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Primary Diagnosis Of Pancreatic Tumor Detection Using Image Segmentation Technique

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Abstract: Pancreatic tumor stands as a prominent cause of cancer-related fatalities globally. Nevertheless, timely revealing of pancreatic cancer offers a potential cure. This study focuses on the revelation of pancreatic tumors through the investigation of CT images. It uses image processing methods to detect tumor. It consists of pre-processing, segmentation and feature extraction and classification phases. The images go through a pre-processing stage to reduce noise from the dataset that was obtained.

Index Terms **- Pancreatic tumor, CT images, feature extraction.**

I. INTRODUCTION

The pancreas is an organ in the back of your abdomen (belly). It is part of your digestive system. It plays a significant part in the digestion system. It is a six-inch pear-shaped gland in the stomach that extracts enzymes to facilitate digestion and produces hormones like insulin and glucagon to control blood sugar. The leading factors contributing to cancer-related deaths globally include Pancreatic ductal adenocarcinoma (PDAC), constituting 90% of pancreatic cancers. The staging of PDAC primarily relies on the extent of tumor infiltration and surrounding. Thanks to medical imaging scans, a substantial portion of cancer patients can detect irregularities in an earlier stage. There are different types of diagnosis of Pancreatic Cancer (PC) such as Tumor Marker Test, Magnetic Resonance Imaging (MRI), Computerized Tomography scan (CT scan), Positron Emission Tomography (PET) Scan, Endoscopic Ultrasound (EUS), Endoscopic Retrograde Cholangiopancreatography (ERCP), Percutaneous Transhepatic Cholangiography (PTC), Biopsy. Many of these tests are conducted to identify, diagnose, and strategize treatment plans for various medical conditions. Five treatment types are used to individuals with PC, such as Surgery, Radiation therapy, Chemotherapy, Chemoradiation Therapy and Targeted Therapy. Treatment with chemotherapy is advised for locally advanced and marginally resectable PDAC. The manual measurement of the tumor volume, which can be a laborious and complicated procedure depending on the radiologist's skill, is among the widespread of crucial steps before to each chemotherapy and radiation treatment. PC originates with the development of cancerous cells in pancreatic tissue. When aberrant cells in the pancreas begin to divide and develop uncontrollably, they create a growth known as a tumor, serves as the cause of pancreatic cancer. The PDAC starts at cells within the duct of the pancreas or ductulus that contain digestive juices and convey the enzymes to the small intestine. The tumor can grow any part of Pancreatic Cancer; normally, the head of the pancreas is very prone to the tumor. A predominant symptom of this particular cancer often includes pain, accompanied by weight loss and jaundice. 95% of the time, Pancreatic Cancer is Pancreatic Ductal Adenocarcinoma, which lies in exocrine cancer. There are two kinds of PC: Pancreatic Exocrine Tumors and Pancreatic Neuroendocrine Tumors (PNETs). Pancreatic Exocrine Tumors is the most common PC around 93% of PC and 7% are PNETs. This cancer mutation is the mutation of cells in the pancreas, which spread erratically and can reach organs and blood vessels if not treated timely. The cause of this mutation of cells remains mysterious to the expert. Smoking and Alcohol Consumption are the major risk factor for PC. However, Diabetes, Chronic inflammation of the pancreas, Family History, and Obesity are other factors. The PC's detection and diagnosis are quite difficult because of its unnoticeable symptoms in the early stage. PDAC in CT scans is definitely among the most difficult tumor segmentation tasks. Three factors are the main sources of difficulty for automated pancreatic and tumor segmentation:

(1) Variability in the pancreas' size, shape, and location, particularly with regard to PDAC mass,

(2) The tiny extent of the pancreas and the appearance of a tumor can be noticed in the entire CT scan,

(3) Weak differentiation in contrast surrounding the boundaries.

In general, there are two kinds of organ segmentation methods: top-down and bottom-up. Top-down approaches use pre-existing knowledge, such as atlases or shape models, that have been created and integrated into the framework through image registration or shape model fitting. Bottom-up methods employ local image similarity grouping or labeling based on pixels or voxels. When it comes to diseased organ segmentation, bottom-up approaches are more successful.

