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Harnessing Deep Learning for Precision Diagnosis of Pancreatic Cancer

Pathapaty Dinshi

Student, Department of computer science and Engineering , Koneru Lakshmaiah Education Foundation, Green fields, Vaddeswaram , A.P

2101050012@kluniversity.in

ORC ID : 0009 0005 9110 6728

Dr PVRD Prasada Rao

Professor, Department of Computer science and Engineering, Koneru Lakshmaiah education foundation, Green fields , Vaddeswaram, A.P

pvrdprasad@kluniversity.in

ORC ID : 00 00000175278013

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Abstract:

Introduction:

The pancreatic cancer cells are developed due to over or high cell growth , these can be also caused by genetic mutation, habits of daily life and medical conditions. Early detection of the pancreatic cancer can be challenging ,treatment often involves chemotherapy ,immune therapy and drugs related to stage of cancer . these drugs often develop side effects .AI driven methods like Random forest , Naïve bayes and CNN , assist with medical professionals in diagnosing pancreatic cancer with the help of Medicals imaging and lab test analysis .preventive measures like maintaining good BMI and dietary changes are some of measures to be taken to ensure low risk of pancreatic cancer .

Objectives:

The deep learning and machine learning can be used for the accurate and early diagnosis of the pancreatic cancer , improving detection rate and patient outcomes. The AI models analyse medical images, lab results and genetic data ,to classify different types and stages of cancer for a perfect personalised treatment strategy .

Methologies:

the AI based method combines machine learning and deep learning for the detection and classification of pancreatic cancer accurately. The machine learning algorithms like random forest and naïve bayes analyse clincal and genetic test result data. The deep learning algorithms like CNN use medical imaging for the detection of tumor in the image.

Results:

The machine learning algorithm is used when we use the lab data, in which we add data to ml model which then predicts whether the data has pancreatic cancer or not, also classifies which type of pancreatic cancer. Where the Dl model uses CT images which automatically detects tumor in images .

Conclusion:

the model enhances medical diagnosis and advanced health care technologies. the integrated approach improves the accuracy, with coordination evolving health care standards . this demonstrates the potential of AI and data integration in addressing complex medical challenges .

key words: Deep learning , Machine learning , Artificial Intelligence , Medical image analysis , Convolution Neural Networks .

I.INTRODUCTION :

Pancreatic cancer generally occur when cell grow at abnormal large form which together form a tumor . the tumor is a pancreatic cancer tumor . several risk factors together combine together in the development of cancer cells the following are some of the reasons for occurrence of pancreatic cancer, firstly genetic mutations ,there are different genetic mutations like inherited mutations and acquired mutations. secondly different life style factors contribute to development of pancreatic cancer. thirdly different medical conditions like diabetes , stones in kidneys and gall bladder. finally, if a family member has a history of having this type of cancer generally increases the risk of another family member in getting this type of cancer .it is most occurred in people above age 60 and is most common in men than in women.

Several measures can be taken to reduce the risk of pancreatic cancer .quit smoking , consuming less alcohol , maintain a healthy weight and healthy BMI , regular blood checkups , eating low or no processed foods . if any family member has a history of pancreatic cancer a person need to get a genetic testing in identifying cancer .Different drugs are given to patients during the treatment. each drug varies in each stages because of its variation and effect of drug on the body . In the initial stage or chemotherapy stage , chemotherapy drugs are given to patients before surgery to slow down the growth of cancer cells.

In the targeted therapy, the drugs ae given to specific type of cancer cell mutations which kills or destroys this type of mutations. Immuno-therapy drugs , these drugs boost the immune system to attack the cancer cells and reduce the cancer cells in the body. Supportive drugs are given to patients who suffer from the side effects of chemotherapy or any type of treatment. This type of drugs are given to patients with stomach issues, anti-nausea drugs, loss of appetite ..etc.

