A HOLISTIC STUDY ON CANCER AND

A COMPARATIVE ANALYSIS OF VARIOUS IMAGE PROCESSING TECHNIQUES TO DETECT CANCER

Dr. Siva Jothi, Asst. Professor. Sri Parasakthi College for Women, Courtallam

Ms. R. Geetha, St. Xavier's College, Palayamkottai.

ABSTRACT

Cancer is one of the leading causes of death in the world today. Studies show that one in three people will suffer from some form of cancer in their lifetime. There are many different kinds of cancer that effect different parts of the body. Cancer is treated in various different ways. Some forms of cancer are curable, and some are not. This paper aims in presenting the overall shape of the cancer disease and how digital image processing techniques are used in detecting cancer. It also reviews the processes and techniques that are used on the medical scans. It is found that computer vision based techniques can diagnose cancer at an expert level and assist in treating them.

Keywords: Benign tumor, Malignant tumor, Computer Aided Diagnosis(CAD), Contour, Morphology.

I.Introduction:

Cancer usually comes from the formation of a tumor. Tumors form in the body when cells are produced unnecessarily. That is to say, that new cells are formed when they are not needed, and they group together to form a tumor. The tumor can be benign, which means that it is non-cancerous, or it can be malignant, which means that it is cancerous. If cells break away from a malignant tumor, they will enter the bloodstream, and spread throughout the body, damaging other parts of the body.
All cancers derive from single cells that have acquired the characteristics of continually dividing in an unrestrained manner and invading surrounding tissues.

Cancer cells behave in this abnormal manner because of changes in the DNA sequence of key genes, which are known as cancer genes. Therefore all cancers are genetic diseases.

The most common cancers are projected to be breast cancer, lung and bronchus cancer, prostate cancer, colon and rectum cancer, bladder cancer, melanoma of the skin, non-Hodgkin lymphoma, thyroid cancer, kidney and renal pelvis cancer, leukemia, endometrial cancer, and pancreatic cancer.

The number of people living beyond a cancer diagnosis reached nearly 14.5 million in 2014 and is expected to rise to almost 19 million by 2024.

II. Types of cancer:

There are around of cancer diseases in the world. Cancer can occur anywhere in the body. In women, breast cancer is the most common. In men, it's prostate cancer. Lung cancer and colorectal cancer affect both men and women in high numbers.

There are five main categories of cancer:

- Carcinomas begin in the skin or tissues that line the internal organs.
- Sarcomas develop in the bone, cartilage, fat, muscle or other connective tissues.
- Leukemia begins in the blood and bone marrow.
- Lymphomas start in the immune system.
- Central nervous system cancers develop in the brain and spinal cord.

III. Imaging scans for diagnosis:

Imaging techniques - methods of producing pictures of the body - have become an important element of early detection for many cancers. But imaging is not simply used for detection. Imaging is also important for determining the stage (telling how advanced the cancer is) and the precise locations of cancer to aid in directing surgery and other cancer treatments, or to check if a cancer has returned.

CT scan:

A CT scan is three-dimensional. By imaging and looking at several three-dimensional slices of a body (like slices of bread) a doctor could not only tell if a tumor is present, but roughly how deep it is in the body. A CT scan can be three dimensional because the information about how much of the X-rays are passing through a body is collected not just on a flat piece of film, but on a computer.

Nuclear imaging: Nuclear imaging uses low doses of radioactive substances linked to compounds used by the body's cells or compounds that attach to tumor cells. Using special detection equipment, the radioactive substances can be traced in the body to see where and when they concentrate. Two major instruments of nuclear imaging used for cancer imaging are PET and SPECT scanners.

PET Scan: The Positron Emission Tomography (PET) scan creates computerized images of chemical changes, such as sugar metabolism, that take place in tissue. Typically, the patient is given an injection of a substance that consists of a combination of a sugar and a small amount of radioactively labeled sugar. The radioactive sugar can help in locating a tumor, because cancer cells take up or absorb sugar more avidly than other tissues in the body.

