IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⋇ Peer-reviewed & Refereed journal ⋇ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

PULMONARY NODULE DETECTION FROM LOW DOSE CT THYROID IMAGES

Mrs. Mamatha[1], Ashwin S P [2], Kiran H A [3], Sandeep Kannappa[4], Nanda Kumar B [5]

Assistant Professor, Electronics and communication Department, East West Institute of Technology, Bangalore, India[1]

Student, Electronics and communication Department, East West Institute of Technology, Bangalore, India[2-5]

Abstract: Thyroid cancer is the deadliest cancer worldwide. It has been shown that early detection using low-dose computer tomography (LDCT) scans can reduce deaths caused by this disease. We aim to present a general framework for the detection of thyroid cancer in chest LDCT images. Our method consists of a nodule detector followed by a cancer predictor method. Our candidate extraction approach is expected to produce higher accuracy on the images of each subject and is also expected to increase precision for all recall values using convolutional neural networks. Our model insists over 3D CNN than other methods as they include different planes in detecting the nodules. In addition, our false positive reduction stage aims to successfully classify the candidates and is expected to increase precision. Our cancer predictor's ROC AUC curve is expected to determine how well our model can classify the nodules from the non-nodules based on the features and their properties.

Keywords: Pulmonary Nodule detection, Thyroid Cancer, Machine Learning, Deep Learning, KNN, Image processing, ANN, Random Forest, Logistic Regression.

I. INTRODUCTION

Thyroid cancer is one of the deadliest cancers worldwide. Around 2 million cases of thyroid cancer are reported worldwide every year while in India, thyroid cancer constitutes about 9.3 per cent of all the cancer related deaths. However, the early detection of thyroid cancer significantly improves survival rate. Cancerous (malignant) and noncancerous (benign) pulmonary nodules are the small growths of cells inside the thyroid. Detection of malignant thyroid nodules at an early stage is necessary for the crucial prognosis. Early-stage cancerous thyroid nodules are very much like noncancerous nodules and need a differential diagnosis based on slight morphological changes, locations, and clinical biomarkers. The challenging task is to measure the probability of malignancy for the early cancerous thyroid nodules.

Various diagnostic procedures are used by physicians, in connection, for the early diagnosis of malignant thyroid nodules, such as clinical settings, computed tomography (CT) scan analysis (morphological assessment), positron emission tomography (PET) (metabolic assessments), and needle prick biopsy analysis. However, mostly invasive methods such as biopsies or surgeries are used by healthcare practitioners to differentiate between benign and malignant thyroid nodules. The National Thyroid Screening Trial (NLST) showed that three annual screening rounds of high-risk subjects using low dose CT reduce the death rates considerably. These measures mean that an overwhelming quantity of CT scan images will have to be inspected by a radiologist. Since nodules are very difficult to detect, even for experienced doctors, the burden on radiologists increases heavily with the number of CT scans to analyse.

To detect malignant nodules, specific features need to be recognized and measured. Based on the detected features and their combination, cancer probability can be assessed. Common computer aided diagnosis (CAD) approaches use previously studied features which are somehow related to cancer suspiciousness, such as volume, shape, subtlety, solidity, spiculation, sphericity, among others. They use these features and Machine Learning (ML) techniques such as Support Vector Machine (SVM) to classify the nodule as benign or malignant

1.1 Pulmonary nodule detection

The pulmonary nodule is a frequently encountered finding on computed tomography (CT). A nodule is of high clinical importance, given it may prove to be an early manifestation of thyroid cancer, which is the leading cause of death from malignancy. Early detection, accurate characterization, and appropriate management of pulmonary nodules require expertise across multiple disciplines such as radiology, oncology, pulmonary medicine, radiation oncology, and thoracic surgery.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁑ Peer-reviewed & Refereed journal ⁑ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

Chest radiography remains the most ordered radiological examination. Unfortunately, radiography has low sensitivity for demonstrating significant lesions and a high false-positive rate for the detection of pulmonary nodules. The greater degree of spatial and contrast resolution provided by CT enables improved sensitivity and specificity for pulmonary nodule detection.

1.2 Machine learning

Machine Learning (ML) is scientific study of algorithms and statistical models that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model of sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering, detection of network intruders, and computer vision, where it is infeasible to develop an algorithm of specific instructions for performing the task. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning.