Different type of medicines are used in different stages of treatment of pancreatic cancer . early stage generally the treatment is surgery or chemotherapy. The drugs or medication given are generally FOLFIRINIX or gemcitabine. Locally advanced pancreatic cancer is a stage where chemotherapy or radiation therapy is done on patient. Medication generally used is folfirinix . Metastatic stage ,also

known as pancreatic stage 4 cancer . Chemotherapy is done on a patient . Genetic mutation based is a another level of pancreatic cancer based on genetic mutations. Usually Allopathnic is used as a medication for pancreatic cancer treatment. Allopathnic medication are generally used for active cancer cases , these can shrink tumor or can remove cancer cells in early stages . it is most effective method . but certain side effects occurs during the consumption of this medication . Nausea, fatigue , hair loss are some of the side effects . the Allopathnic is generally expensive and is not most effective in advanced stages .

Ayurvedic medications are used as a symptom reliefs. These manage symptoms like digestive issues . weakness and boost immunity. These are to used along side allopathic but with the guidance of a doctor .usually ayurvedic medications have no cure of cancer . we cannot stop the treatment of using dedicated therapy even if you are using ayurvedic medications . There are some side effects during different medications . chemotherapy has certain common side effects like nausea , fatigue , loss of appetite and loss of weight . but there are severe side effects which occur during chemotherapy . low blood count , sores in mouth, damage in liver and kidneys are some of the severe side effects of chemotherapy. During targeted therapy , the side effects generally include rashes on skin, dry skin, liver problems .supportive medications which are generally used to support any weakness in body during chemotherapy also have certain side effects like drowsiness, boating and stomach pain. During the immune therapy the side effects generally include flu symptoms , rashes on skin and lung inflammation.

Pancreatic cancer is not caused by life style habits only . but it plays a role in increasing the risk of the cancer .lifestyle habits include heavy smoking ,heavy alcohol consumption , has high BMI and no physical exercise , patients with diabetics (type-2).Non-life style habits include genetic mutations ,chronic illness , medical conditions ,age and gender .There are some remedies and prevention methods for pancreatic cancer .change to a healthier life style to decrease the risk . quit smoking , low alcohol consumption. Maintain a healthy BMI , exercise daily. some dietary remedies include consuming plant based diet , more anti flammatory foods like turmeric, green tea , garlic , ginger , berries ,leafy greens are to taken daily. Ayurvedic remedies like ashwagandha , aloe vera juice , triphala , bitter gourd juice and consuming more water. Medical screening like CT scans And MRI scans are to done regularly to identify any underlying illness.

Early detection of pancreatic cancer occurs at a later stage. This type of cancer usually occurs in the pancreas, which is a vital organ in the stomach area. This organ plays an important role in digestion and glucose regulation, producing enzymes that help in breaking the food and balance the imbalanced hormones to regulate the sugar levels in the blood. This type of cancer differs from other types due to the unique features of the pancreas, which provide numerous benefits to the human body. As a result, this type of cancer is particularly complex, disrupting various functions of both digestion and body processes.

We considered an existing system to tackle cancer detection and classification using numerical datasets; it employs an advanced convolutional neural network, or ACNN, for diagnosis instead of imaging data sets. The ACNN has the ability to adapt any process and interpret numerical values. Given that the ACNN is a deep learning approach, it can easily adapt to the needs of a machine learning

approach. It usually does not concern itself with the pattern in the data. This system uses and processes the numerical values to pinpoint the cancer details. It was particularly useful during non-image dataset availability. It has specific disadvantages because it only considers numerical data, not image data, as most departments in hospitals have an imaginary dataset.

