in these photos that may be invisible that may be extracted by ML models, namely by deep learning techniques like CNNs. [20, 21, 22, 23] Using a technique called computer-aided diagnosis (CAD), ML systems may help dermatologists and other medical professionals determine whether Lung lesions are benign [24]. Improvements in the accuracy and efficacy of ML algorithms for lung cancer identification when they are exposed to more data and learn from a wider variety of cases provide a viable path for early intervention and better patient outcomes in dermatology and healthcare more generally.

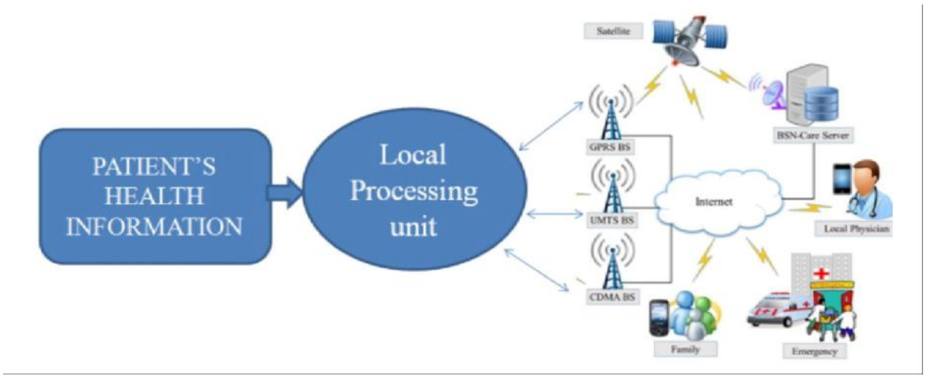

Fig. 2. IoT Based Healthcare system

In an IoT setting, Lungcancer detection and identification are being completely transformed by machine learning (ML) [25]. Images of Lunglesions may be analyzed with great accuracy using ML techniques, in particular convolutional neural networks (CNNs), when used with IoT devices sporting high-resolution cameras and sensors [26,27,28]. ML models have been trained on a wide variety of dermatological datasets to discover subtle patterns and traits suggestive of Lungcancer [29].

The integration of healthcare with the Internet of Things (IoT) has ushered in a new era of technological advancement, offering transformative solutions to improve patient care, streamline processes, and enhance overall efficiency within the healthcare ecosystem. In an IoT environment, medical devices and sensors are interconnected, enabling the seamless collection and exchange of real-time health data. This interconnectedness allows healthcare professionals to remotely monitor patients, track vital signs, and receive instant alerts in case of anomalies or emergencies. Wearable devices, smart implants, and connected medical equipment contribute to the creation of a comprehensive and dynamic health monitoring system. The utilization of IoT in healthcare not only facilitates early detection of health issues but also supports preventive care and personalized treatment plans. Moreover, the integration of IoT technologies enhances data analytics, providing valuable insights for medical research and healthcare management. While the adoption of IoT in healthcare presents immense opportunities for innovation, it also raises important considerations related to data security, privacy, and interoperability that require careful attention to ensure the responsible and effective implementation of these technologies in the evolving landscape of healthcare.

The intersection of deep learning mechanisms and the Internet of Things (IoT) in healthcare has paved the way for significant advancements in the detection and recognition of lung cancer. Deep learning algorithms, a subset of artificial intelligence, are well-suited for analyzing complex medical data, such as imaging scans, and can be employed to identify subtle patterns indicative of lung cancer at early stages. In the context of an IoT environment, medical devices and sensors are interconnected, enabling the seamless collection and transmission of real-time health data, including imaging information crucial for lung cancer diagnosis. This interconnected ecosystem allows for remote monitoring of patients, facilitating prompt detection and timely intervention. Wearable devices and smart sensors contribute to continuous health monitoring, offering a proactive approach to lung cancer detection.

