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Kidney tumor detection and classification using image processing

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ABSTRACT

Kidney cancer is a disorder where the cells of the kidney become abnormal and develop into a tumor. It is also referred to as renal cell carcinoma. The detection of kidney tumor in the early stages is very important; it is said that different imaging techniques can help doctors to decide the cancer stage and determine the appropriate treatment method. The detection and diagnosis of kidney tumors are performed by scanning images of computed tomography. Most existing works in renal kidney cancer is detection and diagnosis of the existence or absence of tumor in the kidney and classify the tumor as harmless or malevolent. The fundamental goal of this paper is to propose a strategy that will characterize the type of cells present in the kidney tumor. This can be accomplished through methods like segmentation, feature extraction using GLCM and classification using multiSVM.

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INTRODUCTION

Malignant kidney growth, also known as malignant renal growth, is a disorder in which renal cells become dangerous and uncontrolled shaping a tumor. Practically all kidney tumors initially show up in the covering of modest cylinders (tubules) in the kidney. One of the advantages is that the majority of kidney cancer can be found in the most primitive stages before they can be spread (metastasize) to remote organs. Early caught cancers are facilitated to diagnose, but these tumors can develop quite large if they are not detected.

Doctors realize that kidney malignancy starts when some kidney cells gain transformations in their DNA. The transformations advise the cells to develop and partition quickly. The gathering abnormal cells structure a tumor that can reach out beyond the kidney. A couple of cells can separate and spread (metastasize) to remote body areas.

There are several factors that can increase the risk of causing kidney cancer such as obesity, smoking, older age, high blood pressure (hypertension), certain inherited syndromes, family history of cancer etc.

In grown-ups, renal cell carcinoma is a very well-known sort of kidney cancer - around 90 percent of cancerous tumors. Others less regular kinds of kidney disease can happen. Adolescents are bound to build up a sort of kidney malignant growth called Wilms' tumor.

The frequency of renal cancer is, by all accounts getting higher. One rationale behind this might be the way that imaging procedures, for example, Computed Tomography (CT) examines, are being utilized more frequently. These tests may prompt the unintentional disclosure of more kidney cancers. As a rule, kidney cancer is found at the beginning time, when the tumors are little and bound to the kidney, making them easier to treat.

An individual with a tumor has certain indications, and this will bring that individual to a doctor. From this, they will almost certainly identify the littlest conceivable symptomatic malignancy (carcinogenic) tumors that are in the beginning period, and the Tests of blood and urine may give doctors intimations about what's causing your signs and symptoms while littlest conceivable asymptomatic tumors are identified by imaging tests which enable doctors to picture a kidney tumor or abnormalities.

MATERIALS AND METHODS

A great number of simulations have been undertaken in the area of tumor detection. Some of the simulations that are related to the proposed work are addressed below,

(Azhari *et al.*, 2014) a method was proposed to segment images and detected edges. The threshold method was used to detect damaged tissue and noise can be removed by filters. They used greyscale images converted from MRIs, or CT scans through the image segmentation transfer process. The research aims to use a canny edge detector frequently used by the edge detection process in similar areas. Several medical constraints and contributions to future work have also been identified.

A detailed cancer survey has been proposed by (Geetha and Selvi, 2015) If you look at the knowledge and experience gained by the expert physicians they can use medical imaging to select the appropriate medical diagnostic optimization technique. This paper conveys an impression of cancer and literature surveys by previous researchers on cancer detection. This work tries to present a comprehensive and detailed comparative study of the different techniques of image processing. The review of the literature shows that new methods must be developed to detect cancer cells more efficiently.

(M.D.Devi and Malathi, 2017) proposes a new method of segmentation of CT scan images of kidney cancer for patients data. The process of segmentation is predicated on the method of setting hybrid levels with elliptical shape restrictions. A fully automated classification technique for the kidney region is introduced using segmentation results. To identify the kidney tumor, RUSBoost and decision trees are used. This approach enables the solution of major regional classification problems: Class imbalance and classification of a number of voxels. The classification is on the grounds of vectors of 64 elements calculated for the orientation of the 3d edge region and neighborhood information for the kidney area. The segmentation efficiency within the meaning of the dice coefficient was 0.850.04. The overall accuracy is 92.1 percent, confirming the solution's usefulness.