Hence we need to use artificial intelligence to analyse and classify whether the taken image or MRI scan has pancreatic cancer or not Artificial intelligence uses both machine learning and deep learning methods to classify and check whether that image has pancreatic cancer or not .the deep learning methods , hybrid algorithms , supervised and unsupervised learning methods and ensemble learning are some of the approaches with which we can classify an image . AI models analyse medical images, lab test results, biopsy results and symptoms stated by patient and draws a result which can assist the doctors in early detection of pancreatic cancer .for example use of AI in Radiology. MRI or MRCP scans are taken which helps in giving the detailed soft tissue image which can be useful to detect blockages in pancreas. the lab test were taken and used by machine learning algorithm to determine whether the given values containing the terms and values related to pancreatic cancer.A recent study presents a groundbreaking analysis that employs a deep learning algorithm to predict the risk of pancreatic cancer using health records 1. The researchers developed a model that identifies patterns and trajectories of a disease. They have used a large data set of over 1 million patients, which includes data on pancreatic cancer. The study results in high accuracy and early detection. The journal of gastro-entrology published a review that examined machine learning models for predicting pancreatic cancer risk using health records. The study encompasses 22 developed machine learning models 2. The results show an accuracy on the curve of 0.85–0.90. It also shows the use of high-quality data enables better results. The key elements include the patient's medical history, laboratory results, and the type of medication prescribed. They have faced several challenges. They are unable to locate previously generated data records, and the complexity of the models makes it challenging to pinpoint the risk factors. A review provides an overview of AI in detection of pancreatic cancer to improve patient outcomes. Tripati. conducted the review, utilizing both AI and ML applications for pancreatic cancer diagnosis 3

Research has proven that AI can enhance cancer diagnosis accuracy, forecast cancer development risk, and devise treatment plans. Researchers also use it to calculate survival rates .. The ESMO study 4 presents a model that elucidates the multimodal machine learning approach for survival prediction. The research used a sample of 150 pancreatic cancer patients. The model achieved a higher accuracy rate, among other benefits. A model was 5 created using machine learning algorithms that predicts the risk of pancreatic cancer using trajectories. The model identifies high-risk patients, performs high-risk prediction, and conducts large-scale EHR analysis. We verify the performance of 6 various machine learning and deep learning techniques for pancreatic cancer detection. It shows an effective approach to detecting pancreatic cancer using CT. The deep learning methods like CNN and RNN outperformed machine learning techniques like SVM, random forest, and CNN in the detection of cancer. CNN has achieved a high score of 94.4%.

The goal of the 7 machine learning study is to find out how different types of gut microbiota interact with pancreatic cancer that has spread and cancer that has not spread. The results show that the machine

learning approach identified a set of microbial markers that can predict the presence of metastatic pancreatic cancer with high accuracy. The study uses deep learning 8 to classify pancreatic cancer into different types using CT images. The model has achieved high accuracy in classifying patients. The study offers the potential for deep learning to enhance the accuracy and efficiency of pancreatic cancer diagnosis and classification. Designing a machine learning and deep learning frame work for early pancreatic cancer detection aims to develop a framework using machine learning for early diagnosis;9.by using advanced computational techniques , the framework aims to enhance the detection. the study ranges and explains about the use of algorithms in detection of cancer and aims for higher potential for use in clinical work flows.10.the article discuss the use of machine learning algorithms in predicting and recommend medicines for cancer patients,The research aimed to predict the recurrence patterns of pancreatic cancer after surgery using supervised machine learning algorithms11,the machine learning models can predict the recurrence patterns in pancreatic cancer which could significantly Impact patient management and outcomes . the study aims to propose a new early detection indicator for pancreatic cancer by using both machine learning and neural network based model utilizing miRNA profiles 12, this approach could significantly enhance the accuracy of diagnosis and facilitate personalized treatment strategies.

The study by M Suneetha explores the role of CNN in predicting pancreatic cancer from medical images .the study uses CNN to extract features from CT scans . by training the model on large data set 13, the researchers found that CNN outperform other models by identifying different patterns that was not easily detected by radiologist as this could reduce the false negatives leading to a earlier treatment and diagnosis. This area focus on using ANN to enhance accuracy and efficiency of diagnosis of pancreatic cancer. the ANN analyse complex medical data to detect early stage cancer. This shows that the use of potential future applications of ai in medical diagnosis emphasizing the need of more extensive data set , improvised algorithm and real world clinical validation.14 If fully integrated ANN based models can assist radiologist and oncologist in making quicker and reliable diagnosis, By refining ANN-based models and incorporating them into clinical practice, the fight against pancreatic cancer could take a significant step forward, improving patient outcomes and survival rates.

