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Prediction Analysis of Pancreatic Tumour using Transfer Learning

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Abstract

Pancreatic cancer is one of the most common types of cancer that affect men. The development of this cancer in the male body impairs a number of health difficulties, both physical and mental. The existence of this illness is associated with a great deal of complexity, mostly linked to image processing and image detecting methods. Different deep learning and transfer learning based approaches and algorithms can be employed to ascertain the same, in addition to image processing techniques. The author of the work typically uses the Kaggle dataset, which has precise information on images of pancreatic cancer that were collected through the data collection process, in order to carry out the proposed research study. 750 photos of cancer and 150 healthy, tumor-undetermined images make up the dataset. Using the notions of a histogram, the normalization technique defines the image in its entirety. In addition, the author suggests using YOLO as a transfer learning-based method and CNN's working theory as a deep learning algorithm. However, the transfer learning-based technique implements the same using a pre-trained model, and in order to get higher accuracy and precision values, further hyper-parameter tuning is also carried out.

Keywords

CNN, deep learning, pancreatic, tumor, radiatio.

1. Introduction

In comparison to the prevalent of other form of cancers which are mostly associated with lungs, breast and colorectal cancer; the presence of pancreatic cancer leads to the number of deaths in many cases. In such a scenario; the malignancy is significantly lower and therefore the prediction is majorly based on age of the individual. Hence the process of screening becomes a challenging task so that low false positive results can be obtained and the final model need not undergo the process of unnecessary assessments in order to justify for false positive results and findings. The associated risk factor with the disease is also expected to be high in terms of pancreatic cancer since its prediction in the early stages in difficult. In the early years when the evolution of the technology was not at this peak; the occurrence of such a form of cancer was majorly based on the genetic factors and was considered to be hereditary. Various biomarkers were used in such a case in order to determine the hereditary factors. The usage of computed tomography which is commonly known as CT scans is majorly used in the detection and diagnosis of the disease. However the usage of various deep learning and machine learning algorithms have also been helpful in order to determine the disease in the early stages. Worldwide, a

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significant incidence of malignant tumors related to pancreatic cancer is noted in males. It is also thought to be the most common type of cancer and typically affects men in the relevant age range. According to a study published in [1], 2.3 million people worldwide were diagnosed with pancreatic cancer in 2020. As a result of the studies, it is anticipated that by 2030, 3.6 million populations will have the disease. Many techniques and technologies are employed in the process of early disease detection. A few of these are tomography, solography, and MRI. The technique of using tomography to find cancerous cells in pancreatic tissue is commonly known. It is also commonly acknowledged that another radiation method can be used to identify the same. Radiation therapy is thought to be an improved scanning method for cancer diagnosis that may result in genetic mutation. On the other side, using the same could potentially result in false positive results. Therefore, the most dependable method of detection is thought to be biopsy, which involves microscopic examination of pancreatic tissue samples. According to writers in [2], the field of histopathology is a broad examination of many biological tissues that might produce cancer cells and can thus be discovered under a microscope. Nonetheless, a specialist or the on-site doctor must do the histology scan procedure. This procedure also aids in the detection and differentiation of a variety of malignancies, both benign and malignant. Nonetheless, an alternative technique for differentiating between the two makes use of computer-aided diagnosis' conceptual working theory (CAD). This type of technology typically uses different histopathological images of the sick tissue to focus on the applications of deep learning and transfer learning based techniques. The radiologist continues to work on it, segmenting the pictures of the tissues and cells that typically show how the disease is occurring within.

Deep learning algorithms can be used to apply and implement a variety of strategies, including CNN and ANN. Using such methodologies has the benefit of allowing for the evolution and utilisation of several layers, which facilitates the extraction of information in-depth. This makes it possible for information to be transferred between layers even more and makes disease predictions more accurate. As a result, all of the information is moved from one layer to the next, becoming gradient in nature as it approaches the last layer. The last layer is made up of data that has been taken from earlier levels, which tends to produce results more effectively. There are several models and algorithms employed, including CNN, ResNeT, and DenseNeT. But all of the models have a tendency to add up the outcomes, blend them together, and provide a single output. Using such models has the benefit of pre-training the network, which improves the accuracy of the working model's prediction of the model's eventual output. Furthermore, if these algorithms and methodologies primarily rely on image processing techniques, there will also be a greater delay in the entire idea of over-fitting.