RELATED WORK

[1] This paper introduced an automated 3D segmentation model for pancreatic sub regions in contrast-enhanced CT images. The model incorporates anatomical constraints using a naive Bayesian approach within a U-Net segmentation framework. It was trained on healthy pancreas CT scans and tested on healthy, precancerous, and cancerous pancreas data. The study, funded by NIH, shows promising results for early pancreatic cancer diagnosis and treatment planning, though further validation with larger data sets is needed. The research adhered to ethical guidelines, utilizing both public and approved internal data sets without patient identifiers.[3] This paper presented a network of convolutional neurons for automatic separation of pancreatic ductal adenocarcinoma (PDAC) masses and surrounding abdominal vessels in CT images. They introduce a modified Attention U-Net called TAU-Net, incorporating information from dense SIFT and 3D-LBP for accurate segmentation. The method utilizes a 3D CNN with 3D LBP maps to localize pancreas slices and employs a hybrid model integrating adjacent slices' data to improve segmentation accuracy. The study achieves promising results, enhancing PDAC diagnosis and visualization, with potential applications in other pancreas tumors and lesions, emphasizing the importance of 3D visualization software for clinical integration.[5] This paper discussed the application of CNN-based sophisticated machine learning techniques for deep learning-based pancreatic tumor prediction techniques. It explores pancreatic cancer classification using MRI and CT scans, emphasizing CNN's ability to directly learn image data without the necessity of segmentation or feature extraction. The study conducts a comparative analysis of various algorithms, highlighting CNN's superior performance and versatility in diagnostic imaging interpretation. The paper anticipates CNN becoming the mainstream technology in medical image processing in the coming decades due to its high efficiency and accuracy.[6] Detecting tumors early, non-invasively subtyping them, evaluating and gauging treatment effectiveness are significant challenges in pancreatic cancer diagnosis. To address this, advanced imaging techniques and sophisticated image post-processing algorithms are being developed. Intensified screening programs utilizing these technologies have the potential to enhance patient outcomes in pancreatic cancer management.[7] This paper discussed the challenges of diagnosing pancreatic cancer, highlighting its low survival rate. It introduces a method utilizing machine learning algorithms (PSO SVM, AdaBoost, and C4.5) and image processing techniques (CLAHE, K-means, PCA) on CT scan images. These methods aim to enhance image quality, segment components, identify objects, and extract crucial information, ultimately aiding in the prompt identification of pancreatic cancer. However, the high cost of technology hinders its accessibility to a significant portion of the population.[8] The study of this paper emphasized the potential of urine-based biomarkers for early PDAC detection, suggesting their combined use for higher accuracy. A six-protein biomarker panel was developed, enabling the identification of early-stage pancreatic cancer in urine samples. The research highlights the significance of multi marker panels, incorporating glycoproteins and CA19-9, along with imaging techniques, to enhance diagnostic strength, providing a promising avenue for early PDAC screening programs.[11] The paper discussed pancreatic tumor detection using a minimum distance classifier, achieving an average accuracy of 65.26%. Due to close gray level intensity between pancreas and surrounding organs, accuracy is moderate. The study suggests improving accuracy through advanced classifiers like artificial neural networks, support vector machines, genetic algorithms, or fuzzy logic. Additionally, utilizing feature extraction techniques such as GLCM and PCA to enhance input data for classifiers can further enhance the precision of pancreatic tumor detection. [18] Segmenting pancreatic tumors and cysts using deep learning is notably more challenging compared to pancreas segmentation alone. Deep learning has gained popularity for pancreatic tumor segmentation because of its capability to automatically extract complex patterns and features from large datasets. Figure 1 shows the overall the history of various methods for pancreas and pancreatic tumor segmentation.