The research objective of (Pawar *et al.*, 2017) is to classify the images based on the shape and regional characteristics using Watershed Transform Techniques. Fruits and vegetables are considered in the image categories. The proposed image classification technique uses watershed transformation for segmentation, from which the features of the Haar wavelet are calculated and classified using the SVM, KNN and Naïve Bayes classifier. A voting technique is used to classify images, and the system's overall accuracy is about 90 %.

(Attia, 2015) A computer-aided system is actually proposed in this paper for the automatic classification of ultrasound kidney disease. It took into account images of five classes: Normal, cyst, stone, tumor and failure. A set of statistical attributes and a different set of multiscale wavelet-based attributes were obtained from each image's Region of Interest (ROI), and in order to shrink the number of characteristics, analysis of the main component was carried out. In the training of a neural network classification, the selected features were used. A correct 97 percent classification rate was achieved using the multi-scale wavelet.

(Ghalib *et al.*, 2014) The SOM growth algorithm and ANN were proposed to divide and conquer in order to check whether the tumor is benign or malignant. The average time of execution = 0.85 sec as this method is iterated dynamically until our data sets converge. In order to optimize the complexity of the algorithm, the probable error value has been significantly increased less progressively, and a faster and more efficient algorithm has been achieved. However, it is found that this compromised the precision of the clustering; a low level of likely error values has been maintained. In the case of Renal, the extracted features of CT scans of the ureter bladder will be useful to recognize the image class (normal/abnormal) by training and testing using classifiers. The values acquired from various methods of segmentation show variations in the same image values.

(Mredhula, 2015) Some ideas for image segmentation methods were suggested, which can be partitioned into different types: image-based, model-based and hybrid. The segmentation of image-based methods is based only on the image information. These consist thresholding, region growth, morphological operations, active contour sets, watershed, fluid connectivity and graph cuts (GCS). However, the results are not as good if the image quality is lower or the boundary information is missing. One

of the advantages of model-based methods is that all these gaps can be filled by using the previous information in the model, even if some object information is missing.

(Ali *et al.*, 2016) proposed an approach to diagnose and detect unhealthy parts of healthy parts and early stages of formation with fully integrated segmentation and image classification. The segmentation of watershed is a good segmentation process to segregate cancer from kidney, to compare the right and left of the kidney and to calculate the statistical texture properties derive from the average standard deviation and average co-occurrence matrix which helps diagnose the type of tumor. Geometric parameters of diameter and area were calculated to obtain cancer irregularities, doctors and radiologists are helped to the identification of the affected parts of the kidney to protect normal parts from radiation to the extent possible

The work proposed by (Gomalavalli *et al.*, 2017) is based on pre-processing, boundary segmentation, extraction and classification of features, while renal CT image is diagnosed with renal carcinoma and measured in size in the initial phase. The functions extracted are used to devise membership functions of fuzzy to attain better accuracy than SVM works. The predicted results are based on texture characteristic values, threshold variations, size of the extended tumor from the renal CT image samples supported by the clinical research center. The detection of limitations in segmentation and morphological operation allows the existence or absence of renal cyst and carcinoma to be diagnosed, which leads to the new formation of tumors in the kidney at an early stage and improves classification accuracy.

(Duth *et al.*, 2017) the method proposed follows Spatial Kernel Fuzzy C - Means (SKFCM) and Variational Level Set Method (VLSM) to minimize all of these imperfections. SKFCM is related to the standard Fuzzy C – Means algorithm making use of the Gaussian RBF kernel as a distance metric incorporating spatial information. The VLSM uses the energy function to control and scale the exact time of processing that will address the complexity of time. The proposed system is a hybrid of the combined approach of both SKFCM and VLSM.