After receiving the radioactive sugar, the patient lies still for about 60 minutes while the radioactively labeled sugar circulates throughout the body. If a tumor is present, the radioactive sugar will accumulate in the tumor. The patient then lies on a table, which gradually moves through the PET scanner 6 to 7 times during a 45-60-minute period. The PET scanner is used to detect the distribution of the sugar in the tumor and in the body. By the combined matching of a CT scan with PET images, there is an improved capacity to discriminate normal from abnormal tissues. A computer translates this information into the images that are interpreted by a radiologist.

SPECT Scan: Similar to PET, single photon emission computed tomography (SPECT) uses radioactive tracers and a scanner to record data that a computer constructs into two- or three-dimensional images. A small amount of a radioactive drug is injected into a vein and a scanner is used to make detailed images of areas inside the body where the radioactive material is taken up by the cells. SPECT can give information about blood flow to tissues and chemical reactions (metabolism) in the body.

Ultrasound : Ultrasound uses sound waves with frequencies above those humans can hear. A transducer sends sound waves traveling into the body which are reflected back from organs and tissues, allowing a picture to be made of the internal organs. Ultrasound can show tumors, and can also guide doctors doing biopsies or treating tumors.

Magnetic Resonance Imaging (MRI): Magnetic Resonance Imaging (MRI) uses radio waves in the presence of a strong magnetic field that surrounds the opening of the MRI machine where the patient lies to get tissues to emit radio waves of their own. Different tissues (including tumors) emit a more or less intense signal based on their chemical makeup, so a picture of the body organs can be displayed on a computer screen. Much like CT scans, MRI can produce three-dimensional images of sections of the body, but MRI is sometimes more sensitive than CT scans for distinguishing soft tissues.

Conventional mammography: Conventional mammography uses X-rays to look for tumors or suspicious areas in the breasts. Digital mammography also uses X-rays, but the data is collected on computer instead of on a piece of film. This means that the image can be computer-enhanced, or areas can be magnified. Eventually, a computer could in certain appropriate situations, screen digital mammograms, theoretically detecting suspicious areas that human error might miss.

Virtual colonoscopy (VC): Virtual colonoscopy (VC) (or Computerized Tomographic Colonography (CTC)) uses x rays and computers to produce two- and three-dimensional images of the colon (large intestine) from the lowest part, the rectum, all the way to the lower end of the small intestine and display them on a screen. The procedure is used to diagnose colon and bowel disease, including polyps, diverticulosis, and cancer. VC can be performed with computed tomography (CT), sometimes called a CAT scan, or with magnetic resonance imaging (MRI).

Staging of cancer:

The American Joint Committee on Cancer (AJCC) and the International Union for Cancer Control (UICC) maintain the*TNM classification system* as a tool for doctors to stage different types of cancer based on certain standards. It’s updated every 6 to 8 years to include advances in our understanding of cancer.

In the TNM system, each cancer is assigned a letter or number to describe the tumor, node, and metastases.

- T stands for the original (primary) tumor.
- N stands for nodes. It tells whether the cancer has spread to the nearby lymph nodes
- M stands for metastasis. It tells whether the cancer has spread to distant parts of the body

The T category gives information about aspects of the original (primary) tumor, such as its size, how deeply it has grown into the organ it started in, and whether it has grown into nearby tissues.

- TX means the tumor can't be measured.
- T0 means there is no evidence of a primary tumor (it cannot be found).
- This means that the cancer cells are only growing in the most superficial layer of tissue, without growing into deeper tissues. This may also be called *in situ* cancer or *pre-cancer.*
- Numbers after the T (such as T1, T2, T3, and T4) might describe the tumor size and/or amount of spread into nearby structures. The higher the T number, the larger the tumor and/or the more it has grown into nearby tissues.

The N category describes whether the cancer has spread into nearby lymph nodes.

- NX means the nearby lymph nodes cannot be evaluated.
- N0 means nearby lymph nodes do not contain cancer.
- Numbers after the N (such as N1, N2, and N3) might describe the size, location, and/or the number of nearby lymph nodes affected by cancer. The higher the N number, the greater the cancer spread to nearby lymph nodes.

The M category tells whether the cancer has spread (metastasized) to distant parts of body).

- M0 means that no distant cancer spread was found.
- M1 means that the cancer has spread to distant organs or tissues (distant metastases were found).