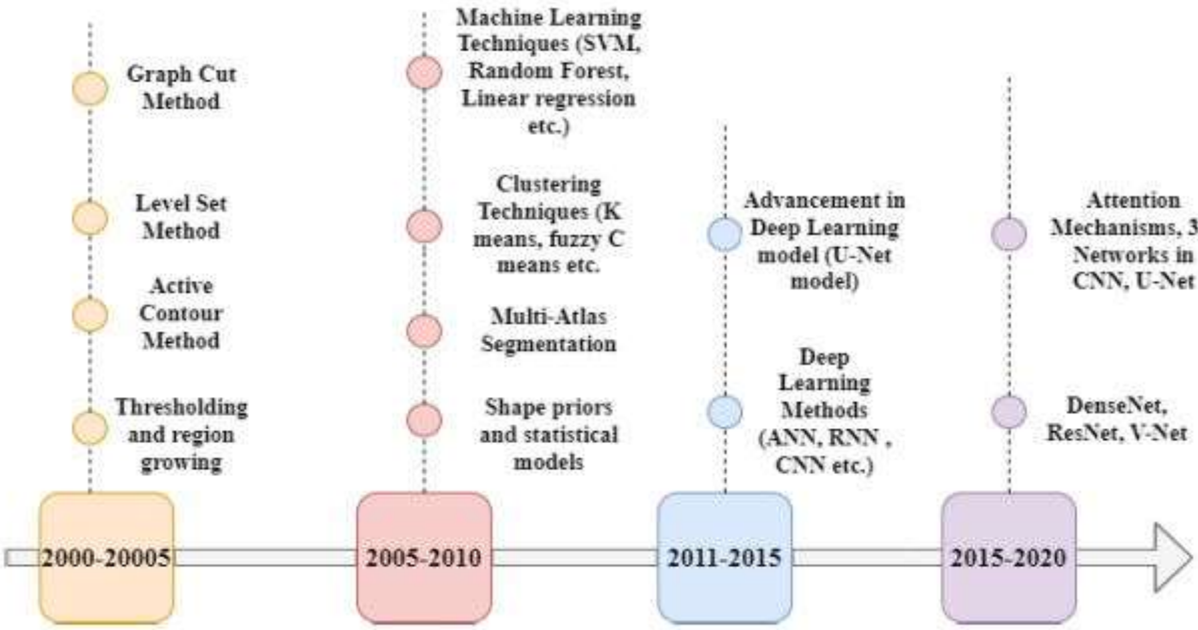

Figure 1: History of various methods for pancreas and pancreatic tumor segmentation [18]

II. Materials and methods

In this research, CT images of pancreatic ductal adenocarcinoma, publicly accessible and titled cancerimagingarchive dataset are used. Total 18,255 images from 82 folders are downloaded from the site. For sample purpose 50 images are considered. The images were in DCM format. A DCM file is an image file stored in the Digital Imaging and Communications in Medicine (DICOM) format, often employed in medical imaging. It stores a diagnostic imaging file, much like a CT scan or ultrasound, and may also encompass patient data for associating the image with the patient. The DICOM format was established by the National Electrical Manufacturers Association (NEMA). NEMA released the initial standard in 1983 and revised it several times in the 1990s and 2000s. This format has been universally adopted as the standard for storing, transmitting, viewing, processing, and printing medical images, including MRIs, CT scans, and ultrasound images. The DCM format is employed for preserving images that could contain ultrasound images, MRI (Magnetic Resonance Imaging) and CT (Computed Tomography) scan sheets among others. The GNU Image Manipulation Program (GIMP)GIMP software is utilized in a Microsoft Windows-based system to access and view the content of these DCM files. It is freely available software. It comprises three categories of pancreatic tumors: intraductal mucinous neoplasms, pancreatic neuroendocrine tumors, and pancreatic ductal adenocarcinoma. CT scan images have resolutions of 512x512 pixels exhibiting diverse dimensions in terms of both size and slice thickness between 1.5 to 2.5 mm. Types of CT scan images which helps to suspect pancreatic cancer are:

[1] Multiphase CT: A multiphase CT involves a set of images taken over several minutes to monitor for changes.

[2] Cross-sectional CT: A cross-sectional CT scan takes images at different angles of your body to get an even better idea of the size and scope of a tumor.

However, CT scans were avoided to figure out the smaller tumor and 40% of tumors are smaller than 2cm. The Fuzzy Logic Toolbox featured by MATLAB (MATLAB, The MathWorks Inc., 1995-2018) comes up with functions, code, app and Simulink block based on Fuzzy Logic to analyze and design a system so as to implement the system in the practical world. MATLAB is efficient software to conduct research regarding disease diagnosis by applying a Fuzzy system.