(Vasanthselvakumar *et al.*, 2017) proposed work on hundred ultrasound images of B-mode with a unique size from different centers. Quality measures for detection and classification have been taken. Experimental results show better performance in the detection of various types of kidney diseases using HOG features. The classification performance measurement was performed using two SVM techniques, such as SIFT and SURF.

(Sankaraiah *et al.*, 2013) proposed methods of segmentation of kidney tumor detection using computed tomography images were systematically studied. There are many algorithms available for CT image segmentation, CT image segmentation can be divided into edge-based, texture-based, thresholding. Computed tomography (CT) also provides a broad range of physiological and anatomical data. Segmentation plays an important role in the detection of tumor CT in the division of an image into different sub-regions with homogeneous properties. This paper examines various methods used to segment MRI and proposes a new approach to incorporate the benefits of regional growth

(Khanna, 2016) says that a formal review of the development of image processing strategies for the detection of tumors was addressed to achieve the best outcomes for the detection and classification of tumors. The scope of the proposed technique appears to be tumor identification deficiencies.

Jayashree *et al.* (2017) The development of cancer identification is examined, which is expected to improve performance compared to recently proposed approaches. The images of the acquired renal cells are noisy. The acquired renal cell images are, therefore, segmented first in order to remove noise from the background using ROI extraction. Based on grading levels, cancer is identified. Furthermore, the overall precision of the system

Duth *et al.* (2016) proposed a Fast and Robust Level Set Method for Medical Image Segmentation Depending on the appropriate initialization of control parameters, the performance of the level set based segmentation. They estimated the level set controlling parameter from the outcome of Robust Spatial Kernel FCM (RSKFCM) in this paper. RSKFCM is based on a standard FCM algorithm that incorporates spatial information and uses the distance metric function of the Gaussian RBF kernel. They conducted experiments with different modalities on medical images. The experimental result highlights the efficacy of the proposed method. The RSKFCM algorithm may well approximate the interest boundaries. Levels set evolution will, therefore, start from a region close to real boundaries. Evaluation of performance was performed on various types of medical images. The results have been promisingly confirmed.

Proposed method

The proposed method Figure 1 is focused on segmentation and classification. In the first stage, the renal CT images of the kidney are acquired, and

preprocessing techniques are applied to reduce the noise in the image, then the preprocessed image is segmented using close morphological operation followed by extracting the features using GLCM. Multisvm enables us to classify the various kinds of tumors or cells in the tumor.

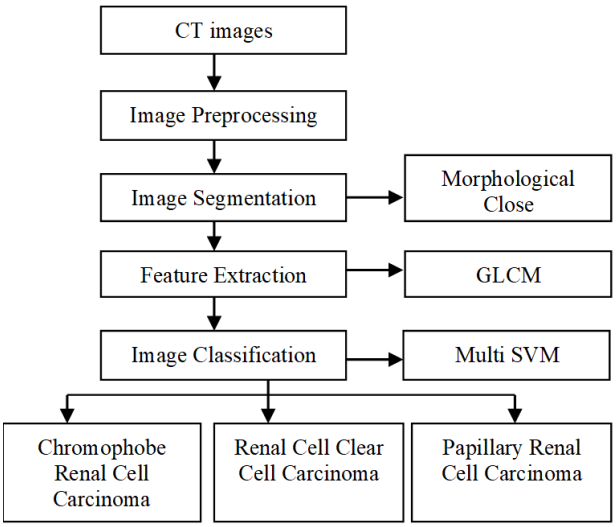

Figure 1: Proposed model

CT images

Computed tomography scan is a non-conspicuous indicative imaging system which uses X-ray and computer technology to create flat or pivotal images of the entire body (often called slices). A CT check shows pictures of any and every part, such as internal organs, muscles, fat and major organs. CT scans are often more detailed and specific than normal X-rays.

CT scans of most of the kidneys are extremely useful in the inspection of either kidney to locate conditions, such as tumors or various sores, obstructive conditions, such as kidney stones, innate abnormalities, polycystic kidney disease, solvent compilation all around the kidneys and abscesses.