The integration of deep learning mechanisms in an IoT healthcare environment not only enhances the accuracy of lung cancer diagnosis but also supports personalized treatment plans. Real-time data analytics enable healthcare professionals to make informed decisions, and the seamless flow of information contributes to more efficient and patient-centric care. However, the implementation of such technologies necessitates careful consideration of data security, privacy, and interoperability challenges. As the synergy between deep learning and IoT continues to evolve, it holds substantial promise for revolutionizing lung cancer detection and recognition, ultimately contributing to improved outcomes and enhanced healthcare delivery.

1.1. Applications of technology in healthcare

Medical record storage and retrieval through electronic means; concerns about the security of medical records have been allayed; health information handling; genome management in the clinic; and monitoring the information contained within electronic health records are just a few examples of how technology can enhance healthcare.

Currently, EHRs may only be used by one organization or network, which limits their owners' ability to make upgrades or share them with others. Such an arrangement of data is not out of the question; the first few blocks of the blockchain may include either non-PHI or PII data. A future when companies and researchers have access to populations in the millions is not out of the question. Data on public health, safety, and clinical research reporting might face serious consequences in today's healthcare systems. Additionally, these technologies enable seamless transitions between healthcare practitioners for patients. Institutions and individuals might theoretically exchange private keys to decode and transfer encrypted medical records stored on the blockchain. This bodes well for HIT's potential to improve its capacity for cooperation and interoperability.

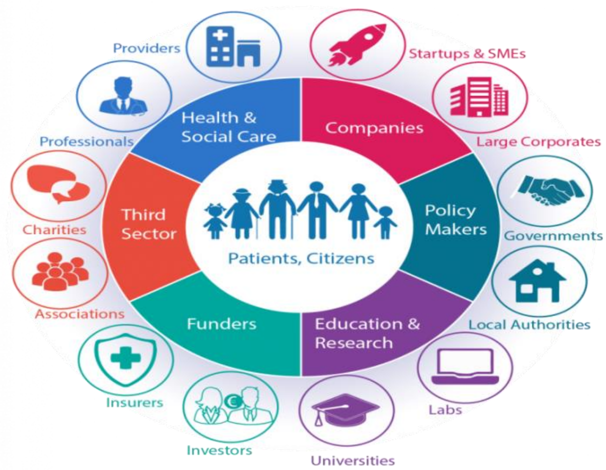

Fig. 3. Healthcare Ecosystem

Improved, less expensive, and more efficient patient care is impossible without such systems. A centralized database may hold patients' medical records, which are updated on a regular basis by authorized professionals. Multiple doctors treating the same patient may avoid making mistakes if they avoided exchanging patient information. This would allow for more individualized care for patients.

A health care system manages interoperable electronic medical records. Assuming the blockchain keeps using the same data set and keeps secure encrypted links to additional data, it should be easy to make a single layer of transactions accessible. It may be simpler to keep devices linked to networks if standard authorization processes and smart contracts are implemented.

1.2. Machine learning

The major goal of machine learning research is to develop "learning" techniques, which are processes that enhance performance on a set of tasks by using data. Everyone knows this is a part of artificial intelligence. In order for ML algorithms to build a model and then draw conclusions or make predictions, they need training data. Machine learning algorithms are used in several domains such as computer vision, voice recognition, email filtering, and more when it becomes too difficult or impractical to create bespoke algorithms to do certain tasks. Machine learning (ML) has close ties to computer science (CS), which is concerned with the use of computers to generate predictions; statistical learning is only a subset of ML. Mathematical optimization research has the potential to provide theoretical foundations, practical applications, and analytical tools that machine learning may use. Data mining is a multi-faceted discipline that uses unsupervised learning to investigate massive databases in an exploratory fashion. When it comes to information and NN, some ML programs mimic human brain function to a surprising degree. One term for machine learning is predictive analytics, and it's finding more and more applications in helping businesses with their challenges.

1.3. Role of Machine learning for health care

The goal of machine learning (ML), a branch of artificial intelligence, is to increase precision and efficiency in healthcare operations. The need of ML in healthcare is being assessed in this research. This study focuses on the most important uses of ML in healthcare and delves into those uses. The potential of ML-based technology to improve healthcare systems overall, expand treatment choices, and provide more personalized care is a hot topic in the research community. In order to get the best outcomes, personalized treatment plans, clinical decision support systems, disease diagnostics, and other machine learning (ML) healthcare applications will become more vital in the future.