This avoids over-fitting problems and causes the resulting images to evolve in a refined resolution. Nonetheless, the theoretical operation of ResNet and the application of CNN as the algorithm are both part of the research study's operational concept. By correctly identifying both positive and negative cases of pancreatic cancer, this technique enables the algorithm to reliably forecast the number of occurrences. Furthermore, by using a transfer learning model, the entire algorithm is trained in a predetermined way, allowing the accuracy results to improve over time.

2. Related Works

Numerous studies have been conducted in the area of identifying pancreatic cancer in males. Scholars have employed the theoretical frameworks of transfer learning, deep learning, and machine learning algorithms. It is highly anticipated that the diagnosis will be made utilizing tomography and ultrasonic tomography results. But as artificial intelligence technologies have advanced, this field has seen a fine-tuning of hyper parameters, allowing for an efficient diagnosis to be made at the appropriate stage. After the relevant data has been gathered, different approaches are used to fine-tune the data image. Below is a list of a few of them.

A. Implementation of Deep Learning Algorithms:

The ongoing machine learning process, which uses several algorithms to diagnose diseases correctly through iterative application, has led to the evolution of deep learning. It has also been extensively noted that machine learning algorithms have been adopted in the medical industry in order to accurately analyze cancer images and make additional disease predictions. The authors of a research study presented in [3] used deep learning models to condense all of the image processing technique's steps. This covered the theory and practice of CNN, RNN, and ANN. The Python libraries that were utilized to implement the suggested model were also covered in the study. It was found that using Python as the programming language optimized the model's overall memory and storage, leading to the production of superior outputs. The study also examined how several deep learning algorithm models, like ANN models, compared to CNN. A thorough analysis was

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conducted based on the layers that were incorporated into the algorithms. The number of parameters and the number of layers involved were the main differences between the models so used. While fewer layers were shown to experience over-fitting problems, more layers created and generated higher and more optimized results. After a general overview of the different techniques, it was determined that using the deep learning algorithm improved the overall correctness of the system model. In a different study project, the authors in [4] focused just on the Dense Network's intricate structures. The model's operation revealed the DenseNet's profoundly iterative nature. There were also other layers involved. In addition, a number of additional sigmoid functions were used in the processing of the same. DenseNet was applied to pathological picture data while taking the workflow process into account. The images taken from the cancer dataset were trained using a deep iterative network. The subsequent phase involved more fine-tuning of the many layers involved, enabling training of the pancreatic cancer dataset. In the research investigation, a thorough and iterative network was created whereby the cancer images of the male patients were gathered and subsequently utilized to forecast the likelihood of developing pancreatic cancer. ResNet was utilized to address the over-fitting problem, and the connectivity network layers were employed to improve and optimize the outcomes.

The deep learning approach was employed by the authors in [5] to classify a variety of images that would be used in the medical field. The authors employed a heavily trained network in order to extract relative features and perform multi-training of the corresponding model on the images that were subsequently acquired from the repository. As a result, the model that was created had to forecast 850 sample images from cancer patients that made up the dataset. Using a supervised learning approach, the labels were applied to the images, and the dataset underwent additional training. By using supervised learning, the model's prediction process was improved, leading to a higher detection accuracy. The multi-training idea was applied in this study by the authors in order to properly label cancer detection. Thus, the model's classification accuracy was enhanced by using a supervised gradient boosting technique. The author classified the same using an algorithm based on gradient boosting implementation. Furthermore, the author employed the theoretical framework of ResNet v2 CNN's overall execution. In contrast, it was found that CNN's many layers helped the model perform better than ResNet v2.This led to the conclusion that using CNN improved the precision factors, which in turn produced superior results when using deep learning algorithms.

Authors in [6] used the tomography charts from the images so collected from the dataset to classify different stages of pancreatic cancer in men. The investigation was conducted using a back propagation network, which involved 100 nodes in the detection procedure. The classifiers employed allowed the diagnosis process to proceed appropriately with the layers of the network in the pre-trained model. The accuracy of the optimization outcomes increased with the number of nodes and layers involved. An accuracy of 72% was produced overall by the CCN architecture. However, the author also used the ResNet working principle as a detection model for pancreatic cancer diagnosis. It was found that the algorithm did not match the degree of precision thus generated because there were fewer layers and nodes involved. Authors in [7] conducted a study wherein they employed histological pictures from the corresponding dataset to classify individuals with pancreatic cancer. Four distinct types and categories of magnified images made up this dataset, which was used to train the CNN model with varied hyper-parameters. The ANN algorithm was examined, and a comparative study of it was also carried out. In order to validate the complete working process, the author employed three strategies in the subsequent research, including the development of DenseNet as the algorithm. The three models underwent training in order to increase their accuracy.