Image preprocessing

Almost in every pattern recognition system, it is a appealing step to enhance its performance and eliminate variations and generate an even more consistent set of data. This method involves recognizing the major source of noise with a proper filtering technique and eliminating the noise.

RGB to lab conversion

Color-based image fragmentation is done by using the color of the image to tackle the problems observed when fragmenting an object in a complex and difficult scene. The image is morphed from the RGB space into the L*a*b * space after preprocessing. The three L*a*b* color space channels are then differentiated, and also a single major channel is chosen depending on the color being considered. Next, genetic color fragmentation is actually performed on a single channel picture, during which the discrete object of interest is practically introduced to the image.

RGB (Red Green Blue) is a color preservative system based on the idea of trichromes, sometimes found in processes that display images using a CRT. RGB is simple to implement, but visually perceived is not linear. It probably depends on the device and also the color specification is semi-intuitive. RGB is quite common in practically every software system, Television, video clip, etc.

A Lab color space is a color opponent space available with lightness dimension L and color parameters a and b based on non-linearly condensed colorspace coordinates of CIE XYZ. ”lab” color spaces create a platform which can be measured as well from XYZ space just using basic formulas, but it is more standardised than XYZ perceptually. Perceptually uniform ensures that a shift in the same color value should lead to a change of approximately the same visual significance. This can enhance the reproduction of tones when collecting colors in constrained accuracy values. Both Lab spaces are comparative to the white point of the XYZ information that they just were transformed from. Lab values do not describe absolute colours, even if the white point is also specified. The goal is to identify different colours in an image by analyzing the L*a*b * colour space.

Image segmentation

Image segmentation is defined as the image divisions into regions that are relevant to a particular task; it is a problem of labeling. Segmentation is the main step to analyze and interpret images. Detecting and classifying the tumor at an early stage is most essential in order to plan appropriate treatment. The doctor visually examines these CT scans for kidney tumor detection and diagnosis. Therefore, the segmentation method was proposed to overcome this, which extracts the part of the tumor from the kidney.

Morphological operation

Morphology is a huge range of image processing procedures that process shaped images. In morphological operation, all pixel in the image is altered depending on the value of other pixels in its vicinity. A morphological procedure is sensitive to particular types in the loaded image that can be formed by choosing the shape and size of the neighborhood. A strel object is a flat morphological, structural element that is an important area of dilation and ero-

sion.

Close- it performs open morphology, followed by dilation of erosion. This closure is similar to erosion, which removes the bright pixels from the image edge. This operation is essentially used to preserve the foreground regions similar to the element of structuring and to remove all other foreground pixels. A flat structuring element is a two-dimensional binary neighborhood that includes the true pixels in the morphological calculation and does not include the false pixels. The structuring element's center pixel called the origin recognizes the pixel in the processed image. A strel function is used to create a flat structuring element. This element can be used with binary and grey images.

Feature Extraction

Features are nothing else but unique signatures of the given image or unique properties that define an image in simple words. To differentiate between images, the feature is extracted.

GLCM (Grey Level Co-Occurrence Matrix)

GLCM is a widely used method for the analysis and classification of medical images. This method provides us with information on the relative position of two pixels. The GLCM is formed by counting the total amount of pairs of pixels at a certain distance. The statistical characteristics of texture characteristics like(energy, contrast, homogeneity and correlation) derive from the grey co-occurrence matrix and mean gray level, a standard deviation that helps diagnose the kind of tumor.