Data mining is a field of study within machine learning and focuses on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics. Machine learning tasks are classified into several broad categories. In supervised learning, the algorithm builds a mathematical model from a set of data that contains both the inputs and the desired outputs. For example, if the task were determining whether an image contained a certain object, the training data for a supervised learning algorithm would include images with and without that object (the input). and each image would have a label (the output) designating whether it contained the object. In special cases, the input may be only partially available, or restricted to special feedback. Semi-supervised learning algorithms develop mathematical models from incomplete training data, where a portion of the sample input doesn't have labels.

Classification algorithms and regression algorithms are types of supervised learning. Classification algorithms are used when the outputs are restricted to a limited set of values. For a classification algorithm that filters emails, the input would be an incoming email, and the output would be the name of the folder in which to file the email. Regression algorithms are named for their continuous outputs, meaning they may have any value within a range. Examples of a continuous value are the temperature, length, or price of an object. In unsupervised learning, the algorithm builds a mathematical model from a set of data which contains only inputs and no desired output labels.

Machine learning is a sub-domain of computer science which evolved from the study of pattern recognition in data, and from the computational learning theory in artificial intelligence. It is the first-class ticket to most interesting careers in data analytics today. As data sources proliferate along with the computing power to process them, going straight to the data is one of the most straightforward ways to quickly gain insights and make predictions. Machine Learning can be thought of as the study of a list of sub-problems, viz: decision making, clustering, classification, forecasting, deep-learning, inductive logic programming, support vector machines, reinforcement learning, similarity and metric learning, genetic algorithms, sparse dictionary learning, etc.

Supervised learning, or classification is the machine learning task of inferring a function from a labeled data. In Supervised learning, we have a training set, and a test set. The training and test set consists of a set of examples consisting of input and output vectors, and the goal of the supervised learning algorithm is to infer a function that maps the input vector to the output vector with minimal error. In an optimal scenario, a model trained on a set of examples will classify an unseen example in a correct fashion, which requires the model to generalize from the training set in a reasonable way. In layman’s terms, supervised learning can be termed as the process of concept learning, where a brain is exposed to a set of inputs and result vectors and the brain learns the concept that relates said inputs to outputs. A wide array of supervised machine learning algorithms are available to the machine learning enthusiast, for example Neural Networks, Decision Trees, Support Vector Machines, Random Forest, Naïve Bayes Classifier, Bayes Net, Majority Classifier etc., and they each have their own merits and demerits.

1.3 Deep learning

Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabelled. Also known as deep neural learning or deep neural network, Deep learning is an artificial intelligence (AI) function that imitates the workings of the human brain in processing data and creating patterns for use in decision making.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 1, January 2025
DOI: 10.17148/IJARCCE.2025.14158

Deep learning has evolved together with the digital era, which has brought about an explosion of data in all forms and from every region of the world. This data, known simply as big data, is drawn from sources like social media, internet search engines, e-commerce platforms, and online cinemas, among others. This enormous amount of data is readily accessible and can be shared through fintech applications like cloud computing. However, the data, which normally is unstructured, is so vast that it could take decades for humans to comprehend it and extract relevant information. Companies realize the incredible potential that can result from unravelling this wealth of information and are increasingly adapting to AI systems for automated support.

Deep learning, a subset of machine learning, utilizes a hierarchical level of artificial neural networks to carry out the process of machine learning. The artificial neural networks are built like the human brain, with neuron nodes connected like a web. While traditional programs build analysis with data in a linear way, the hierarchical function of deep learning systems enables machines to process data with a nonlinear approach.

Most deep learning methods use neural network architectures, which is why deep learning models are often referred to as deep neural networks. The term "deep" usually refers to the number of hidden layers in the neural network. Traditional neural networks only contain 2-3 hidden layers, while deep networks can have as many as 150. Deep learning models are trained by using large sets of labelled data and neural network architectures that learn features directly from the data without the need for manual feature extraction.

One of the most popular types of deep neural networks is known as convolutional neural networks (CNN or ConvNet). CNNs eliminate the need for manual feature extraction, so you do not need to identify features used to classify images. This automated feature extraction makes deep learning models highly accurate for computer vision tasks such as object classification.

1.4 Algorithms

The most common methods and techniques used for the detection of cancerous thyroid nodules are:

1.4.1 Image processing

Image processing is a method to perform some operations on an image, to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image.