IV. Treatment for cancer:

Common Treatments for Cancer

- Surgery
  - Surgery is one way to help diagnose cancer. In most cases, the only way to know if a person has cancer and what kind of cancer it is, is by taking out a small piece of tissue (called a *sample*) and testing it. The diagnosis is made by looking at cells from the sample with a microscope or by doing other lab tests on it.
  - This procedure is called a biopsy. Biopsies taken during surgery are often referred to as surgical biopsies.
  - How a sample is taken depends on where the tumor is and what type of cancer is suspected.

ISSN: APPLIED
2018, Volume – 1; Issue – 1;

- Chemotherapy

Chemotherapy is the use of strong drugs to treat cancer. You will often hear chemotherapy called "chemo" (KEY-mo), but it's the same thing.

Chemo was first used to treat cancer in the 1950s. Chemo may be used to:

- Keep the cancer from spreading.
- Make the cancer grow slower.
- Kill cancer cells that may have spread to other parts of the body (metastasized – meh-TAS-tuh-sized).
- Make side effects from cancer better, like pain or blockages
- Cure cancer.

- Radiation Therapy

Radiation (ray-dee-A-shun) therapy (ther-uh-pee) is the use of radiation to treat cancer and other problems. There are different types of radiation. One that you may know about is x-rays. If you've ever had an x-ray of your chest or any other body part, you've had some radiation. Radiation is used in much higher doses to treat some types of cancer.

Radiation is used to kill cancer cells. Special equipment sends high doses of radiation to the cancer cells or tumor. This keeps the cells from growing and making more cancer cells. Radiation can also affect normal cells near the tumor. But normal cells can repair themselves and cancer cells cannot.

Sometimes radiation is the only treatment needed. Other times it's one part of a patient's cancer treatment plan. Radiation therapy is not like chemotherapy (key-mo-THER-uh-pee, often called chemo). Radiation treats just the tumor. Chemo uses drugs to treat the whole body. So chemo might be used if a person has cancer in many places. Radiation affects only the part of the body being treated.

- Targeted Therapy

Targeted therapy is a special type of chemotherapy that takes advantage of differences between normal cells and cancer cells. It's sometimes used alone, but most often other cancer treatments are used with targeted therapy. Block or turn off chemical signals that tell the cancer cell to grow and divide

- Change proteins within the cancer cells so the cells die
- Stop making new blood vessels to feed the cancer cells
- Trigger your immune system to kill the cancer cells

Carry a toxin to the cancer cell to kill it, but not normal cells

- Immunotherapy

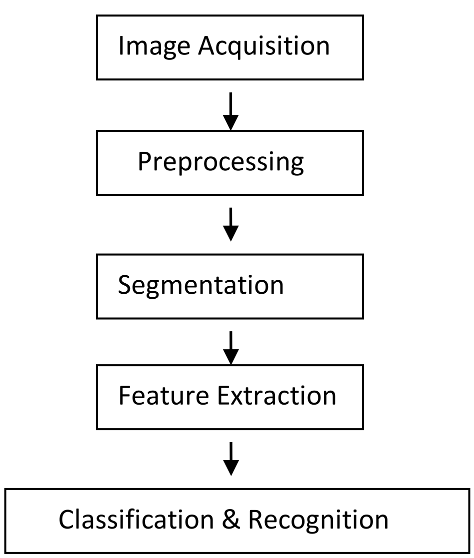
Immunotherapy is treatment that uses certain parts of a person's immune system to fight diseases such as cancer. This can be done in a couple of ways:

- Stimulating your own immune system to work harder or smarter to attack cancer cells

Giving you immune system components, such as man-made immune system proteins.

V. Application of image processing techniques in Cancer diagnosis:

Basic diagrammatic model:



Cancer cells are defined with wide range of features and may be easily misinterpreted by radiologists while reading large amount of results provided in screening programs. To help radiologists provide an accurate recognition, a computer-aided detection (CAD) and computer-aided classification (CAC) algorithms are being developed. These algorithms can help doctors and radiologists for getting a more reliable and effective diagnoses and help reducing the number of false positives. Fig6 represents the cycle of image processing techniques involved in identifying the cancer cells [7].