B. Image Processing Technique

One of the most often utilized techniques in the medical analysis of different disorders is image processing. Early illness detection is aided by the identification of the cells responsible for pancreatic cancer in males. This can only happen if the cancer cells are extracted from the histopathology pictures and additional processing is started. In this kind of situation, the normalization approach is essential for removing the overall contrast and intensity of the histopathological image. The normalization method was examined by the authors in [8] in order to apply the ideas of unsupervised learning to the image processing technique. A stain-vector approach was also used for this purpose. Furthermore, neural networks were utilized by the author to facilitate the classification process. A 70 percent accuracy rate was obtained overall using the stain-vector approach. In contrast, it was shown that the normalization method produced higher accuracy levels when CNN was used as the neural network. The overall influence made on the prediction model was stronger as a result of the CNN's additional layers being involved. Authors in [9] conducted more study in which they proposed a de-convolution model based on the blind and color method, which is based on the Bayesian technique of disease detection, and evaluated the anticipated system model. Upon obtaining the histopathological images from the dataset, the programm commenced by identifying any anomalies. In order to eliminate the background vectors, a color-based vector matrix is determined in the following step. Compared to the method the authors presented in [7], this made the process of detecting cancer cells faster and more reliable. It was therefore noted that an alternative segmentation method was employed with this color vector based matrix procedure. Similar work to that of [9] was offered in a different study by the authors in [10]; however, the authors here suggested implementing supervised learning approaches with a combination of transfer learning algorithms. To diagnose pancreatic cancer in men, a total of six algorithms—ResNet, DenseNet, Inception Net, CNN, Naive Bayes, and SVM—were employed. Histopathological photos were used to create a similar image segmentation algorithm, which resulted in high levels of accuracy and significantly lower false positive rates.In a different study that the authors of [11] suggested, they used deep learning principles to build a convolutional network based on the neural complexity of the system model. By selecting only the pertinent characteristics from the resulting image collection, CNN's use helped to improve the system model's overall accuracy. Every image reached the sharpening threshold, producing superior results by enhancing the edges and sides of the image. Furthermore, a thorough investigation of image augmentation was conducted utilizing pancreatic tissue tomography. A bimodal intensity histogram was produced in the following phase. By using this technique, the author was able to expand the image's general region of interest and, as a result, improve the overall forecast result that the model was likely to produce.

C. Transfer Learning Technique

The function of classification is crucial for medical analysis in the realm of medicine. This is carried out in order to classify the corresponding disease as either positive or negative. The use of CNN as the neural networking algorithm is another crucial component of this. This is done in order to carry out the diagnosis in an efficient manner. However, a significant amount of medical dataset is needed for these purposes. It is anticipated that lesser datasets will provide an inaccuracy of false positive outcomes. Given that they seem to protect their sensitive data, patient privacy is another reason for this observation. Because of this, transfer learning is applied for the same goal, enabling accurate disease diagnosis through the identification of the cells that give rise to pancreatic cancer. In a research study, authors in [12] classified pancreatic cancer images from the Kaggle library using the principles of transfer learning. There were 180 infected images of pancreatic cancer patients in the repository after 250 healthy patient images. DenseNet was used by the authors as their transfer learning-based model. The author conducted a comparative analysis between DenseNet and ResNet in the next step. It was found that using ResNet increased performance and produced optimized accuracy with precise precisions. The colored photos of the cancer were turned to gray scale and then further categorized. Owing to the use and use of transfer learning, the networking model underwent extensive pre-training using one thousand image classes. Later on, the authors were able to boost the resolution of the picture dataset by using settings that the DenseNet used. Because of the DenseNet's extensively trained model, the implementation produced better accuracy results with lower false positive rates. Additionally, a sigmoid function was employed to get rid of the over-fitting problems. In order to facilitate an effective comparison between DenseNet and ResNet, the author built a comprehensive comparative analysis. In a different study [13], the authors analyzed and diagnosed the existence of cancer cells in the male body using the InceptionNet concepts. They got the dataset from the Kaggle repository for this use. Two csv files including over 2596 files of patients with positive pancreatic cancer were found in the repository. The authors' overall accuracy rate was 87.63 percent. Author in [14] used the conceptual working theory of CNN as the algorithm in order to boost and enhance the overall accuracy of the system model thus developed. The Medical images from the Kaggle repository was obtained and further trained so that respective algorithms could be applied on them. A transfer learning based model named as AlexNet was also implemented in conjunction to the CNN. This amalgamation of two algorithms led to a better comprehensive understanding of the algorithms. A 512 x 512 vector matrix was used by AlexNet in order to determine the dataset images with high resolution intensity. This led to an overall increase of the last CNN layer; also known as the pooling layer. This pooling layer had achieved the maximum amount of iterations that could be performed by the respective layer. This also helped into developing many other approaches which used this concept of maximising the task of the pooling layer. Apart from this an improvised form of

