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Diagnosis Of Lung Cancer Based On Contrast, Entropy And Energy With Digital Image Processing

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Abstract

The various working models for the classification and diagnosis of the lung cancer has been worked out till data to assist the medical experts with the usage of the different techniques of the digital image processing in the appropriate dealing of the different image sample detected tumour cells. In the present day, it requires the classification of the lung cancer and COVID-19 as both will be affected to the common part of the human internal body structure. If it cannot be diagnosed in early stages in the era of COVID-19, which may result in different medical approach hence in this present research article we are trying to provide the clear distinction among the cancer cells and COVID-19 at the initial stage of the article theoretically and subsequently it is predicted with the image processing techniques with the consideration of the few parameters such as Contrast, Entropy and Energy of the input biomedical images. The input samples are considered from the open source freely downloadable physionet resource datasets. It can noted that with the classification of biomedical datasets with the above mentioned parameters at initial stages with the suitable algorithm based calculation will assist the medical experts for the better clarity of the disorders.

1. Introduction

"Prevention is better than cure", It is a well-known proverb in English. Here is an approach to reduce the death rate caused of cancer by detecting in early stage. In 2019, World Health Organization conducted a survey. According to the survey made by WHO in 2020 shows that there were 19.3 million new cases and a death of 10 million people. The figure 1, shows the different regions of the world affected by the cancer. The blue colour indicating the first rank and the red indicating the 5th to 6th rank. It is clearly seen that all the part of the Earth are being effected.

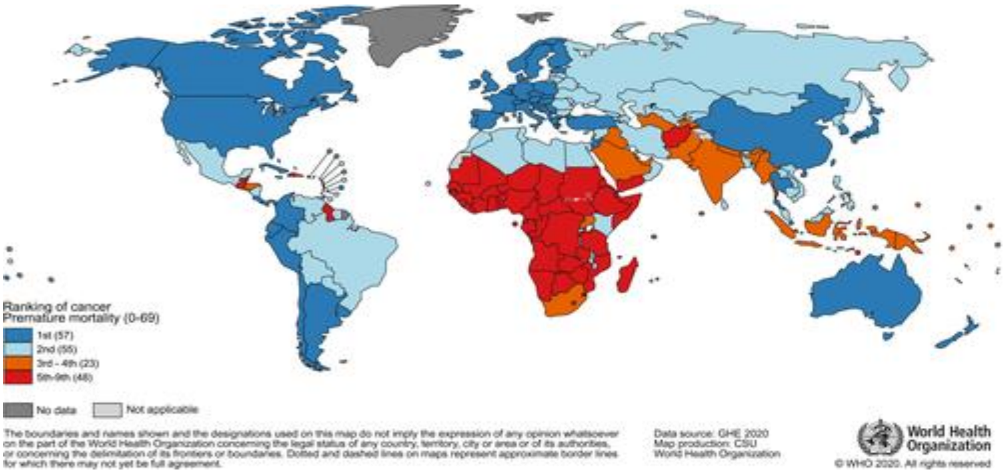


Figure 1: the survey of cancer deaths by WHO.

The simpler definition of cancer cells that it is an uncontrollable growth of cells. The human body is made out of cells. These cells grow, divide and finally die. If there are any genetic modifications in the older cells, then the cells grow uncontrollably. This growth causes a mass creation which is termed as a tumor. If the tumor cells are spread all over the body, then they are called as malignant tumours. If these tumours, does not spread, then they are called as benign. The classification of cancer has been proposed by different studies. One simple classification is mentioned below, which is based on the origin of the cancer cells. i) if the cancer cells begins with a skin or the tissues or internal surface of the organs and glans, then it is called as carcinoma. ii) if the cancer cells develop within that, issues that support or connect to any of the body part, then it is termed as sarcoma. iii) When the healthy blood cells grow uncontrollably, this kind of cancer is termed as leukaemia. iv) If the cancer begins within the lymphatic system of a human body, then it is called as lymphoma. These are the few brief classifications of cancers. The cancer classification can still further be continued.