VI. Literature survey:

Mokhled [5], discussed the various lung tumor detection techniques for different stages. Three methods were proposed for image enhancement, to remove the noise from the image and to make the image better: Auto enhancement, Gabor Filter and FFT (Fast Fourier Transform), Gabor filter is more efficient because it can effectively optimize the border differences among the lung regions. For the image segmentation, to separate the region two methods were proposed: Thresholding, Marker-controlled watershed segmentation. To differentiate the extracted region from the lung structure binarization and masking approaches were proposed. In binarization, if the total numbers of black pixels were less than threshold value, then it was classified as abnormal otherwise normal. In Masking, White area inside the lung region was referred as mass. Blue color of the mass shows normality while RGB shows the abnormalities of the mass. On the basis of these features, system classification accuracy was less.

Disha, Gagandeep [6], proposed a CAD system in which wiener filter was used to remove the noise content. For extraction of lung region, image slicing algorithm was applied. To enhance the quality of image various morphological operations like opening, closing followed by erosion, dilation were applied to remove any irrelevant information in the image. With image segmentation each and every pixel were assigned a label so that the pixels who have same label, represent visual characterstics.Image segmentation is basically represent a set of contour (edge detection).Sobel method was used for the edge detection because of its accuracy and two dimension values of the pixels so that no pixel can be left. In this paper, five features (area, calcification, shape, size, contrast Enhancement) were extracted on the basis of which the ROI was classified as tumor or non-tumor. .

Omar, Watson [7] focused on the texture of the region of interest. CE-CT (Contrast Enhanced Computer Tomography) images were used for the fractal analysis to differentiate between aggressive (advanced stage) and non- aggressive (early stage) tumors. These images were in time sequence. The main aim of this research was to enhance tumor stage prediction accuracy by identifying the malignant tumor. For this work, DICOM images were acquired, then by using Differential Box Counting (DBC) algorithm these images were transformed into the Fractal Dimension images .The ROI was easy to identify and can be selected manually after the fractal transformation. The differentiation accuracy between aggressive and non aggressive tumor was up to 83% and this system also gave the information about the aggressiveness.

S.K Vijai[8], proposed a CAD system in which different image processing techniques combined with neural network were applied on the images. Noise content present in the image was removed using non-linear total variation denoising algorithm. To separate the lung region and to convert the image into binary form optimal thresholding was used. Morphological operations were applied on threshold image to remove any blood vassals which has a value less than defined value. Region growing method was used for the extraction of region of interest. GLCM (gray level co-occurrence matrix) was obtained which consist the white pixel values occurred in the ROI.Then from this matrix several textural features were calculated and these features were applied to input nodes of the back propagation network. On the basis of the inputs applied to the network a single output was obtained which gave the value between 0 and 1 and a threshold value was defined. The output value more than the threshold value predicted cancerous and value less than threshold value predicted non cancerous. The accuracy of this system was 86.3% and the implementation time was less than 3 minutes.

Lee [9], presented a template matching technique with the combination of conventional template matching for the detection of lung nodule in helical CT images. This technique was applied on both, inside the lung region and on the lung walls. In order to detect the nodules inside the lung region the generic algorithm for template matching (GALM) was used and for detection of nodule at the lung walls, lung wall template matching (LWTM) was used. There were number of false positives (FP) observed as a result, which decreases the system accuracy, so in order to reduce the FP values total 13 features had been calculated,9 for generic algorithm template matching and 4 for lung wall template matching. For this system, detection of nodules in low contrast was difficult and the number of FP was high.

Jinsa [10], presented a system for the detection of lung tumor in CT scan images using artificial neural network. In this System, the scan image which was in gray scale firstly converted to binary image using grey level thresholding. The morphological opening was applied to the segmented image. The statistical parameter mean, standard deviation, skewness, kurtosis, fifth and sixth central moment were calculated. For the pattern classification two neural networks feed forward and feed forward back propagation networks were used. As compare to the feed forward network, feed forward back propagation network provided better results because feed forward BPN was based on supervised learning. The weights were changed according to the applied input and flow of information travelled in a feedback manner. The network was trained with 13 training function among all function training dx function gave the maximum classification accuracy with minimum mean square error. Two training functions were proposed with which the sensitivity of the system was increased to 91.4% with 30FP/scan.