1.4.2 K-nearest neighbours (KNN)

K-Nearest-Neighbour (KNN) is a non-parametric instance-based learning method. In this case, training is not required. The algorithm begins by storing all the input feature vectors and outputs from our training set. For each unlabelled input feature vector, we find the k nearest neighbours from our training set. The notion of nearest uses Euclidean distance in the mdimensional feature space. For two input vectors x and w, their distance is defined by

$$d(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

1.4.3 Difference image technique

Image differencing is an image processing technique used to determine changes between images. The difference between two images is calculated by finding the difference between each pixel in each image, and generating an image based on the result. For this technique towork, the two images must first be aligned so that corresponding points coincide, and their photometric values must be made compatible, either by careful calibration, or by postprocessing (using colour mapping). The complexity of the pre-processing needed before differencing varies with the type of image.

1.4.4 Artificial neural network

Artificial neural networks (ANN) or connectionist systems are computing systems inspired by the biological neural networks that constitute animal brains. The neural network itself is not an algorithm, but rather a framework for many different machine learning algorithms to work together and process complex data inputs. Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules.

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁎ Peer-reviewed & Refereed journal ⁎ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal from one artificial neuron to another. An artificial neuron that receives a signal can process it and then signal additional artificial neurons connected to it.

1.4.5 Random forest

Random forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

1.4.6 Logistic regression

Logistic regression is a supervised learning classification algorithm used to predict the probability of a target variable. The nature of target or dependent variable is dichotomous, which means there would be only two possible classes. In simple words, the dependent variable is binary in nature having data coded as either 1 (stands for success/yes) or 0 (stands for failure/no). Mathematically, a logistic regression model predicts $P(Y=1)$ as a function of X.

1.4.7 Computer-aided detection

Computer-aided detection (CADe), also called computer-aided diagnosis (CADx), are systems that assist doctors in the interpretation of medical images. Imaging techniques in X-ray, MRI, and ultrasound diagnostics yield a great deal of information that the radiologist or other medical professional must analyse and evaluate comprehensively in a short time. CAD systems process digital images for typical appearances and to highlight conspicuous sections, such as possible diseases, to offer input to support a decision taken by the professional. CAD is an interdisciplinary technology combining elements of artificial intelligence and computer vision with radiological and pathology image processing.

1.4.8 Support vector machine

Support vector machines (SVMs, also support-vector networks) are supervised learning models with associated learning algorithms that analyse data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into highdimensional feature spaces.

1.4.9 Convolution neural network

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets can learn these filters/characteristics. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlaps to cover the entire visual area.

1.5 MOTIVATION

Detecting malignant thyroid nodules from computed tomography (CT) scans is a hard and time consuming task for radiologists. A lot of CT scan analysis techniques exist for thyroid nodule detection and classification, which have sensitivity of up to 94% but with low specificity and high False Positive rate in the classification of nodules. On the other hand, thyroid cancer screening studies show that blood tests have higher specificity and lower sensitivity as compared to imaging tests. Unfortunately, currently, there is no single biomarker which is 100% sensitive and specific for thyroid cancer diagnosis. The nodules' features are better learned through computer based deep learning methods as compared

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025
DOI: 10.17148/IJARCCE.2025.14158

to radiologists. This motivated us to take up this project and build an efficient deep learning model to reduce the false positive results of CT techniques.

1.6 OBJECTIVES

• To develop a smart health care system consisting of two parts:

(i) Nodule detection systems, wherein the candidate nodules are detected from the original CT scan by filtering the unwanted noise, masking and morphological operation.
(ii) False positive reduction systems, wherein, from a set of given candidate nodules, they are classified into benign or malignant tumors using 3D CNN methods.

• To build and train a model based on 3D CNN(Convolutional Neural Network) architecture to efficiently detect pulmonary nodules.

• To explore the original LDCT volume into an isotropic volume in order to work with the same voxel size for all subjects to tackle the problem of unbalanced classes of data.

• To experiment the different built CNN model to get maximum accuracy of nodule detection and nodule classification.

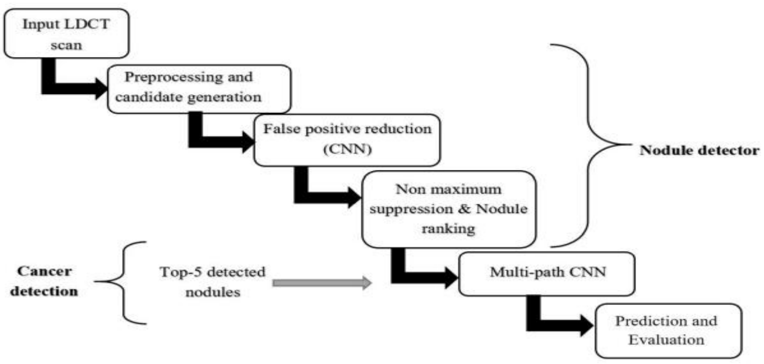
II. METHODOLOGY

In the proposed system, we are designing the system for thyroid nodule detection and classification using Deep learning approach. These Deep learning approaches help in detecting the thyroid nodule and classify them as benign or malignant thyroid cancer. Some of the methods such as three dimensional convolutional neural networks (3D- CNN) is used to find the nodules from the non – nodules.