The major difference between cyst and tumours:

Cyst and tumours both are a kind of lumps that can appear on the skin or on the tissue or any part of the organs of human body. The major difference between cyst and a tumor is that a tumor often refers to the area where there is an extra growth of tissue. Whereas as a cyst is a small pod-like a structure that is filled with materials like air or fluid. Treatment for cancer may include chemotherapy, and medications depending on the level of cancer.

We are mainly concentrating on the cancer that is caused to the lungs. Lungs are one of the vital organs in human body. Lungs help in supply of oxygen to the blood from the atmosphere. The inhalation causes the oxygen to insert into the blood and it releases the carbon dioxide when we exhale. The smokers have great risk of getting lung cancer. Lung cancer is one of the mostly find cancers among the human beings. Coming to the classifications of lung cancer, it is broadly classified into 2 types. The first one is a Small Cell Lung Cancer (SCLC) and the second one is Non-Small Cell Lung Cancer (NSCLC). There is also a 3rd classification which is called as carcinoid. Figure 2, shows the different classification and types of lung cancer.

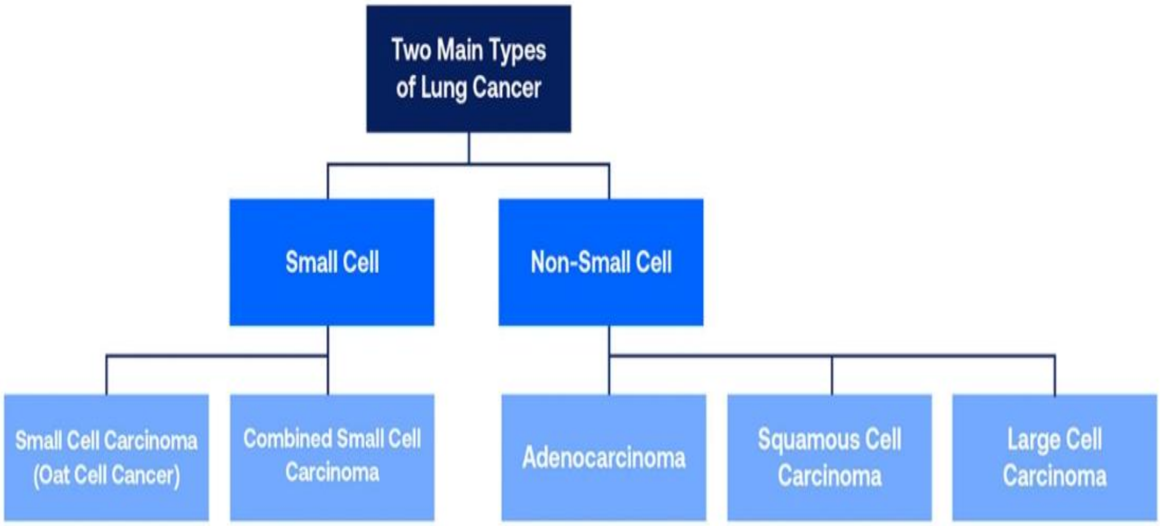
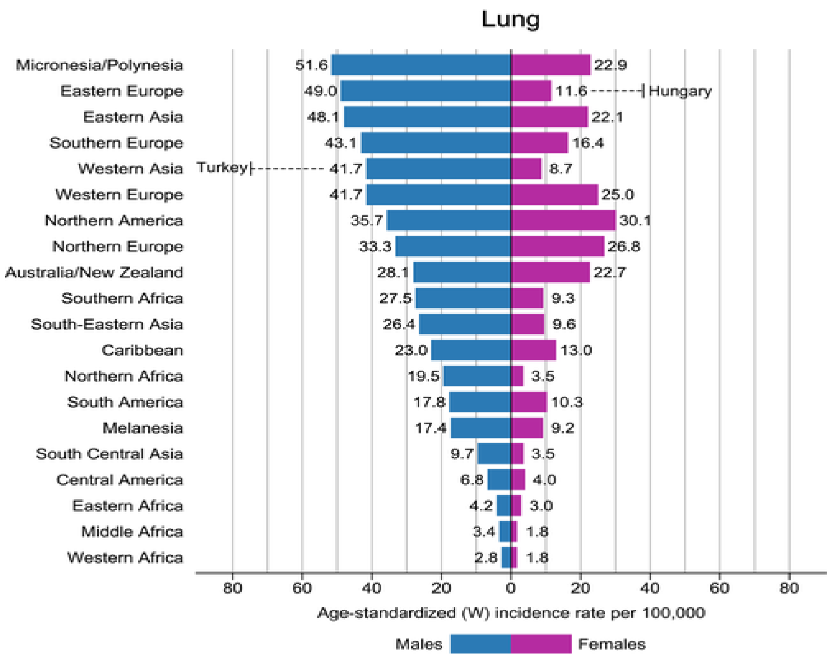


