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Survey on Pancreatic Tumour Segmentation

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Abstract: **Pancreatic tumors are abnormal growth of cell in digestive enzymes and hormone producing cell.. Pancreatic adenocarcinoma is one of the most aggressive malignant tumors which remain the fourth leading cause of the cancer related death. The prognosis for patients diagnosed with this pancreatic tumor has always remained extremely poor. Unlike brain, pancreas is not protected by skull .It is surrounded by various organs and fatty tissues in the abdomen and hence detection and segmentation is not appropriate. Most of the abdominal CT images include noises along with the visceral fat in the proximity of pancreas makes it very challenging for early detection. Though much work still needs to be done, developments in the field provide the hope for early prediction of pancreatic cancer could become a reality in the not-so-distant future. A comprehensive survey of segmentation of pancreatic tumour is done in this paper.**

Keywords: Pancreatic adenocarcinoma, computed tomography, segmentation.

I. INTRODUCTION

Generally healthy cells grow in a normal and controlled way unlike the cancerous cells. Pancreatic cancer is developed from cells that grow uncontrolled and progressively forming a tumour in pancreas. Early diagnosis of this tumour is very strenuous. Even though it gets detected, we need to take great care not allowing it to spread further as it may get incurable where surgeries may also end up helpless. Pancreatic cancers are divided into two main groups, namely exocrine and endocrine tumors each of which behave differently and hence are treated differently. More than 95% of the tumors account to exocrine while less than 5% of all pancreatic tumors account to endocrine tumors. Pancreatic adenocarcinoma is a low incident but highly mortal disease. By 2030 it is expected to be the second leading cause of all cancer deaths. While there is no peculiar reason still found, on why a person is affected by tumour. Some of the factors leading to this disease are smoking, diabetes, obesity, pancreatitis, genetic disorder etc. Laboratory results which show high amount of carbohydrate antigen (CA 19-9) confirms the presence of tumour. Treatment of this tumour is based on the four stages of cancer prevailing. Stage 1 is the early, localised and resectable pancreatic cancer. Next stage is where the tumour starts growing into the duodenum, bile, and the nearby tissues of the pancreas and is still resectable. Stage 3 is locally advanced and very occasionally resectable. Stage 4 is very advanced and unresectable. Relatively it is the impact of TNM (Tumour Node Metastasis). Recent detection methods include ANN based image classifier developed in MATLAB software to detect tumors from the PET scan images of diagnosed persons. PET is a kind of nuclear medicine imaging which captures those cells consuming more amount of FDG (Flu-deoxy-glucose). The highest accuracy shown through ANN is 98%.But for more promising results , we can make use of Deep convolutional networks. It is said that it results with higher segmentation accuracy.

II. LITERATURE SURVEY

[1] “A Hybrid tool on Denoising and enhancement of abdominal CT images before organ and tumour segmentation” Hasan Koyuncu, Rahime Ceylan [IEEE 2017]

This paper mainly explains Block-matching and 3D filtering algorithm for elimination of Gaussian noise. Peak-signal-to-noise ratio and Structural similarity index are used to evaluate the performance. Ultrasonography can detect even small sized tumors which the CT or MRI scan fails to capture. CAD is a computer aided diagnosing system which gives us information by detecting the boundary of the tumour. Many algorithms are used such as DSIFT, Jaccard Index, Dice coefficient, Graph based algorithm, Edge based algorithm, Kernel density estimator, Graph cuts etc. Drop-out is one form of regularization which improves the performance in CNN. This mainly helps us with more texture information. It is otherwise said that it removes over fitting. But the main advantage is its increasing training-time.

[2] “Progress in fully automated abdominal CT interpretation” Ronald M.Summers [AJR: 207, July 2016]

This paper covers the broad swath of applications in the abdomen including organs like lymph node, adipose tissue, muscle, bowel, spine, and tumour analysis. A CT image of a lesion is combined with other modalities like PET and MRI in order to improve segmentation. One of the limitations found is requirement of greater availability of CT datasets in order to advance the field. Machine learning, a computer science discipline, has shown a tremendous effect in the advancements in the field of radiology CAD. There has also been a recent explosion of research activity on the usage of deep-learning for radiologic image analysis. Refinement of neural networks is mostly used to make decisions from the data.