With MATLAB, we can:

- Visualize and explore 2D images and 3D volumes
- Process very large multi resolution and high-resolution images
- Simplify medical image analysis tasks with built-in image segmentation algorithms
- Use cutting-edge machine learning techniques for classification
- Parse, load, visualize, and process DICOM images

Processed sampled images as follows:

- *Collected Original images*:
  Figure 2 shows collected CT scan images of pancreatic cancer tissues.

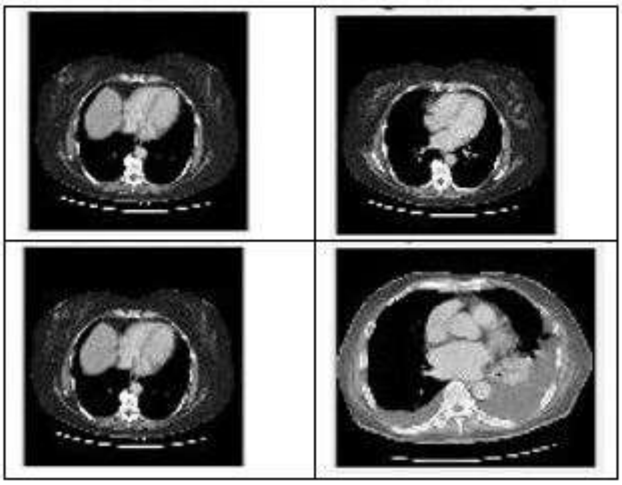

Figure 2: CT scan images of pancreatic cancer tissues [13]

- *Converted to grayscale image*:
  It simplifies algorithms and also reduces complexities associated with computational requirements. It creates space for more accessible learning opportunities for people who are unfamiliar with image processing. This is because grayscale compresses an image to its minimal pixel representation. It facilitates easier visualization. It distinguishes between shadow details and highlights in an image primarily because it operates in two spatial dimensions (2D) rather than three (3D). Color complexity is also minimized. A typical 3D image requires camera calibration, including adjustments for brightness among other factors. The grayscale conversion option is highly beneficial for captured images that do not require color detail matching. Grayscale transformation has been used in medical practice for computer aided diagnosis. It is very crucial as the images from ultrasound X-Ray and computer tomography (CT) scans rely heavily on them to give the right advice and treatment. Image segmentation is vital here as the various organs and tissues of the human body have different values in grayscale. Images captured by medical staff are segmented to differentiate the various anatomical structures. That way the unique features and defects of each organ or tissue is easily identified. The 3D technology creates bounding boxes which makes objects easily detected. The 2D object detection also highlights areas of specific medical interest.

- Filtered images:
  Achieved image by converting RGB image into gray image. Applied median filtering to reduce noise and retain sharp boundaries of image. Median filtering is a common nonlinear operation used in image processing to reduce "salt and pepper" noise. A median filter proves to be more efficient than convolution when the objective is to concurrently diminish noise while conserving sharp boundaries. Figure 3 shows Filtered images.

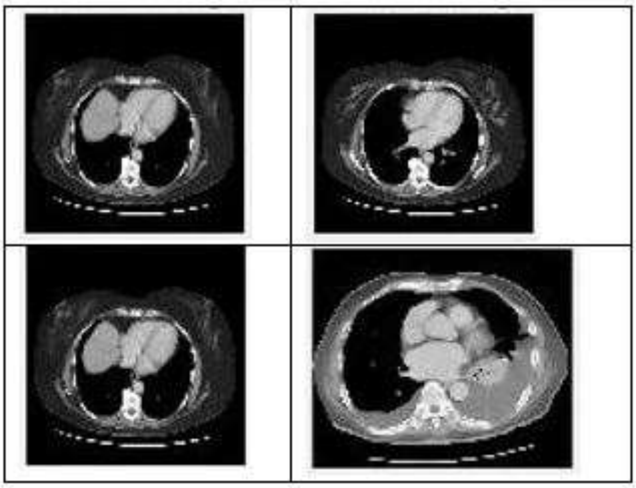

Figure 3: Filtered images

- Histogram of filtered images:
  An image histogram is a graphical representation depicting the distribution of tones in a digital image. It displays the number of pixels for each tonal value. By examining the histogram of a specific image, a viewer can quickly assess the entire tonal distribution. Figure 4 shows histogram of filtered images.