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convolutional layer was also developed based on the working of a typical CNN. The layer in each and every neuron function appeared to perform its task of normalisation and factorisation in an appealing manner. A ResNet model was thus built and its features were combined along with CNN. Since the ResNet model was heavily trained, the process of training it with new sample images of pancreatic patients was thus eliminated. This process ensured that malignancy classification could be done in an efficient manner. Around 82percent of the image dataset was classified and the process also generated minimised levels of false positive results.

3. Methodologies Used

Tomography is a procedure that is frequently used for cancer diagnosis and detection. Aside from this, performing a pancreatic biopsy seems to be a more expensive and precise way to find evidence of the same. On the other hand, the second approach necessitates extensive time investment from a medical specialist who may manually examine and confirm every step of the procedure. To do this, a number of medical professionals, including pathologists, gather and assess the procedure involved in defining the image. However, there are a number of processes that must be taken in order to prepare this image, including image segmentation, image gathering, and adjusting the ratio and resolution of the cells that cause cancer. This leads to the conclusion that the pancreatic biopsy procedure must be carried out under a microscope, which makes it a laborious procedure. As a result, applying and carrying out transfer learning algorithms after deep learning algorithms is a combined procedure. Numerous researchers have largely adopted this technique for the same reason. Because the CNN networking model has numerous layers, it seems to be useful to use in the medical industry.

The workflow of the proposed methodology includes the process of collecting data from the dataset or the repository. The initial stages also include training and testing of data so that the final implementation can occur on the algorithms thus selected. The entire workflow is depicted in figure below. In the process of training the dataset; the images of patient pancreatic CT scans is obtained and the images from the abdomen are taken into consideration for the purpose of diagnosis. In the next stage, augmentation of the same occurs wherein the acquired dataset is augmented so that the overall data size of the dataset could be increased and accurate results could be obtained. The augmentation thus created is followed by three different levels linked structures beneath it wherein the process of medical image recognition is performed. The background from the image is removed and further recognized with the help of YOLO. The author has however proposed the implementation of one deep learning algorithm namely CNN and the implementation of one transfer learning algorithm named YOLO. Hence the CT scan images of the pancreatic area are obtained and further diagnosis of the model is done. This process of diagnosis involves the management of appropriate level of resolution so that the obtained image does not fades or stretches away during the process of implementation. In the next stage binary values for each generated pixel is calculated and further training of the dataset occurs on the pancreatic images.

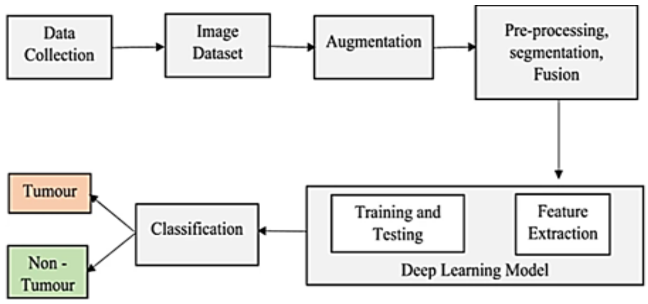

Figure 1: Workflow of the Proposed Methodology

As observed in Figure 1 above; the dataset is initially collected from the respective repository and further the process of augmentation is applied on it. This is primarily done so as to increase the overall size of the data. The process also includes various steps of transformation and rotational steps which are done on the original dataset. In the next stage; the pre-processing steps are done which also requires cleaning and transformation of the data. The next step involves the process of extracting only relevant features which would be required by the model to generate respective results. Following this step; the built model the trains and finally tests on the dataset thus acquired. For the purpose of testing the data, the model is run for 100 epochs using Adam as the optimizer. Two algorithms of YOLO and CNN are used in order to train and classify the obtained dataset. Once the process of classification is done; the obtained images are further categorized as either pancreatic tumor positive or negative. However the accuracy and precision of the system model is calculated on the basis of accuracy vs. the loss curve. A confusion matrix is also used in order to determine the same. Once the results from both the algorithms are generated; the system model compares on the highest generating accuracy algorithm and declares it as the optimized algorithm for the detection and diagnosis process of pancreatic tumor.