2. Literature review

There are a number of studies that have been carried out on lung cancer, and some of these researches are given and discussed in this section.

The use of a machine learning algorithm to the diagnosis and classification of lung cancer was taken into consideration by A. Mishra and colleagues (2023). There are a number of domains in which deep learning has been shown to be particularly effective, including medical image processing, nodule detection and classification, feature extraction, and lung cancer stage prediction [1].

At the time of the diagnosis of lung cancer, DL was presented by M. Sangwan and colleagues (2023). Deep learning techniques were going to be used in the research project to examine radiography images in search of indications of lung cancer [2].

It was M. Dirik and colleagues (2023) who first presented the concept of utilizing machine learning to diagnose lung cancer. One of the primary goals of the research was to enhance the speed and accuracy with which novel scenarios may be examined [3].

This article is a simplified version of an introduction to CNN in radiology that was provided by R. Yamashita and colleagues (2018). There were two hurdles that were discussed in this article. These concerns were a limited dataset and the possibility of overfitting. The paper would then provide solutions to these problems [4].

Machine learning approaches were used in the study that was conducted by A. Saha and colleagues (2023) on the segmentation and prognosis of lung cancer. Within the context of CT lung cancer diagnosis, researchers were investigating a number of different disease detection methodologies [5] in order to improve the accuracy of CAD systems.

The researchers Yu et al. (2019) were able to recognize melanoma in dermoscopy images and identify it automatically. In order to address problems about degradation and overfitting, which often become more prominent as the depth of a network increases, they make use of residual learning as the first phase in the process [6].

J. Yanase and colleagues (2019) proposed the concept of computer-aided diagnostics in the field of medicine. This paper addresses some recent research accomplishments that have been achieved in the direction of these issues, and it offers a discussion of those accomplishments. [7]

Y. Yuan and colleagues (2019) focused their attention on how to improve dermoscopy image segmentation by using CNN and DCNN. For the sake of this investigation, they have developed a more intricate network design that has smaller kernels in order to enhance the discriminating power of their work. [8]

In the year 2020, Y. N. Fu'adah and colleagues reported their research efforts about the development of an automated lung cancer classification system that takes use of a CNN. It is [9].

DL techniques for identifying lung cancer were the primary emphasis of M. Aharonuet al.'s (2023) research report. The existing DL approaches for detecting lung cancer were subjected to a comprehensive examination that they carried out [10].

Deep learning and feature analysis of CT and histopathological pictures were applied by V. Rajasekar et al. (2023) in order to provide the illness prognosis in lung cancer [11].

S. Wankhade and colleagues (2023) introduced a novel hybrid deep learning strategy that was created for the diagnosis of lung cancer utilizing neural networks. The CCDC-HNN was a novel technique that was suggested in this research for the purpose of early and accurate detection [12].

A research was carried out by F. W. Alsaade and colleagues (2021) that investigated the use of artificial intelligence algorithms in the process of developing a lung lesion detection system for the purpose of detecting melanoma. Both cutting-edge deep learning algorithms and more conventional artificial intelligence machine learning methodologies were used in the development of the suggested solution. [13]

The neutrosophic and DL methods were proposed by S. Banerjee and colleagues (2021) as potential techniques to the diagnosis of melanoma lesions [14].

Shawon et al. (2021) were able to make a prediction about the likelihood of acquiring lung cancer, and a computer-assisted lung cancer detection method that is based on CNN has been shown to be successful. [15]

As highlighted by Toh et al. (2021), who zeroed emphasis on the healthcare sector and the vast amounts of data made available by the IoT, machine learning methods are being used to enhance patients' lives. There are exciting new opportunities and formidable new challenges that arise from using these strategies. Many areas of medicine rely on machine learning, including natural language processing (NLP), medical imaging (GI), and medical literature (MI). Accurate diagnosis, detection, and prediction of outcomes are vital to many of these fields. Even though there is a wide network of medical devices that generate data nowadays, the infrastructure required to effectively use this data is often absent. The large range of medical data formats increases the potential for background noise and makes formatting and analysis more challenging. This article provides an overview of machine learning (ML) in healthcare, including its current state, brief history, and essentials. [21]