Figure 2: Classifications of lung cancer.

Here is a small survey that relates the lung cancer with respect to gender and the geographical countries. Figure 3, represents the average percentage of men and women affected with lung cancer.



Source: GLOBOCAN 2020.

Figure 3 shows the survey of lung cancer related with gender and the countries.

2. COVID – 19

COVID-19 is a 21st century pandemic. One of the terrible diseases that mankind has seen ever. It is a contagious respiratory disorder that started spreading from Wuhan, China. This disorder Caused severe bronchitis and congestion in the respiratory system. This also led to death of several patients all over the world. The corona virus symptoms are fever with chills, cough, shortness of breath, tiredness and short of oxygen level in the blood, nausea, diarrhea. The mode of transmission of the virus is through the droplets of infected Patient. In extreme cases, the patient is found to have a formation of Mucus lumps in the lungs. This leads to the condition in breathing discomfort. The lumps of mucus accumulate from the bottom of the lungs, leading to shortening the breath and the oxygen supplied to the body. As the congestion increases, it leads to the contraction of heart muscles and finally leading to death of the patient.

A. Differentiating between COVID 19 and lung cancer.

A study of clinical expertise found that can differentiate between the lung cancer and COVID-19 symptoms. There are few symptoms that overlap with the conditions of both cancer and COVID-19. The analysis can be differentiated after a patient testing negative for covered and still persist the cough for more than 3 weeks. The patients of lung cancer may experience unexplained persistence of cough, fatigue, recurrent chest infection and unexplained persistence of breathlessness. Whereas, the patients of COVID-19 will have a dry cough, fever, loss of smell, loss of tastes. There are few unclear and intermediate Symptoms. These symptoms may lead to both lung cancer or it might also be COVID-19. The symptoms are cough, unclear onset and persistence, Flu like symptoms lasting for more than 3 weeks, Difficulty in taking long Breaths, are few.

B. Anatomy of lungs.

The preliminary organs of respiratory in human body are lungs. The responsibility of lungs is to extract oxygen from the air and transfer that into the bloodstream. Extract the carbon dioxide from the bloodstream and release it to the air. Humans have 2 lungs, left lung and right lung. Thoracic cavity of the chest contains the 2 lungs of human body. The right lung is heavier than the left lung. Figure 4, shows the anatomy of the lungs. Where the primary trachea is divided into primary bronchi, secondary bronchi, tertiary bronchi and bronchioles.

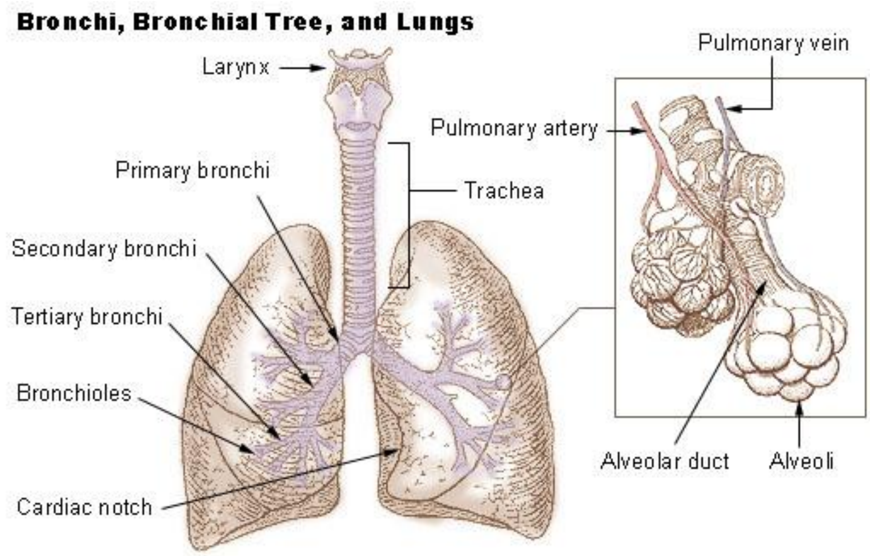


Figure 4: Anatomy of lungs.