Daw, Chung, Wen [11], presented an extension of neural network based fuzzy model for the detection of lung nodule .After the thresholding stage, some part of the blood vessels or the large airways may also be removed. So, in order to fill these areas, morphological closing and labeling was done. In order to make distinction between the nodules and other structure in lung region, three main features area, brightness and circularity were calculated. This neural network based fuzzy model consists of four layers: input layer, fuzzification layer, rule inference layer, defuzification layer. With this system, the classification accuracy of 89.3% was achieved. The false positive value was 0.21. The main advantage of this system, it was faster, no prior knowledge was required, the fuzzy rules were defined using learning procedure and Detection rate was high.

A.Amutha, Wahidabanu[12], presented level set Active contour model for the detection of lung tumor. This method was based on kernel function having the minimum mean square error value. Then second order features were calculated which were based on the histogram of the noise free image. The classification between the normal and abnormal lung image was made on these features. The drawback of this system, it was only able to work on 2-D images.

Anam, Usman, Younus [13], proposed a method in which median filter was used to remove noise content, the background was removed using gradient mean and variance, then to segment the lung region optimal thresholding was used. Then different morphological operations were applied to remove the unwanted information. The region of interest was extracted and five texture based features were calculated. These features formed a vector which was given to the hybrid classifier based on neural network. The hybrid classifier was a combination of self organizing network and multilayer perceptron. The drawback of this system was computational time for larger data set was more.

VII. Conclusion:

In this the complete knowledge about Cancer disease is presented, and also the various techniques to detect the cancer disease has been surveyed. All the systems have been designed to achieve the detection accuracy as maximum as possible with less false positive value. It has been concluded that optimal thresholding is better for image segmentation and edges are detected more efficiently using sobel method. But the thing is accuracy and precision varies depending on the type of the image chosen for detection. The best method for detecting cancer tumor is yet to be identified by doing great research work.

VIII. REFERENCES

[1] www.nlm.nih.gov/medlineplus/tutorials/lungcancer/oc0791 05.pdf.

[2] Singapore Cancer Society, http://www.singaporecancersociety.org.sg.

[3] http://www.cancer.org/acs/groups/content/@research/docum ents/webcontent/acspc-042151.pdf.

[4] http://www.indianjcancer.com

[5] Mokhled, "Lung Cancer Detection Using Image Processing Techniques," Leonardo Electronic Journal of Practices and Technogies, Issue 20, January-June 2012 p.147-158.

[6] Disha, Gagandeep,"Identifying Lung Cancer Using Image Processing Techniques," International conference on computational techniques and artificial intelligence ICCTAI'2011

[7] Omar S. Al-Kadi, D.Watson,"Texture Analysis of Aggressive and Nonaggressive Lung Tumor CE CT Images," IEEE Trans. Bio-Medi Eng.Vol.55 No.7, page 1822-1830, July 2008.

[8] S.K.Vijai Anand, "Segmentation coupled Textural Feature Classification for Lung Tumor Prediction,"ICCCCT'10.

[9] Younbum Lee,Takshi Hara,Hiroshi Fujita,Shigeki Itoh, and Takeo Ishigaki,"Automated Detection of Pulmonary Nodules in Helical CT Images Based on an Improved Template-Matching Technique," IEEE Transaction on medical Imaging,Vol.20 page 595-604,july 2001.

[10] Jinsa Kuruvilla, K.Gunavathi," Lung Cancer classification using neural networks for CT images, "computer methods and programs in Biomedicine113 (2014) 202-209.

[11] Daw-Tung Lin, Chung-Ren Yan, Wen Tai Chen , "Autonomous detection of pulmonary nodules on CT images with a neural network-based Fuzzy system," Computerized medical imaging and graphics 29(2005) 447-458.

[12] A.Amutha, Dr.R.S.D.Wahidabanu," Lung Tumor Detection and Diagnosis in CT scan Images,"International conference on Communication and Signal Processing, April 3-5, IEEE, 2013.

[13] Anam Tariq, M.Usman Akram and M.Younus Javed," Lung Nodule Detection in CT Images using Neuro Fuzzy Classifier," IEEE, 2013.