The study utilizes ensemble learning techniques, which integrate multiple machine learning models such as Random Forest, Gradient Boosting, and Voting Classifiers to improve diagnostic accuracy 15. By combining the predictions of different models, ensemble methods can reduce bias, enhance generalization, and minimize false positives and false negatives. The findings suggest that ensemble learning significantly outperforms individual machine learning models in identifying pancreatic cancer cases, making it a promising approach for early detection. This research highlights the growing importance of AI-driven methodologies in the medical field, emphasizing the need for advanced computational techniques to support radiologists and healthcare professionals in early diagnosis and effective treatment planning. the study proposes an AI-driven system that leverages deep learning models to analyse medical imaging data, particularly CT and MRI scans, to detect pancreatic cancer at an early stage .The research utilizes advanced convolutional neural networks (CNNs) and other deep learning architectures to automatically identify cancerous regions in the pancreas with high accuracy. 16The "AI-Powered Pancreas Navigator" aims to assist radiologists by providing precise predictions and reducing diagnostic errors. The study’s findings indicate that AI-based approaches significantly

outperform traditional diagnostic methods, enabling faster, more reliable, and non-invasive detection. By integrating deep learning into cancer diagnostics, this research paves the way for improved early detection strategies, personalized treatment planning, and enhanced patient outcomes, reinforcing the role of AI in transforming modern healthcare.

II. Objectives :

The principal aim of utilizing deep learning for the precise diagnosis of pancreatic cancer is to augment early detection and raise diagnostic accuracy, hence elevating patient survival rates. The model employs sophisticated machine learning and deep learning methodologies to examine medical pictures, including CT scans, MRIs, and histopathology slides, for the detection of malignant patterns. Convolutional Neural Networks (CNNs) are essential for feature extraction, facilitating accurate categorization of pancreatic cancer. Furthermore, the integration of diverse machine learning models, such as Naïve Bayes and Random Forest, facilitates the analysis of clinical history, biomarkers, and genetic alterations for a thorough diagnosis. This method seeks to diminish false positives and false negatives, thereby decreasing diagnostic inaccuracies. AI-driven models enhance personalized medicine by recognizing cancer subtypes and suggesting customized treatment strategies. Moreover, deep learning improves radiological interpretation, facilitating superior decision-making by healthcare practitioners. The deployment of AI-driven decision-support systems facilitates a swifter and more precise diagnostic process, enhancing the efficacy of cancer detection. These models can interact with electronic health records (EHRs) to deliver real-time cancer risk assessments, facilitating the early identification of high-risk individuals. Deep learning substantially decreases diagnostic time and enhances healthcare accessibility, particularly in distant regions, by automating image and data processing. Moreover, predictive AI models can assess patient reactions to particular therapies, enabling tailored therapy. The research additionally aids in the identification of novel biomarkers and enhances oncology investigations using AI-driven insights. The deployment of ethical AI is crucial, guaranteeing impartial and accountable diagnoses while perpetually enhancing model precision with updated medical data. This project seeks to transform pancreatic cancer detection by incorporating deep learning methodologies, upgrading medical technology, and improving patient outcomes through more accurate and timely therapies.