The steps that will be followed are:

• Detecting the nodule presence through filtering, masking, morphological operation and regional maxima.

• Cancer prediction, also known as nodule classification is used to determine whether the detected nodule is cancerous(malignant) or non-cancerous(benign), which involve steps such as input from nodule detector and multi-path convolutional neural network.



2.1 Data pre-processing

Commonly used Data pre-processing tools are:

2.1.1 Pandas

Pandas is a Python data analysis library used for enhancing analytics and modelling. It is a free library with the cutest name. In the year 2008, Data science devotee Wes McKinney developed this library while he was working at AQR

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

Capital Management, to make data analysis and modelling convenient in Python. Prior to pandas, this programming language worked well only for data preparation and munging. pandas simplify analysis by converting CSV, JSON, and TSV data files or a SQL database into a data frame, a Python object looking like an Excel or an SPSS table with rows and columns. Even more, pandas are combined with the I Python toolkit and other libraries to enhance performance and support collaborative work.

2.1.2 NumPy

It is a library for the Python programming language, adding support for large, multidimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. Moreover, NumPy forms the foundation of the Machine Learning stack. NumPy targets the C, Python reference implementation of Python, which is a non-optimizing bytecode interpreter. Mathematical algorithms written for Python often run much slower than compiled equivalents. NumPy addresses the slowness problem partly by providing multidimensional arrays and functions and operators that operate efficiently on arrays, requiring rewriting some code, mostly inner loops, using NumPy. Python bindings of the widely used computer vision library OpenCV utilize NumPy arrays to store and operate on data. Since images with multiple channels are simply represented as three-dimensional arrays, indexing, slicing or masking with other arrays are very efficient ways to access specific pixels of an image. The NumPy array is used as a universal data structure in OpenCV for images and performs many operations like extracts feature points, filter kernels and many more, that vastly simplifies the programming workflow and debugging.

2.1.3 PyTorch

PyTorch is an open-source machine learning library used for developing and training neural network based deep learning models. Unlike most other popular deep learning frameworks like

TensorFlow, which use static computation graphs, PyTorch uses dynamic computation, which allows greater flexibility in building complex architectures. PyTorch uses core Python concepts like classes, structures and conditional loops that are a lot familiar to our eyes, hence a lot more intuitive to understand. This makes it a lot simpler than other frameworks like TensorFlow that bring in their own programming style.

2.2 Nodule detector

It takes a subject's thyroid LDCT scan as input and gives the detected nodules with high probability of being malignant as the output**.**

2.2.1 Input

We aim to generate the nodule candidates for each subject over the entire thyroid volume to benefit from the three-dimensional information provided by the LDCT scans. We would interpolate the original LDCT volume into an isotropic volume in order to work with the same voxel size for all subjects.

2.2.2 Thyroid volume filtering and masking

We would filter the volume using a 3D median filter for noise reduction. After filtering, we aim to extract the thyroid volume with a calculated mask to avoid unnecessary information processing, which may lead to an increased number of false positives. We then propose to use a linear combination of the mean and standard deviation of each scan independently to get the threshold value. Following thresholding, morphological closing shall be used to fill borders and holes, and to remove small objects and structures connected to the image border but still retaining the original image.

2.2.3 Candidate generation

We shall perform an opening by reconstruction over the extracted thyroid volume, given that the candidates are light regions in the scan. A marker volume would be created by eroding the 3D volume with an ellipsoid. The objective of the candidate generation is to extract all light components (higher density tissue) inside the thyroids.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025
DOI: 10.17148/IJARCCE.2025.14158

2.2.4 Nodule classification

From the regional maxima, we compute connected components per subject and their centroids. We aim to design and train a three-dimensional convolutional neural network (3D CNN) for false positive reduction with 3D candidates (volumes centered at the calculated centroid) as input. In contrast of 2D CNNs when using 3D convolutions, we shall analyze one additional spatial dimension which is important to differentiate nodules from other structures such as vessels that may look similar in one slice independently.