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Dataset of the Image

A dataset with pancreatic images of the patients is obtained from the Kaggle repository. A total of 4080 images are gathered from 300 patients. Due to the process of image augmentation being performed on the dataset, each image is thus altered in order to fit in the appropriate form of data augmentation process. Amongst the data set images acquired; a total of 3289 images were manually verified for disease positive and were hence proven to pancreatic cancer patients. The rest of the images were proven to be disease negative.

Urinary Biomarker

The impact of urinary biomarkers plays a vital and significant role in order to detect and determine the diagnosis of pancreatic cancer. Once its diagnosis is done; the advanced stage of the disease treatment becomes restricted and minimal and hence the process of its prognosis is not up to the mark. The primary reason for its occurrence is the stage of unreliability of non-invasive biomarkers which are eventually used manually by professional pathologists. Various types of biomarkers can be used for pancreatic prognosis. Some of them include:

- Osteopontin: this biomarker is a form of glycoprotein which is used to express the cancer which is detected through urine
- Tumor-associated trypsin inhibitor (TATI): this is a form of protein which if present in higher amounts can directly lead to the advanced and last stage of pancreatic cancer amongst its patients. Hence, its investigation through the usage of a potential biomarker is important
- Human epididymis protein 4 (HE4): this is another form of glycoprotein which can be detected through a urine sample and lead to the diagnosis of the disease at the right stage

Code and Results

This section of the research paper illustrates the code snippets which are required in order to implement the system model. All the threshold values are calculated using the algorithms which are to be used such as YOLO and CNN. The execution of the code has been occurred and computed in the Python environment and is further used to detect the tumor region from the acquired images of the dataset.

By making use of the algorithms thus used; the purpose of binary classification is thus being done and finally the parameters are used so that the final accuracy and precision of the model can be detected. The confusion matrix for respective binary classification is depicted below:

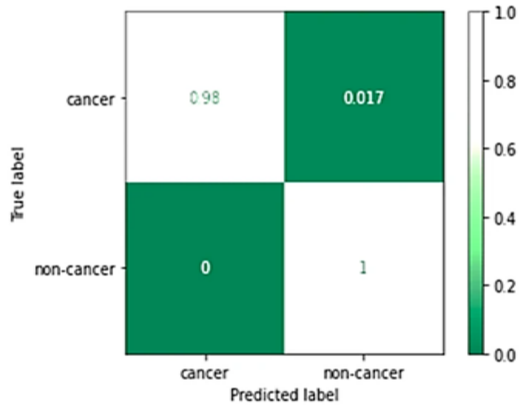

Figure 3: Confusion Matrix

The primary aim of the developed model is to diagnose the cancer in the early stages so that the prediction mechanism can be done in an accurate manner with appropriate treatments being provided to the same. For this purpose a proper channel for coordination is thus required along with manual examination of the patient. In addition to this; the research and development team tends to accurately understand the perspective of deep learning and machine learning algorithms so that the final outcomes and results might not alter and therefore generate accurate results in terms of augmenting the image dataset with respect to its shape, size and position. The sequence of disease diagnosis takes place by considering the images of pancreas in four stages namely; image screening and localization of the pancreatic image. The rest two of the processes include the division of the sample image so that data augmentation can take place and the final step of diagnosing the disease.

4.Conclusions and Future Works

Deep learning has helped advance the field of medicine by improving the ability to analyses and predict a wide range of illnesses. In order to assist the pathologist in grading pancreatic cancer based on pathological images, a unique automated YCNN was introduced in this work. The system's foundation is made up of the Py-charm and Google Colab platforms, along with the YOLO model for data-driven prediction. Input photos are scaled up and separated into 224×224 pixel patches before being fed into the YCNN all at once. The patches are then patched back together to create a single full image after CNN is used to classify them into their corresponding grades. The pathologist receives the final result at that point. F1-score values of 1.00 and 0.99 have been recorded on the datasets, both of which are positive. By implementing the most sophisticated deep learning model, growing the image dataset, and employing augmentation to raise the model's learning rate across a range of colour changes, the suggested method could be improved. Furthermore, a more modern technique for creating synthetic images can be designed to produce more pathology-related images of pancreatic cancer under the supervision of experts prior to the start of the training process. As of right now, the results of this study could help pathologists diagnose pancreatic cancer at a consistent grade by utilising an easy-to-use web interface that doesn't require installation. If the system can increase its accuracy and reach a value closer to 1, we expect that in the future it will give the pathologist an additional opinion.

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