III.SYSTEM ARCHIETECTURE :

In the System architecture of machine learning ,it generally shows how the raw data changes into required values or result. Once the data is uploaded , we extract the data set and preprocess the data . then we need to test and train the data according to the model or algorithm , we get the predicted results , by using the predicted results we generate graphs and performance analysis, we take the data which are CT scans images and the algorithms like CNN is used to test and train the image . the results indicate the presence or absence of tumor in the uploaded image .by using the results we generate performance Analysis. The fig 3.1 and 3.2 are the system architecture for machine learning and deep learning . the architecture shows

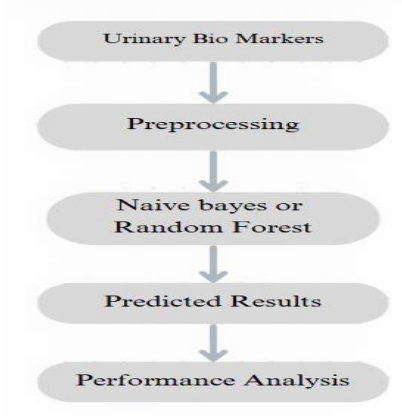

Fig 3.1 System Architecture for Machine learning

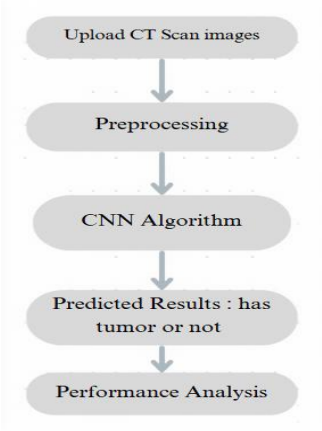

Fig 3.2 System Architecture for deep learning

IV.ALGORITHM:

The random forest algorithm is

1. Input:

- Dataset D with features X and labels Y

- Number of trees (N)

- Number of random features for splitting (M)

2. Data Preprocessing:

- Load dataset D

- Split dataset into training set and testing set

- Normalize data

3. Model Training:

- Initialize a Random Forest model with N trees

- For each tree in the forest:

. Train a Decision Tree on D_i:

- At each node:

a. Select M random features from all features

b. Find the best feature to split using enyropy

c. Split data into nodes

d. Continue splitting until conditions are met

e. Store the tree in the Random Forest model

4. Model Prediction:

- For a new input sample X_:

1. Pass X_n through each tree in the forest

2. Collect predictions from all trees

3. Use majority values to get the final prediction

5. Model Evaluation:

- Predict labels for test using the trained model

- Compare predicted labels with actual labels (Y_test)

- Compute evaluation metrics

6. Output:

- Return the trained Random Forest model

- Return the final predicted result for new input

The algorithm for naïve bayes algorithm

1. Input:

- Dataset D with features X and labels Y

2. Data Preprocessing:

- Load dataset D

- Split dataset into training set (X_train, Y_train) and testing set (X_test, Y_test)

- convert data and normalise data

3. Model Training:

- Calculate prior probabilities for each class:

P(Class) = (Number of samples in class) / (Total samples)

- For each feature in X:

1. Compute the likelihood

- For categorical features: Use frequency-based probability

- For continuous features: Assume normal distribution and use Gaussian probability formula:

$$P(X|Class) = (1 / \sqrt{2\pi\sigma^2}) * \exp(-((X - \mu)^2 / 2\sigma^2))$$

where μ = mean and σ^2 = variance of the feature for the class

2. Store these probabilities for later use

4. Model Prediction:

- For a new input sample X_new:

1. Compute posterior probability for each class using Bayes' Theorem:

$$P(Class|X) = [P(X|Class) * P(Class)] / P(X)$$

2. Select the class with the highest probability as the predicted label

5. Model Evaluation:

- Predict labels for X_test using the trained model

- Compare predicted labels with actual labels (Y_test)

- Compute evaluation metrics

6. Output:

- Return the trained Naïve Bayes model

- Return the final predicted result for new input

The algorithm for CNN is

1. Input:

- Dataset D with images and corresponding labels Y

2. Data Preprocessing:

- Load dataset D

- Normalize pixel values (scale between 0 and 1 or -1 and 1)

- Split dataset into training (X_train, Y_train) and testing (X_test, Y_test)