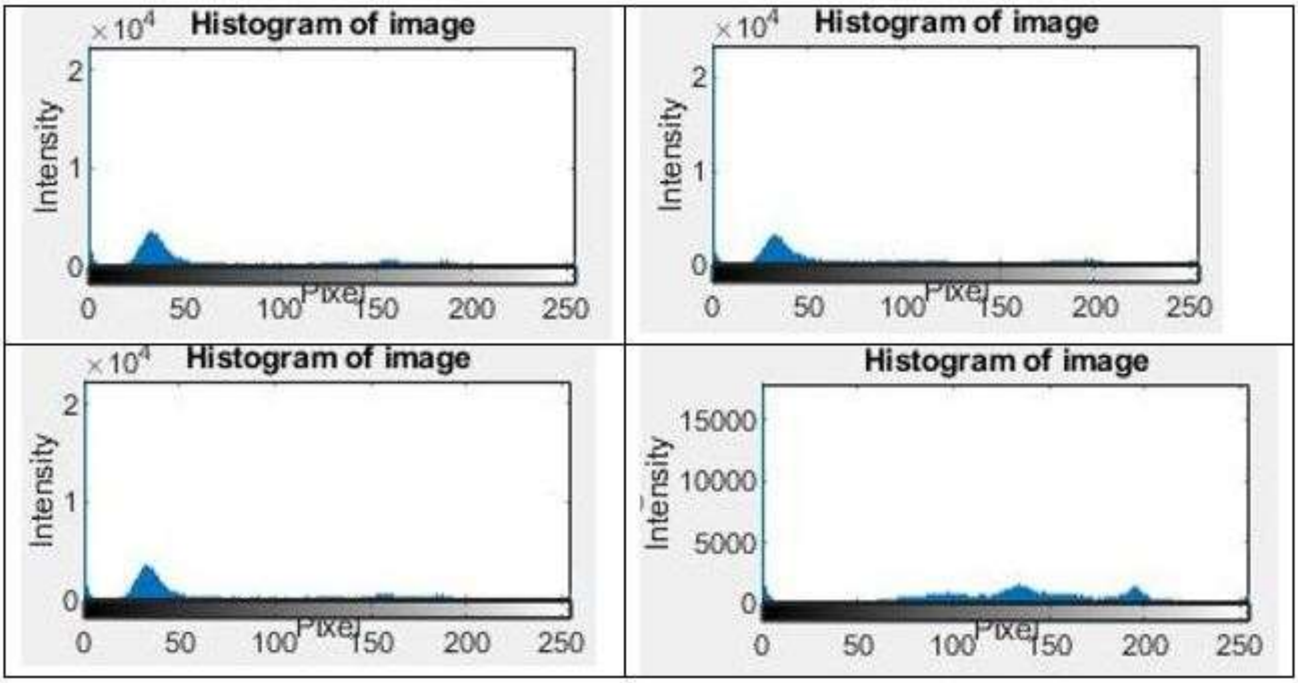

Figure 4: Histogram images

- Converted to Binary images:
  Applied Otsu's thresholding method for Segmentation in which pixel values are checked and found best spot where two classes can be categorized into a duo of by minimizing variance over histogram of it. Otsu's method is a popular technique employed for image thresholding. It separates an image into two classes, foreground, and background, corresponding with grayscale intensity values of its pixels. Furthermore, Otsu's method uses the grayscale histogram of an illustration to identify an optimal threshold value that distinguishes between two regions with maximum inter-class variance. Figure 5 shows converted binary images.