2.3 Cancer prediction

2.3.1 Predictor input

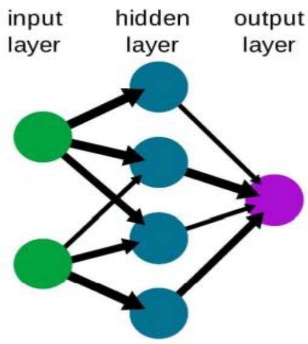
xIn practice, the malignancy of a nodule is determined by a biopsy of a sample of the nodule tissue. Our proposed method relies only on the visual information of the LDCT. Therefore, we want our predictor model to use as much relevant information (i.e., detected nodules) as we can provide from our nodule detector. We shall feed our predictor model with the five topscored nodules from our nodule detector.

2.3.2 Multi-path convolutional neural network

We aim to train a multi-path network of 5 paths, all with the same 3D CNN architecture of the nodule classification network. As an input for each of the 5 paths of the multi-path network, we shall use the 5 top detected nodules in the previous stage.

2.4 Prediction models

Deep learning algorithms are programs that can learn from data and improve from experience, without human intervention. Learning tasks may include learning the function that maps the input to the output, learning the hidden structure in unlabeled data; or 'instance-based learning', where a class label is produced for a new instance by comparing the new instance (row) to instances from the training data, which were stored in memory. 'Instance based learning' does not create an abstraction from specific instances. Here to predict whether the detected thyroid is benign or malignant, we propose a multi-path network of 5 path with 3D CNN model. We design a novel multiple paths convolutional neural network, which feeds different versions of images into separated paths to learn more comprehensive features. This model aims to achieve a better presentation for image than the traditional single path model. We intend to acquire better classification results on complex validation set on both the top 1 and top 5 scores. We ought to train our multi-path predictor model for many epochs using the trained weights from our detector as the initialization parameters.



We aim to train our predictor model using extracted features from the previous nodule detector model.

III. IMPLEMENTATION

Implementation is the process of converting a new system design into an operational one. It is the key stage in achieving a successful new system. It must therefore be carefully planned and controlled. The implementation of a system is done after the development effort is completed

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025
DOI: 10.17148/IJARCCE.2025.14158

Steps for Implementation

Front-End Development Using Python Tkinter:

Modern computer applications are user-friendly. User interaction is not restricted to console- based I/O. They have a more ergonomic graphical user interface (GUI) thanks to high-speed processors and powerful graphics hardware. These applications can receive inputs through mouse clicks and can enable the user to choose from alternatives with the help of radio buttons, dropdown lists, and other GUI elements.

Tkinter Programming:

Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fast and easy way to create GUI applications. Tkinter provides a powerful object- oriented interface to the Tk GUI toolkit. Tkinter has several strengths. It's cross- platform, so the same code works on Windows, macOS, and Linux. Visual elements are rendered using native operating system elements, so applications built with Tkinter look like they belong on the platform where they're run.

Implementation Issues

The implementation phase of software development is concerned with translating design specifications into source code. The primary goal of implementation is to write source code and internal documentation so that conformance of the code to its specifications can be easily verified and so that debugging testing and modification are eased. This goal can be achieved by making the source code as clear and straightforward as possible. Simplicity clarity and elegance are the hallmarks of good programs and these characteristics have been implemented in each program module.

The goals of implementation are as follows.

- Minimize the memory required.
- Maximize output readability.
- Maximize source text readability.
- Minimize the number of source statements.
- Minimize development time

Module specification:

Module Specification is the way to improve the structural design by breaking down the system into modules and solving it as an independent task. By doing so the complexity is reduced and the modules can be tested independently. The number of modules for our model is three, namely preprocessing, identification, feature extraction and detection. So each phase signify the functionalities provided by the proposed system. In the data pre-processing phase noise removal using median filtering is done.

Data flow Diagram of Training and Testing Phase

The System design mainly consists of

1. Image Collection

2. Image Preprocessing

3. Image Segmentation

4. Feature Extraction

5. Training 6. Classification

1. Image Collection

The dataset that we have used in this project is available publicly on the internet

2. Image Preprocessing

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025
DOI: 10.17148/IJARCCE.2025.14158

The goal of pre-processing is an improvement of image data that reduces unwanted distortions and enhances some image features important for further image processing. Image pre-processing involves three main things a) Grayscale conversion b) Noise removal c) Image enhancement

a)Grayscale conversion: Grayscale image contains only brightness information. Each pixel value in a grayscale image corresponds to an amount or quantity of light. The brightness graduation can be differentiated in grayscale image. Grayscale image measures only light intensity 8 bit image will have brightness variation from 0 to 255 where '0' represents black and '255' represent white. In grayscale conversion color image is converted into grayscale image shows. Grayscale images are easier and faster to process than colored images. All image processing technique are applied on grayscale image.

b) Noise Removal: The objective of noise removal is to detect and remove unwanted noise from digital image. The difficulty is in deciding which features of an image are real and which are caused by noise. Noise is random variations in pixel values.