3. Model Architecture:

- Define a sequential CNN model with layers:

1. Convolutional Layer:

- Apply multiple filters (kernels) to extract features

- Use activation function (ReLU) to introduce non-linearity

2. Pooling Layer:

- Reduce spatial dimensions

3.Flatten Layer:

- Convert feature maps into a 1D vector

5.Fully Connected Layer :

- Perform classification using activation function

6. Output Layer:

- Number of neurons = Number of classes

4. Model Training:

- Compile model

- Choose evaluation metric (e.g., accuracy)

- Train the model using:

- Forward propagation

- Backpropagation

- Use batch processing for efficiency

- Repeat for multiple epochs to improve performance

5. Model Evaluation:

- Test the model on X_test

- Compute accuracy and other performance metrics (precision, recall, F1-score)

6. Model Prediction:

- For a new input image X_new:

- Resize and normalize image

- Pass it through the trained CNN model

- Return predicted class label

7. Output:

- Return trained CNN model

- Return predicted label for new input image

V. Methodologies:

The developed method uses an Ai based model which uses both Machine learning and Deep learning to identify and classify different pancreatic cancer.Naïve Bayes, a probabilistic machine learning algorithm, can be applied to pancreatic cancer detection by classifying patient data into cancerous or non-cancerous categories based on various clinical features. The algorithm uses Bayes' Theorem to calculate the probability of a patient having pancreatic cancer given their symptoms, medical history, and diagnostic test results. For pancreatic cancer detection, Random Forest can analyse clinical features, biomarkers, genetic data, and imaging results to distinguish between cancerous and non-cancerous cases. Its ability to handle large, complex datasets makes it a reliable tool in medical diagnostics, though careful feature selection and tuning are essential for optimal performance. This study was approved by the Institutional Ethics Committee of Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India (Approval No: KLU/IEC/2025/03/AI-PC).

The following figure 5.1 shows how an machine learning algorithm takes data and gives the report. Convolutional Neural Networks (CNNs) are deep learning models highly effective in pancreatic cancer detection, particularly for analysing medical imaging data such as CT scans, MRI, and histopathological slides. CNNs automatically extract hierarchical features from images, enabling precise tumor detection and classification. CNNs improve diagnostic accuracy by detecting subtle patterns in medical images, aiding in early detection and treatment planning .

The below figure uses an deep learning based approach known as CNN . we train and test the data to determine if the uploaded image contains pancreatic cancer or not

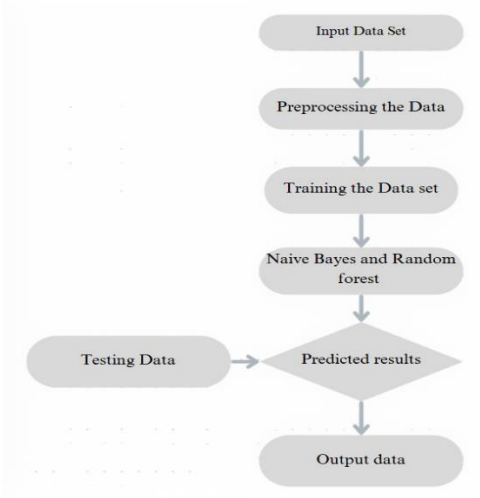

FIG 5.1

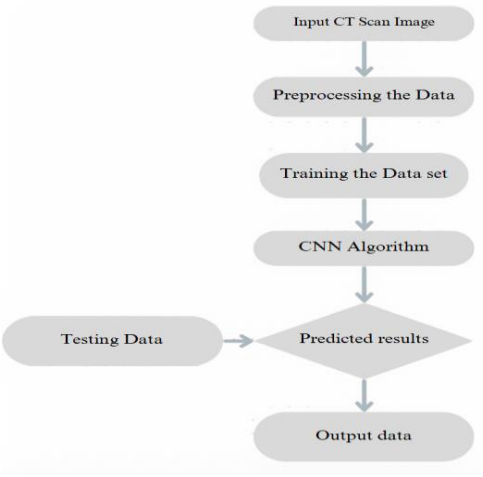

Fig 5.2

Convolutional Neural Networks (CNNs) are deep learning models highly effective in pancreatic cancer detection, particularly for analysing medical imaging data such as CT scans, MRI, and histopathological slides. CNNs automatically extract hierarchical features from images, enabling precise tumor detection and classification. CNNs improve diagnostic accuracy by detecting subtle patterns in medical images, aiding in early detection and treatment planning .