At this stage, the database consists of two parts training data and testing data. All types of tumors that are clear cell RCC, papillary RCC, chromophobe RCC are extracted and stored in trained data with normal kidney features. GLCM evaluation of 13 characteristics of the affected region has been done, which are as follows:

- Contrast
- Correlation
- Energy
- Homogeneity
- Mean
- Standard deviation
- Entropy
- RMS(Root mean square)
- Skewness
- Variance
- Smoothness
- Kurtosis
- IDM(Inverse difference movement)

Figure 2: CT image

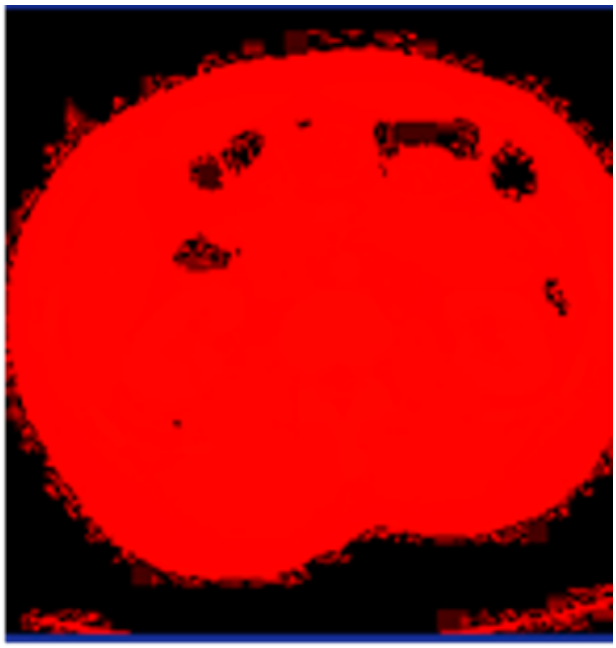

Figure 3: RGB to lab

Image classification

Support Vector Machine (SVM) is a form of supervised learning models and algorithms related to learning that examine the data and recognize different patterns used for classification.