We are using median filter to remove unwanted noise. Median filter is nonlinear filter, it leaves edges invariant. Median filter is implemented by sliding window of odd length. Each sample value is sorted by magnitude, the centermost value is median of sample within the window, is a filter output.

c) Image Enhancement: The objective of image enhancement is to process an image to increase visibility of feature of interest. Here contrast enhancement is used to get better quality result.

3**. Image Segmentation** Image segmentation are of many types such as clustering, threshold, neural network based and edge based. In this implementation we are using the clustering algorithm called mean shift clustering for image segmentation. This algorithm uses the sliding window method for converging to the Centre of maximum dense area. This algorithm makes use of many sliding windows to converge the maximum dense region. Mean shift clustering Algorithm This algorithm is mainly used for detecting highly dense region.

Feature Extraction:

There are many features of an image mainly color, texture, and shape. Here we are considering three features that are color histogram, Texture which resembles color, shape, and texture.

5. Training Training dataset was created from images of known Cancer stages. Classifiers are trained on the created trainingdataset. A testing dataset is placed in a temporary folder. Predicted results from the test case, Plots classifiers graphs and add feature-sets to test case file, to make image processing models more accurate

6. Classification The binary classifier which makes use of the hyper-plane which is also called as the decision boundary between two of the classes is called as Convolution Neural Network. Some of the problems are pattern recognition like texture classification makes use of CNN. Mapping of nonlinear input data to the linear data provides good classification in high dimensional space in CNN. The marginal distance is maximized between different classes by CNN. Different Kernels are usedto divide the classes. CNN is basically a binary classifier that determines hyper plane in dividing two classes. The boundary is maximized between the hyperplane and two classes. The samples that are nearest to the margin will be selected in determining the hyperplane is called support vectors.

CNN Algorithm Explanation

The invention of the CNN in 1994 by Yann LeCun is what propelled the field of Artificial Intelligence and Deep learning to its former glory. The first neural network named LeNet5 had a very less validation accuracy of 42% since then we have come a long way in this field. Nowadays almost every giant technology firms rely on CNN for more efficient performance. The idea to detect diseases in mulberry leaf incorporates the use of CNN before we dive into the "functionality and working of CNN" concept, we must have a basic idea on how the human brainrecognizes an object in spite of its varying attributes from one another. Our brain has a complex layer of neurons ,each layer holds some information about the object and all the features of the object are extracted by the neurons and stored in our memory, next time when we see the same object the brain matches the stored features to recognize the object, but one can easily mistake it as a simple "IF-THEN" function, yes it is to some extent but it has an extra feature that gives itan edge over other algorithms that is Self-Learning, although it cannot match a human brain but still it can give it a tough competition . Image is processed using the Basic CNN to detect the diseases in leaves.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

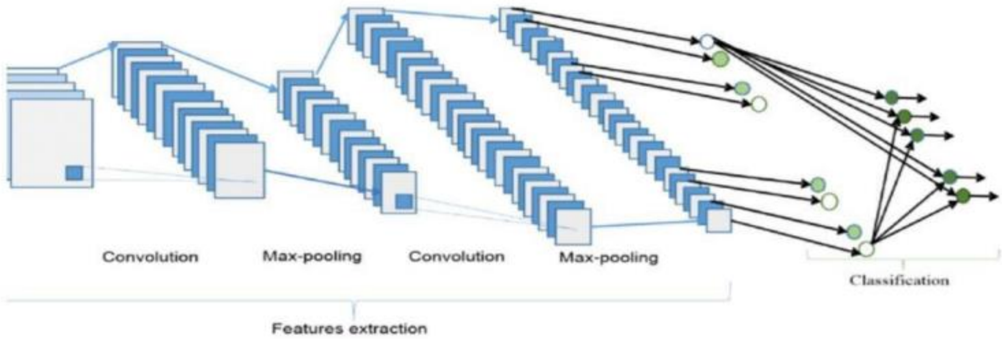
International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⋇ Peer-reviewed & Refereed journal ⋇ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

The data training in our CNN model has to satisfy following constraints: 1) No missing values in dataset. 2) The dataset must distinctly be divided into training and testing sets, either the training or the testing setshouldn't contain any irrelevant data out of our model domain in case of an image dataset all the images must be of the same size, one uneven distribution of image size in our dataset can decrease the efficiency of our neural network. 3) The images should be converted into black and white format before feeding it into the convolution layer because reading images in RGB would involve a 3-D numPy matrix which will reduce the execution time of our model by a considerable amount. Any kind of corrupted or blurred images should also be trimmed from the database before feeding it into the neural network. This is all about data pre-processing rules, let us dive right into the working of the convolution neural network.