[3] “Pancreatic tumour growth prediction with elastic-growth decomposition, image-derived motion, and FDM-FEM coupling”Ken C.L Wong, Ronald M.Summers, Electron Kebebew, and Jianhua Yao [IEEE 2016]

This paper briefs us on the usage of FDM-FEM coupling in where pressure is reduced in simulation and personalization time. Optimization framework helped in properly identifying the model parameters. One of the

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limitations is that this paper has not showcased the numerical accuracy of FDM-FEM coupling. The paper has mainly concentrated on the methods of extracting motion information from images. Mass effect is mainly used for highly deformable objects. Cell invasion is used for image-based personalization. FEM cannot be used to solve the reaction-diffusion equation as it may increase the computational complexity. The prediction performance is represented by recall, precision, dice-coefficient, relative volume difference(RVD and average surface distance(ASD).

[4] "Fast edge detection using structured forests" Piotr Dollar and C.Lawrence Zitnick [IEEE 2014]

This paper has proposed a generalized structured learning approach that is applied along with edge detection. One of the main advantages is that it is computationally efficient. The novel approach of this paper is to learn decision trees using structured labels for determination of splitting function. On the other hand, edge localization is done by finding zero-crossings. The edge enhancement step simply involves calculation of the gradient vector at each pixel in the smoothed image. Efficient implementations combine the smoothing and enhancement steps by convolving the image with a derivative of the Gaussian kernel. Results from edge detection cannot be used directly. Post processing steps must follow to combine edges into edge chains to represent the region border. The more prior information used in the segmentation process, the better the segmentation results can be obtained.

[5] "Rich feature hierarchies for accurate object detection and semantic segmentation" Ross Girshick, Jeff Donahue, Trevor Darrell, Jitendra Malik [IEEE 2014]

This paper has applied high-capacity convolutional neural network to bottom-up-region proposals only to localize and segment objects. It explains that CNN dramatically leads to higher object detection performance on PASCAL VOC. Sliding-window approach is also used. The second principle contribution of this paper is to show that supervised pre-training on a large auxiliary dataset followed by domain specific fine tuning on small dataset is an effective paradigm for learning high capacity CNNs whenever data is scarce. It is learned that there occurs a need to apply non-maximum suppression that rejects a region if it has an intersection-over-union-overlap with a higher scoring selected region larger than a learned threshold. This paper has actually shown 30% relative improvement over previous results.

[6] "A generic approach to pathological lung segmentation" Awais Mansoor,Ulas Bagci, Ziyue Xu, Brent Foster, Kenneth N.Olivier, Jason M.Elinoff, Anthony F.suffredini, Jayaraman K.Udupa, Daniel J.Mollura [IEEE 2014]

This paper has adapted fuzzy-connectedness-image segmentation algorithm. Various image segmentation methods include threshold method, edge-based-method, region based method, clustering based method, watershed method etc. Threshold algorithm makes decisions based on information from local pixels and is very effective when the intensity levels of the objects fall squarely outside the range of background levels. Bottom-up-approach is being used to classify image patches at different resolutions providing hierarchial cascade of information in super pixels. It merely starts with a very fine partition and applying connected fitters to the initial image, only then merges with the neighboring image until target segmentation is reached. With the help of MRI, we still find difficulty in defining actual boundaries due to the overlapping of abnormal tissues. Accurate segmentation of the pathological lung is challenging since lung pathologies hold appearances different from the normal lung tissue.

[7] "Dropout: A simple way to prevent neural networks from over fitting" Nitish Srivastava, Geoffrey Hinton, Alex Krizhevsky, Ilya Sutskever, Ruslan Salakhutdinov [Journal of machine learning 2014]

Dropout is a technique for improving neural networks by reducing over fitting. Here each model is weighed equally unlike in the Bayesian neural network where each model is weighted taking into account the prior and how well the model fits the data. But the only disadvantage lies in slow training. With more training time, one can use high dropout and suffer less over fitting. A dropout network typically takes 2-3 times longer to train than the standard neural network of the same architecture. On the other hand dropout can be seen as a way for adding noise to the states of hidden units in a neural network. The author has also stated that speeding up dropout is an interesting direction for future work.

[8] "Regression forests for efficient anatomy detection and localization in computed tomography scans" A.Criminisi, D.Robertson, E.Konukoglu, J.Shotton, S.Pathak, S.White, K.Siddiqui [Elseiver 2013]

This paper proposes a new algorithm for efficient detection and localization of anatomical structures in 3D computed tomography studies. Marginal Space learning is one of the most popular approaches for object localization. Depending upon the area of application, segmentation can be broadly classified into three methods known as boundary based segmentation method, region based segmentation method and hybrid. Still it is very challenging to define exact boundaries of normal and abnormal tissue. PDE and PDF are extensively applied in image segmentation along with a kernel function which will help us suppress the noises in the extracted regions of interest an ensemble of regression trees are trained to precisely predict the location and size of all desired organs. The main goal is to achieve accurate anatomy localization in seconds on a conventional machine. Location estimates are obtained by a multivariate regression forest algorithm.