VI. RESULTS:

Analysis of both pancreatic and non-pancreatic cancer :The two images which we have taken are CT scans. The model then receives these images as input. The model then reprocesses, trains, and tests the data using the algorithms.

The fig. 6.1 displays a CT scan image of the pancreas, which is free of pancreatic cancer due to the absence of any small molecules. Upon uploading this image, it becomes clear that there is no pancreatic cancer present. The fig. 6.2 shows a CT scan of the pancreas, which, when uploaded, demonstrates that the uploaded image has pancreatic cancer because it has small modules in it. The images are taken when we need to find image processing for detection of pancreatic cancer and non-pancreatic cancer.

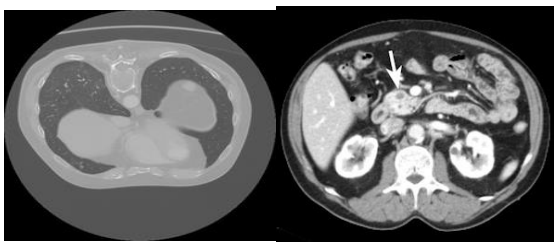

Fig - 6.1 and fig – 6.2

The analysis of machine learning is done in a different manner . as it is a machine learning algorithm we need to mechanically upload the data set. The model tests and trains it according to the algorithm and we need to enter values manually to find if the data which was entered has pancreatic cancer or

not. The below figure 6.3 shows the manual input of values in the tables and we need to select the algorithm which then gives whether data entered has predicted cancer or not.

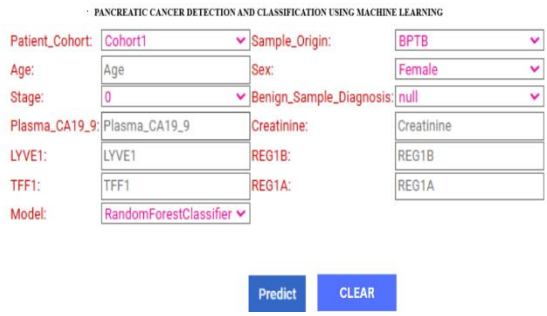

Fig 6.3

If the image uploaded has tumor , the image on processing shows that it has tumor in it . the below image shows when uploaded image has pancreatic tumor in it.

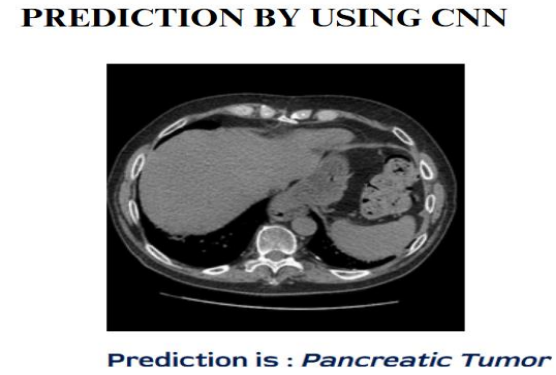

Fig 6.4

VII. PERFORMANCE ANALYSIS AND GRAPH:

The data which we entered in the table then shows the performance analysis of both the algorithms which we used like naïve bayes and random forest classifier. The below table 7.1 shows the performance analysis of Random forest and Naïve bayes.