It was critical to apply the technology responsibly, as Ozaydin et al. (2021) introduced, since the usage of ML—a branch of AI—in healthcare has been rapidly rising in recent years. Some of the most prevalent criticisms of ML approaches are addressed in this article, along with potential remedies. These solutions include topics like as bias, model performance tracking, and "black box" systems. It is possible that some of these problems may be solved using ML approaches. They argue that increased physician involvement in the creation, assessment, and ongoing monitoring of ML applications in healthcare is necessary to maximize the advantages while reducing its hazards.[22]

At the Microsoft Research Toronto Lab, Ghassemi et al. (2020) offered assessments of the challenges and opportunities in medical ML. Modern EHRs gather data that may be examined in many ways, allowing for the solution to queries having clinical value. Healthcare is a perfect environment to use machine learning due to the ever-increasing amount of data collected in EHRs. Clinical learning has its own unique challenges that make it harder to use traditional machine learning approaches. Mislabeled diseases, illnesses with several underlying endotypes, and an underrepresentation of healthy individuals are all issues plaguing electronic health record systems. To help readers better understand these challenges and the potential contributions that the machine learning community may make to the medical industry, this article serves as a primer [23].

Medical treatment and machine learning were both advanced by Char et al. (2018). They need to resolve the ethical issues that come up with machine learning before we can enjoy its benefits in healthcare [24].

Potential, risks, and new approaches to deep learning in healthcare were presented by Nisar et al. (2021). Among the many medical applications of deep learning that will be covered in this article are the detection of breast cancer lymph node metastases, mental health disorders, and other similar conditions. Brain, heart, and lung conditions are categorized here. Key criteria are used to generate comparison tables once each group's findings have been summarized. Data, software, hardware, and methods are only few of the many resources used by DL models. Lastly, we go over some of the barriers that deep learning models face right now and where we think research should go in the future [25].

When it came to healthcare machine learning, Seneviratne et al. (2020) supplied the missing pieces. Machine learning algorithms have lately outperformed human physicians on clinical data. 1-3 Thanks to the widespread availability of big data repositories, the widespread use of standard data formats, and the remarkable effectiveness of convolutional neural networks, Radiologists, pathologists, and dermatologists have been at the forefront of this movement. Utilizing electronic health records (EHRs), -omics, and data supplied by patients, very precise diagnosis and prediction algorithms have been created. 4 Public anxiety over the future of medicine is evident in editorials like "The AI Doctor Will See You Now" and similar ones. 5 Among experts in the field, there is a more complex consensus: In due time, doctors who use AI will supersede their human colleagues.[26]

Analyzing AI's function in healthcare was the focus of Wiring et al. (2020). There is a widespread belief that artificial intelligence (AI) and machine learning (ML) may uncover hidden patterns in the massive amounts of data generated by medical treatment on a daily basis, therefore revolutionizing the healthcare system. The use of these advancements is expected to significantly raise the bar for patient care. For artificial intelligence and machine learning to grow, the regulatory and legal landscape must be favorable. This chapter will define artificial intelligence (AI), explain how it works, and go over some of the benefits it might bring to healthcare and the life sciences. Surgical robots, clinical trials, and diagnostics are just a few of the many healthcare AI applications covered. This chapter provides a thorough analysis of the primary legal obstacles related to AI in healthcare, as well as proposed solutions to these issues. Among these difficulties are concerns with the regulatory system as a whole, product responsibility, the protection of intellectual property rights, and reimbursement [27].

The authors continued their research on the positive effects of AI applications and health data sharing [28, 29]. Several studies have considered using automated ML and DL for predictive analysis in healthcare and clinical note analysis [30, 31].