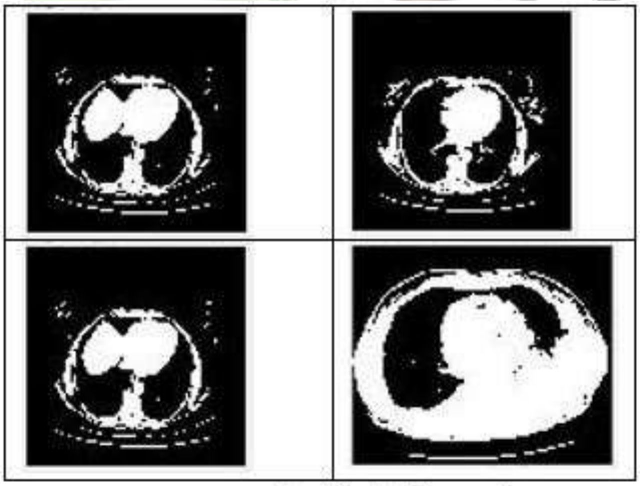

Figure 5: Binary images

- Found Region of Interest:
  Figure 6 shows region of interest derived from binary images.

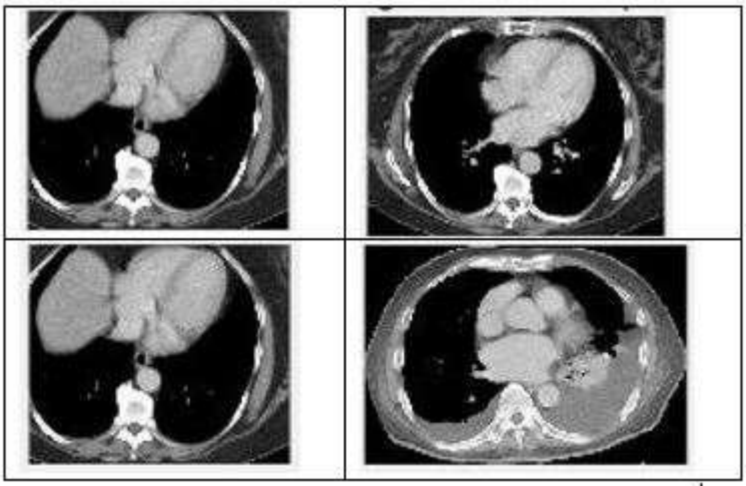

Figure 6: Region of Interest

III. CONCLUSION

It stands as among the most devastating illnesses that can be diagnosed globally, with a notably low five-year survival rate. Most of occurrences in this situation are caused by pancreatic cancer, making it among the most prevalent causes. The improved accessibility of diagnostic imaging procedures has allowed a significant portion among cancer patients, enabling the detection of irregularities earlier in the process. Because a significant quantity of people cannot afford the expensive infrastructure and gear required to use the technology, it is difficult to spread. In this paper, pancreatic tumor is detected. Since gray level intensity of pancreas and other organs in abdomen are very closely related the precision of the system is moderate. However, the accuracy can be improved by applying feature extraction methods such as GLCM and PCA. These features can be given as input to the classifiers in order to categorize various areas within the image. Additionally, their applications in medical image interpretation are also explored, particularly for pancreatic tumors. The classification of pancreatic cancer in MRI and CT scans is investigated. A dataset of computerized tomography images is used for evaluation among cancer patients, enabling the detection of abnormalities at an earlier stage suggested strategy. Pre-processing CT images is essential to enhance their visual quality before further processing. The images in the collection frequently contain noise, which is removed during pre-processing. Afterwards, the segmentation process is completed. During this procedure, the areas of pancreatic cancer are identified and delineated. The results are promising but require further validation and approval in larger datasets. Accurate segmentation of pancreatic subregions facilitates reliable analysis and quantification of local morphological changes in the pancreas, which can aid in early diagnosis and treatment planning for pancreatic cancer (PC).

Environmental (Non-Genetic, Including Lifestyle, And Clinical Factors) Risk Factors of Pancreatic Cancer by The Level of Evidence

Table 1: Factors indicating risk level

Level of Risk	Factors
Very Strong	Cigarette smoking, chronic diabetes, obesity
Strong	Poor oral health/oral hygiene, chronic pancreatitis, no history of allergies, heavy alcohol drinking, dietary patterns with a low amount of vegetables and fruits.
Moderate	Dietary patterns rich in meat and animal products, oral/gut microbiome, hepatitis B or C infection
Unclear	Environmental tobacco smoke, light to moderate alcohol drinking, physical inactivity, coffee, Helicobacter pylori infection

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