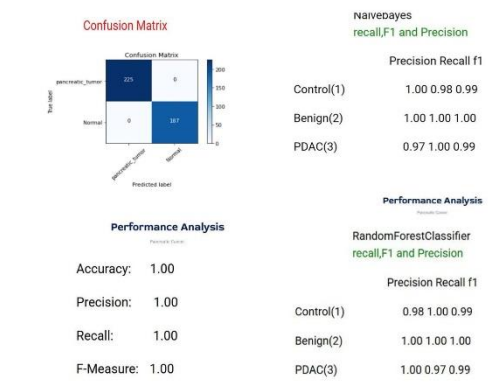

Fig 7.1

The graphical analysis graph fig 7.2 and 7.3 shows that model graph values of pancreatic cancer cases with respect to non-pancreatic cancer cases. The pie chart `below shows the average number of patients to have pancreatic cancer to non-pancreatic cancer .the bar graph states the average performance analysis between random forest and naïve bayes.

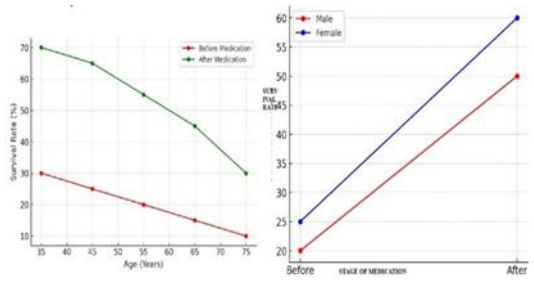

FIG 7.2

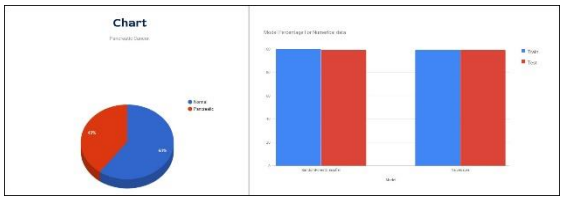

Fig 7.3

VIII. LATEST DEVELOPMENTS OF USING ML AND DL IN DETECTING PANCREATIC CANCER

The early detection of pancreatic cancer have been greatly enhanced by the use of machine learning and deep learning techniques. DL techniques , in particular like CNN has been use to cross analyse the images from CT AND MRI scans . these developed a high accuracy in identifying tumor , early diagnosis. Some studies show that use of DL algorithms focuses on identifying multiple lesions and tumor , which can improve a diagnosis precision.

A type of blood based bio markers identification method know as ctDNA has been used for the early diagnosis of the pancreatic cancer . Researchers developed a blood test called PAC-MANN , which identifies pancreatic cancer at an early stage . the test rate showed at a value of 85% accuracy when combined using CA 19-9 test.ML algorithms have been used to analyse large data sets , clinical, molecular data of patients to predict the outcomes , to personalised their individual treatment. SVM and RF are used to predict tumor and surviving rate . a model develop by Harvard using AI know as “CHIEF” has shown high accuracy in detecting various cancers in particular pancreatic cancer.it achieved a whole of 94% accuracy in detection of cancer , which is more than 36 % of remaining AI models.

In general sense ,the integration of machine learning and deep learning holds its promise in early diagnosis , patient treatment ,and patient outcomes . Advances in Deep Learning and Machine Learning: Keeping abreast of the most recent developments in these fields and applying them to improve the accuracy and performance of the system. Cooperation with Healthcare Institutions:

Working together, healthcare institutions and providers can incorporate the system into clinical processes to guarantee its useful application in actual healthcare situations.

IX.CONCLUSION:

In conclusion, this model not only contributes to the current state of medical diagnosis but also sets the stage for a new era of healthcare technology. The integrated approach offers a glimpse of the potential to revolutionize patient care, aligning with ever-evolving healthcare standards and the pursuit of more accurate and holistic diagnostic methods. This project serves as a testament to the potential of data integration and advanced technology in addressing complex medical challenges, paving the way for a more informed and effective healthcare system.

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