3. Problem statements

While the integration of deep learning mechanisms and IoT in lung cancer detection presents exciting prospects, it also introduces several critical issues that demand careful consideration. One significant concern revolves around data security and privacy. The interconnected nature of IoT devices and the transmission of sensitive health information raise potential risks of unauthorized access and breaches, emphasizing the need for robust encryption and cybersecurity measures to safeguard patient data.

Another challenge lies in the standardization and interoperability of diverse medical devices and data formats within the IoT ecosystem. Ensuring seamless communication between different devices and systems is essential for the effective integration of deep learning models, requiring the establishment of common standards across healthcare platforms. Additionally, the ethical implications of utilizing deep learning algorithms for healthcare decisions, particularly in the context of potentially life-altering diagnoses like lung cancer, raise concerns about transparency, accountability, and the need for a human-centric approach.

Addressing these issues is crucial to harness the full potential of deep learning in an IoT healthcare environment for lung cancer detection while prioritizing patient privacy, data integrity, and ethical considerations. There have been several studies conducted on the topic of Lung cancer detection, the usual research effort has been plagued by inefficiencies and a lack of accuracy [21-24]. To reduce total size of the image collection, photo compression is required. It could help shorten the time spent on training and testing [25, 26]. Moreover, the image quality must be improved to raise the level of precision. It has been shown that a hybrid strategy may improve efficiency and quality [27-30].

4. Proposed Work

In the work that has been given, the currently used model includes a training phase in which a dataset for the detection of Lung cancer is taken into consideration for training purposes. At this point, the dataset is being preprocessed to resize the photographs and compress those images via the use of the Huffman approach. Before the beginning of the real processing, this stage will take place. After the data has been preprocessed, a hybrid model that is recommended that uses compression and noise removal with the CNN model to get a more accurate result. This model takes into account both of these models. Figure 2 presents the process flow of research work by considering the multiple sets as shown below.

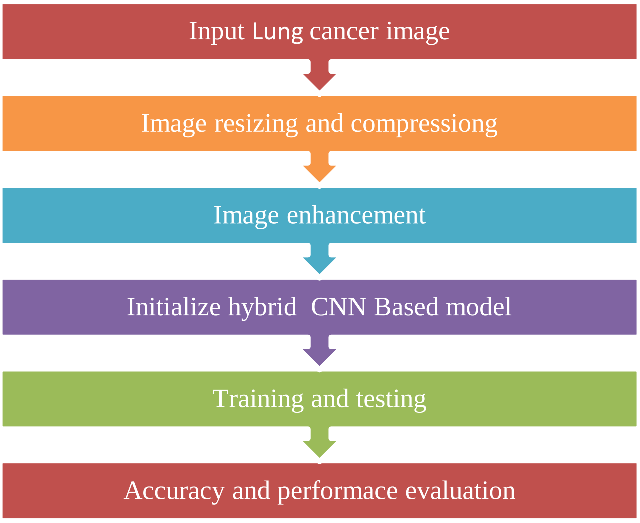

Fig. 3. Process flow of proposed work

Within the confines of this investigation, we compared and contrasted two separate CNN models to ascertain which of the two would perform better when it came to the categorization of images displaying Lungcancer. In the end, we were able to successfully train a CNN, which resulted in correct predictions being obtained by us. The image set is passed to the training model to make it understand whether the candidate is authentic or not. Then testing is applied over the dataset to assure accuracy of proposed hybrid CNN based model.

Figure 4 shows the Proposed Hybrid CNN Model in which multiple blocks are to be considered.The hybrid CNN model is the name that we give to the hybrid model that we built for categorizing photographs of lung cancer. As a component of this scientific endeavor, it was conceived and created. Even while prior studies employed the Conventional CNN approach, the researchers didn't invest much effort into figuring out how to increase the overall effectiveness of the models. Even though these studies were responsible for an increase in accuracy, there is still room for improvement speed with which training, testing, and validation may be carried out. During classification and prediction confusion matrix is produced. The accuracy parameters are calculated.