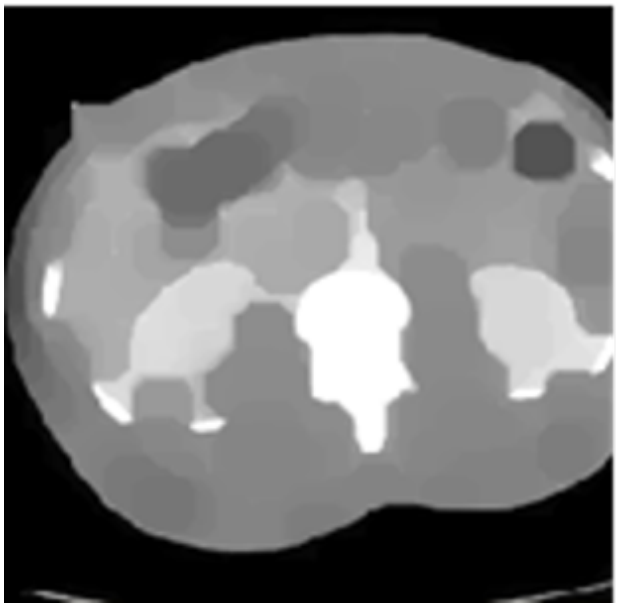

Figure 4: Close

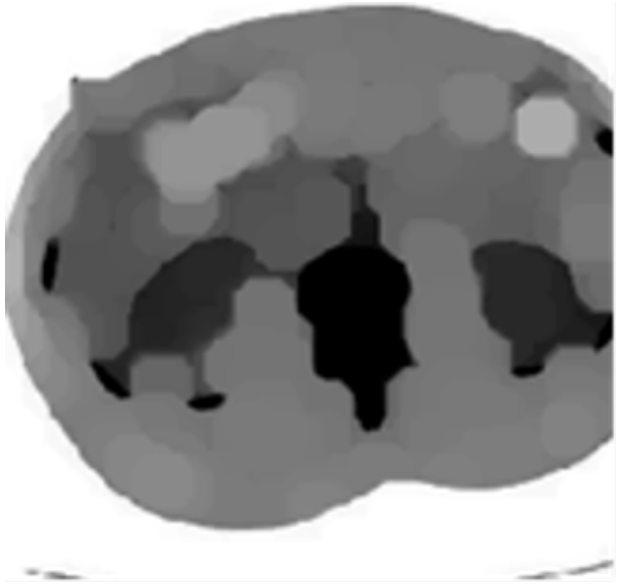

Figure 5: Compliment

MultiSVM

Originally designed for binary classification, support vector machine (SVM). How to extend it effectively for multi-class classification remains an ongoing research problem. Several methods have been proposed in which it is usually attempted to build a multi-class classification by combining several binary classifications. Some authors have also proposed methods that take all classes into account at once. Since solving multiclass problems is computationally more expensive, comparisons of these methods have not been seriously carried out using large-scale problems. The problem of classifying instances into one of three or more classes is multiclass or multinomial classification. Multiclass SVM intends to allocate labels to instances using support vector machines, which draw labels from a finite set of several elements. The approach used to do this is to reduce the single multiclass problem via one - to - all into multiple binary classification problems.

In this phase feature, extracted parameters are used for classification. MultiSVM classifier compares the feature extracted trained dataset which is stored with the input data to classify which kind of tumor it belongs to, or it is a normal kidney.

Advantages of this proposed method are listed below:

- It identifies the kind of cancer cell present in the kidney.
- MultiSVM is used for more than two classifications.
- Increases the accuracy level.

Drawbacks of this method are listed below:

- It is not suitable for large dataset.
- Efficiency can be increased.

Table 1: Values obtained from feature extraction

Features	Values
Contrast	0.0986767
Correlation	0.981171
Energy	0.181455
Homogeneity	0.952557
Mean	76.1263
Standard deviation	56.2968
Entropy	6.53016
RMS(Root mean square)	13.6173
Skewness	0.153058
Variance	2325.11
Smoothness	1
Kurtosis	2.47898
IDM(Inverse difference movement)	255

Types of kidney tumors

In the kidney, there are both benign and malignant tumors. Generous tumors once in a while, cause clinical issues except for oncocytoma. Dangerous tumors, then again, are of incredible clinical significance and merit extensive accentuation. By a long

Figure 6: Classification result

shot, renal cell carcinoma is the most widely recognized of these dangerous tumors, trailed by Wilms tumor, which is found in kids and at last urothelial tumors in calyxes and beams. Kidney tumors are referred to as renal cell carcinoma with three main classifications.

Clearcell RCC

This is the most widely recognized subtype of RCC, representing 70% of all RCCs. These tumors emerge from the renal cortex and are regularly extensive.

Papillary RCC

In all RCCs, the papillary RCC represents 10 - 15 %. The malignant cells create a finger-like projection in the tumor.

Chromophobe RCC

5% of the RCCs are chromophobic. Cell identified with this sort of malignancy will, in general, be bigger in size.

Implementation

Dataset

The dataset is collected from The Cancer Imaging Archive (TCIA), a large publicly available archive of medical cancer images. DICOM is TCIA's primary image storage file format. It contains the most commonly used imaging techniques such as PET, CT, MR, etc. and the use of purely real data set collected from Medical laboratory which contains CT images of kidney cancer patients.

RESULTS AND DISCUSSION

Figure 2 represents the CT scan image,Figure 3 represents the conversion of image to the lab space, Figure 5 represents a morphological close operation, and Figure 5 represents the compliment of the close image.

Table 1 represents feature extraction values of the segmented image, which obtained using GLCM and Figure 6 represents the multisvm result that is kind of kidney cancer.

CONCLUSION

Considering the existing works kidney tumor identification and classification will detect and classify the tumor as either benign or malignant, which does not give any information about the types of cells present in the tumor hence our proposed model will classify the kidney tumor into four classes that is three types of tumor (clearcell RCC, papillary RCC, chromophobe RCC) and a normal kidney. The proposed model uses morphological close for segmentation followed by extraction of features using GLCM, classification is performed using mutiSVM, which classify to multi classes with approximately 89% of accuracy compared to other methodologies. To apply the proposed strategies to a larger dataset, further work is needed, and it is necessary to develop a new method to detect cancer cells more efficiently.

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