[9] "SLIC superpixels compared to state-of-art superpixel methods." Radhakrishna Achanta, Appu Shaji, Kevin Smith, Aurelian Lucchi, Pascal Fua, Sabine Susstrunk [IEEE 2012]

Superpixel algorithms group pixels into meaningful atomic regions that is used to replace the rigid structure of the pixel grid. Graph based algorithm helps mainly in superpixel

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generation. Another alternative used is the Gradient-ascent-based algorithm for the function of clustering and refining the clusters. This paper has provided an in-depth performance analysis of modern superpixel techniques. And has also portrayed an empirical comparison of five-state-of-the-art algorithm concentrating on boundary adherence, segmentation speed, and performance of the preprocessing step in segmentation work. Based on k-means clustering a new method is proposed for generating superpixels in addition.

[10] "Image compression based on wavelet transform" Liu Bo, Yang Zhaorong [IEEE 2012]

Wavelets often used to represent and analyze multi-resolution images which can also be applied to 1D signals. It is also very useful for image compression (e.g., in the JPG-2000 standard).It can easily remove noise and image storage space. An algorithm called the 'fast wavelet transform' (FWT) has been developed by Mallat in order to achieve fast and efficient implementation of the discrete wavelet transform. The FWT is similar to the two-band sub-band coding scheme which is also based on the relationship between the coefficients of the DWT at adjacent scales. Direct discrete wavelet transform implementation is theoretical invertible. However, due to the finite register length of the computer system, inversion errors could occur and it would result in unsuccessful image reconstruction. In practical cases, the wavelet coefficients will be rounded to the nearest integer in the discrete transformation stage. This makes the lossless compression impossible. Subsequent studies on the fast wavelet transform improved the discrete wavelet transform based on the multiresolution theory and made implementation of the transform feasible using convolution.

Table.1 Analysis of Algorithms in Various Works

Sl. No	Title Of The Paper	Proposed Algorithm	Observation	Limitations
1	A Hybrid tool on denoising and enhancement of abdominal CT images before organ and tumour segmentation	Block-matching, 3D filtering	Helps in denoising and enhanceme-nt	BFO cause information loss
2	Progress in fully automated abdominal CT interpretation	CAD	Efficient in automated imaging analysis	Increased pressure for commoditization
3	Pancreatic tumour growth prediction with elastic growth decomposition ,Image derived motion and FDM-FEM coupling.	DIRECT,MLSL, SUBPLEX	Simulation time is reduced. Improved accuracy	Contradicts incompressible nature of soft tissues
4	Fast edge detection using structured forests	Random decision forest, Gain criterion	Faster, Improves sharpening, speed. No loss in recall.	Higher cost per pixel.
5	Rich feature hierarchies for accurate object detection and semantic segmentation	Scalable detection algorithm	Combines low-level image features with high-level context	Data scarce vision problem
6	A generic approach to pathological lung segmentation	Dice similarity coefficient, Random forest classificati on	More accuracy, Reliable	Absence of denoising mechanism. Performance failure in dense pathologies.
7	Dropout: A sample way to prevent neural networks from overfitting.	Dropout, RBM, DRB	Supervised in vision/speech recognition. Reduces overfitting. Easy approximat-ion.	Prevents unit from co-adapting too much. Slow to train, Difficult to scale to large network sizes.
8	Regression forests for efficient anatomy detection and localisation in computed tomography scans	Multi atlas registration Semantic visual navigation	Higher precision, Improved location estimation.	Fails to estimate the organ extent, Inaccurate alignment.
9	SLIC superpixels compared to state-of-art superpixel methods.	SLIC method, PASCAL	Faster, memory efficient, Reduces number of distance calculations .	GCIO & TP09 do not consider color information
10	Image compression based on wavelet transform	Fast wavelet transform, Integer to integer wavelet transform	Efficient for lossy compressio-n Useful in image compressio-n.	Occurrence of inversion error, Degradation of image reconstruction

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III. CONCLUSION

In this paper we have accomplished a survey of various segmentation techniques for images of pancreatic tumour. A comparative study is made on various algorithms along with its advantages and disadvantages. There is future scope in the improvement of the present methodology as no method guarantee cent percent accuracy. It is observed that a hybrid solution for image segmentation consisting of a combination of two or more techniques is being the best approach to solve the problem of image segmentation.

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[5] Ross Girshick, Jeff Donahue, Trevor Darrell, Jitendra Malik "Rich feature hierarchies for accurate object detection and semantic segmentation" [IEEE 2014]

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