Accuracy: It is useful heuristic for judging quality of training that a model has received as well as the possibility for the model's future performance.

$$\text{Accuracy} = \frac{\sum \text{TP+TN}}{\sum \text{TP+TN+FP+FN}} \quad (1)$$

Precision: It measures how often a model produces true positive predictions.

$$\text{Precision} = \frac{\sum \text{TP}}{\sum \text{TP+FP}} \quad (2)$$

Recall: It is a metric used to evaluate its efficacy; recall is proportion of predictions made.

$$\text{Recall} = \frac{\sum \text{TP}}{\sum \text{TP+FN}} \quad (3)$$

F1 Score: In the discipline of ML, models are scored using the F1 score. It combines the precision and dependability of a model.

$$\text{F1} = 2 \times \frac{\text{precision} \times \text{recall}}{\text{precision+recall}} \quad (4)$$

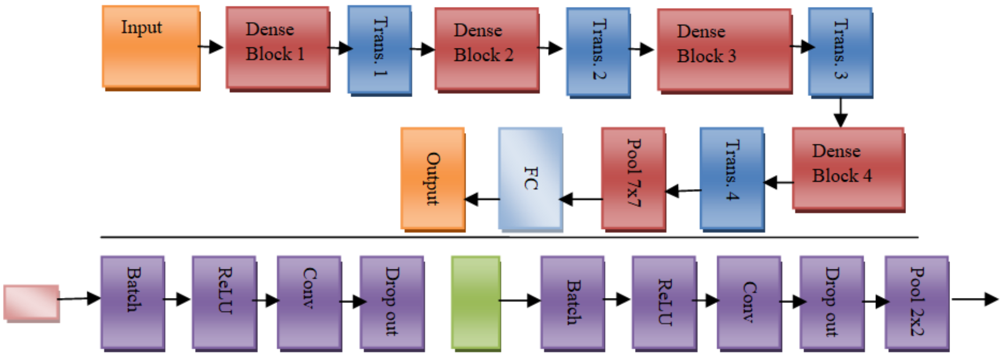

Fig. 4. Proposed Hybrid CNN Model

5. Result and Discussion

Data on lung cancer cases were gathered over course of three months in the autumn of 2019 at aforementioned IQ-OTH/NCCD specialized institutions.

It features CT images from lung cancer patients at various stages. Oncologists & radiologists from these institutions annotated IQ-OTH/NCCD. There are a total of 1190 pictures in the dataset, each depicting a section of a CT scan for one of the 110 patients (see in Figure 4).

Dataset have been collected from

https://www.kaggle.com/datasets/adityamahimkar/iqothnccd-lung-cancer-dataset.

Following completion of the training, a testing operation was carried out to get the confusion matrix, which is shown in the following section.

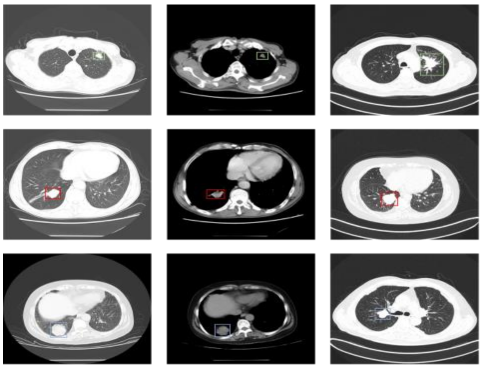

Fig. 5. Lung cancer images

5.1. Accuracy of DL during classification of lung cancer images

This part is going to concentrate on the deep learning aspect of the proposed study, which is where the confusion matrix will be discussed after testing as shown in Table 1.

Table 1. Confusion matrix of proposed work

	Detected	Not detected
Detected	992	7
Not detected	8	993

TP: 1985

Overall Accuracy: 99.25 %

In Table 2, there are accuracy parameters in the case of the proposed work by considering Table 1.

Table 2. Accuracy in case of proposed model

Class	Accuracy	Precision	Recall	F1 Score
1	99.25%	0.99	0.99	0.99
2	99.25%	0.99	0.99	0.99

5.2. Comparison of Accuracy Parameter

Table 3 presents the accuracy of the proposed and conventional model considering recall, and f1-score.