Convolution Neural Network layers



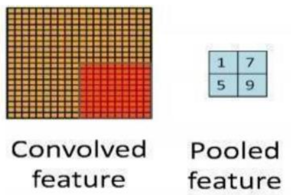
Convolutional Neural Network Layers

A.Convolution layer

This layer involves scanning the whole image for patterns and formulating it in the form of a 3x3 matrix. This convolved feature matrix of the image is known as Kernel. Each value in the kernel isknown as a weight vector.

B. Pooling layer

After the convolution comes to the pooling here the image matrix is broken down into the sets of 4 rectangular segments which are non-overlapping. There are two types of pooling, Max pooling and average pooling. Max pooling gives the maximum value in the relative matrix region which is taken. Average pooling gives the average value in relative matrix region. The main advantageof the pooling layer is that it increases computer performance and decreases over- fitting chances.



Structure of CNN in matrix format

C. Activation layer

Implementation It the part of the Convolutional Neural Networks where the values are Normalized that is, they arefitted in a certain range. The used convolutional function is ReLU which allows only the positive values and then rejects the negative values. It is the function of low computational cost.

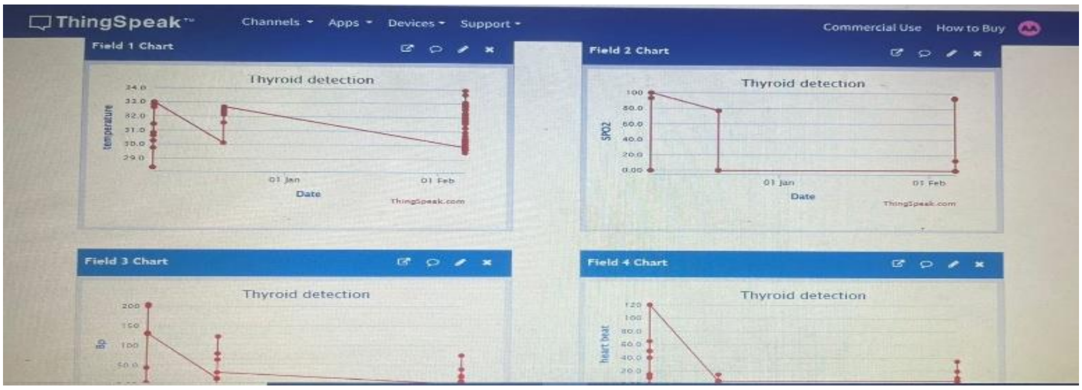
ISSN (O) 2278-1021, ISSN (P) 2319-5940

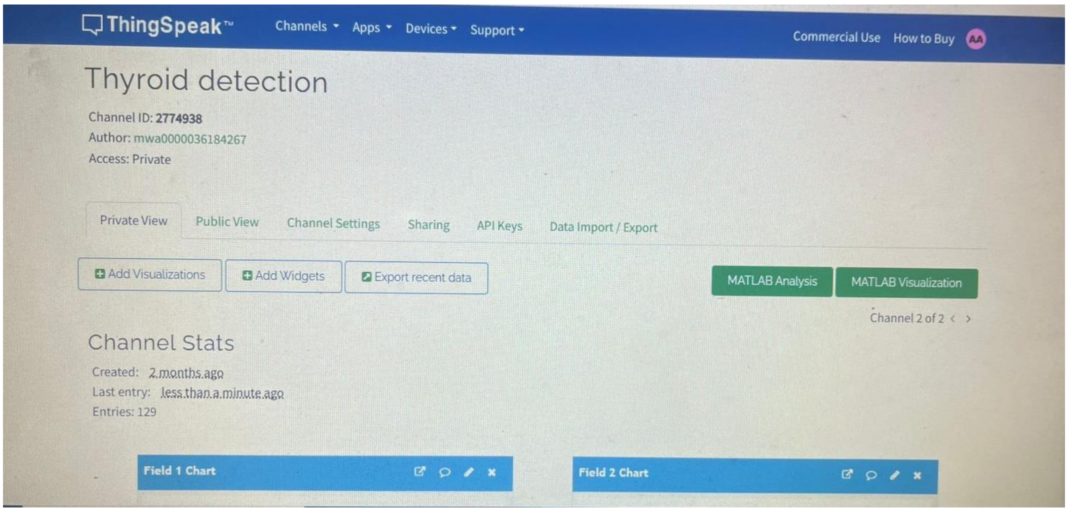
International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14158