Table 3. Comparison of Accuracy parameters

Models	Accuracy	Recall	Precision	F1-Score
Conventional CNN	95.75%	89.40%	89.42%	92.65%
Proposed Hybrid CNN model	99.25%	99%	99%	99%

Considering table 3, there is graphical representation of average accuracy parameters in the case of the proposed and conventional model considering recall, f1-score as shown in Figure 4.

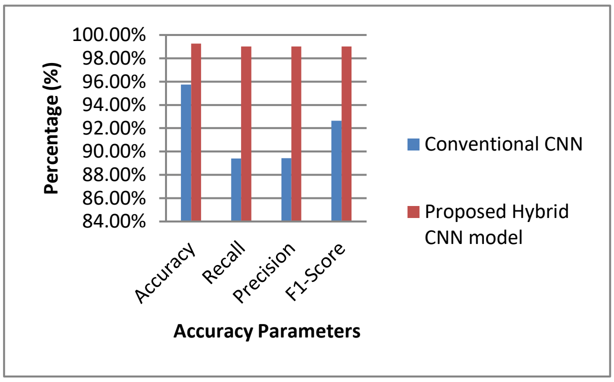

Fig. 6. Comparison of proposed work to conventional

6. Conclusion

According to the aforementioned simulation, the work given here improves accuracy while simultaneously boosting performance. Noise reduction and hybrid techniques have improved accuracy measurements including f-score, recall value, and precision, while image compression has further improved performance. The study done allowed for these advancements to be made feasible. ML in an IoT setting is greatly enhancing Lungcancer detection and diagnosis. In particular, images of lung lesions recorded by IoT devices equipped with high-resolution cameras and sensors may be accurately analyzed by CNNs. Both patients and medical professionals benefit from this novel tool. Dermatologists may benefit from using machine learning-powered diagnostic tools, which might lead to faster treatment and improved patient outcomes. The condition of one's lung may be tracked in real time and in a continuous manner in an IoT environment. Simulation results conclude that accuracy is 95.75% in case of conventional approach where as it is 99.25% in case of proposed hybrid model. Precision, recall, F1-Score in case of conventioal work are 89.4%, 89.42% and 92.65% respectively where as these are 99% in case of proposed work. According to the aforementioned simulation, the work given here improves accuracy while simultaneously boosting performance. Noise reduction and hybrid techniques have improved accuracy measurements including f-score, recall value, and precision, while image compression has further improved performance. The study done allowed for these advancements to be made feasible. ML in an IoT setting is greatly enhancing Lungcancer detection and diagnosis. In particular, images of lung lesions recorded by IoT devices equipped with high-resolution cameras and sensors may be accurately analyzed by CNNs. Both patients and medical professionals benefit from this novel tool. Dermatologists may benefit from using machine learning-powered diagnostic tools, which might lead to faster treatment and improved patient outcomes. The condition of one's lung may be tracked in real time and in a continuous manner in an IoT environment.

7. Future Scope

The future scope of lung cancer detection and recognition using deep learning mechanisms within the healthcare IoT environment holds immense promise for transformative advancements in medical diagnostics. As deep learning algorithms continue to evolve, we can anticipate heightened precision in detecting subtle patterns indicative of early-stage lung cancer. The integration of multi-modal data, including genetic information, patient history, and environmental factors, is likely to provide a more comprehensive understanding of individual health, enabling more accurate and personalized lung cancer detection. Real-time monitoring through wearable devices and IoT sensors will play a pivotal role, allowing for continuous health assessment and immediate interventions. Moreover, the future may witness the incorporation of predictive analytics to assess an individual's risk of developing lung cancer, paving the way for proactive preventive measures. Standardization efforts in data formats and interoperability will enhance the seamless exchange of information, ensuring that deep learning models can leverage diverse datasets for more effective lung cancer detection. The evolving synergy between deep learning and IoT in healthcare not only holds the potential to revolutionize early diagnosis but also to significantly improve patient outcomes through personalized and timely interventions.

Conflicts of interest

The authors declare no conflicts of interest.

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