IV. RESULT





CONCLUSION

This project aims to provide an efficient way to detect the presence of nodule and classify them. While there have been similar projects in the past, this project aims to bring a more accuracy in detecting nodules and reduce the false positive rate. With this platform developed, even radiologists can easily learn how to use it to their advantage. In this project, the

DOI: 10.17148/IJARCCE.2025.14158

proposed method helps in identifying thyroid nodules using Deep learning algorithm such as 3D Convolutional neural network model that helps in analyzing the large datasets and predicting with high accuracy.

Although the problem of nodule detection is extremely unbalanced with high intra-class variance, we expect our approach to detect thyroid nodules and predict cancer effectively. We design a candidate proposal method which is expected to increase the precision for all recall values using the convolutional neural networks. In addition, the dataset provided shall train the three-dimensional convolutional neural network to classify the nodules from non-nodules and increase the precision to achieve a close to human performance. As for the cancer diagnosis, we aim to train a multi-path 3D CNN cancer predictor which is expected to be a better performer as 3D shall include another plane which would provide a clear visibility of the nodules and it is also expected to decrease the false positive rate

REFERENCES

[1] Y. Chunran, W. Yuanyuan and G. Yi, "Automatic Detection and Segmentation of Thyroid Nodule on CT Images," 2018 11th International Congress on Image and Signal Processing, Biomedical Engineering and Informatics (CISP-BMEI), Beijing, China, 2018, pp. 1-6, doi: 10.1109/CISP-BMEI.2018.8633101.

[2] S. Kido, Y. Hirano and N. Hashimoto, "Detection and classification of thyroid abnormalities by use of convolutional neural network (CNN) and regions with CNN features (RCNN)," 2018 International Workshop on Advanced Image Technology (IWAIT), Chiang Mai, 2018, pp. 1-4, doi: 10.1109/IWAIT.2018.8369798.

[3] Wang, Q., Shen, F., Shen, L. et al." Thyroid Nodule Detection in CT Images Using a Raw Patch-Based Convolutional Neural Network". J Digit Imaging 32, 971–979 (2019).

[4] Dev C., Kumar K., Palathil A., Anjali T., Panicker V. "Machine Learning Based Approach for Detection of Thyroid Cancer in DICOM CT Image". In: Hu YC., Tiwari S., Mishra K., Trivedi M. (eds) Ambient Communications and Computer Systems. Advances in Intelligent Systems and Computing, vol 904. Springer, Singapore (2019).

[5] Zheng, Sunyi, et al. "Deep convolutional neural networks for multi-planar thyroid nodule detection: improvement in small nodule identification." Medical physics (2020).

[6] Liu, Siqi, et al. "No Surprises: Training Robust Thyroid Nodule Detection for Low-Dose CT Scans by Augmenting with Adversarial Attacks." arXiv preprint arXiv:2003.03824 (2020).

[7] Perez, G., Arbelaez, P. Automated thyroid cancer diagnosis using three-dimensional convolutional neural networks. Med Biol Eng. Computer 58, 1803–1815 (2020).

[8] A. Iyer, H. Vyshnavi A M and K. Namboori P K, "Deep Convolution Network Based Prediction Model for Medical Diagnosis of Thyroid Cancer - A Deep Pharmacogenomic Approach: deep diagnosis for thyroid cancer," 2018 Second International Conference on Advances in Electronics, Computers and Communications (ICAECC), Bangalore, 2018, pp. 1- 4, Doi: 10.1109/ICAECC.2018.8479499.

[9] N. S. Nadkarni and S. Borkar, "Detection of Thyroid Cancer in CT Images using Image Processing," 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2019, pp. 863-866, Doi: 10.1109/ICOEI.2019.8862577.

[10] D. Jayaraj and S. Sathiamoorthy, "Random Forest based Classification Model for Thyroid Cancer Prediction on Computer Tomography Images," 2019 International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2019, pp. 100-104, doi: 10.1109/ICSSIT46314.2019.8987772.

[11] Cui, S., Ming, S., Lin, Y. et al. "Development and clinical application of deep learning model for thyroid nodules screening on CT images". Sci Rep 10, 13657 (2020).