The right lung occupies more area than the left lung. The right lung has more lobes and segments compared to the left one. The Right lungs are divided into 3 lobes by 2 fissures. The middle lobe, the upper lobe and the lower lobe. The left lung is only divided into 2 lobes, the upper lobe and the lower lobe by one oblige fissure.

3. Image processing and its importance in the arena of Lung cancer

The process of extracting useful information from the image by manipulating the data of the image is coined as image processing. Got 3 major steps in image processing. i) image acquisition, ii) manipulating the image data and iii) generation of report or altering the image after the image analysis. Figure 5, shows a generalized block diagram of image processing [1-2].

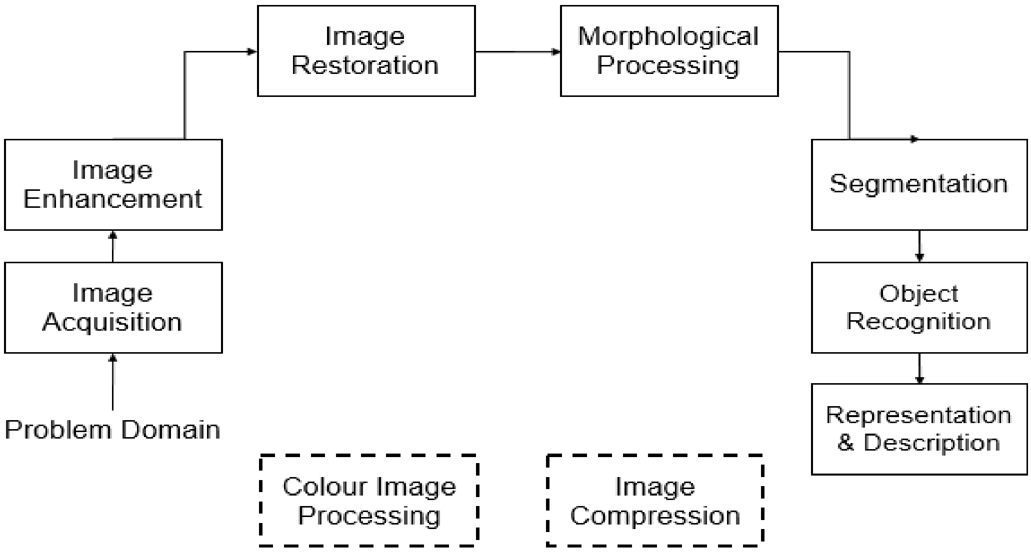


Figure 5. Block diagram of image processing.

Figure 3 explains the process of image processing. The very first step is to acquire the image that is in the digital form, called as **Image Acquisition**. The most appealing areas of digital image processing is **Image Enhancement**, this step is used to highlight certain features of interest. To improve the appearance of the image, **Image Restoration** is used. Day today the colour images and its usage are increasing over the Internet. This is leading to improving the **Colour Image Processing**. **Wavelet and Multi Resolution Processing**, this involves representation of an image in various resolution and various degrees. **Compression,** to improve the storage capacity, the images are compressed and they are stored or it will be transmitted. **Morphological Processing**, this is used to describe the shape and represent the image. **Segmentation,** is a process of partition the image into constituent parts of object. **Representation and description,** representation is a part of the solution that transformed raw data to the suitable format. Description is simply extracting the attributes required for the results. **Object recognition**, assigning the label by recognising is termed as object recognition [4,5,6].

A. Biomedical image processing.

To achieve the clinical analysis and medical intervention, the process of creating adipic table and viewable interior body part organs is termed as biomedical Imaging. The Mayo medical images are used to find the abnormalities in the tissues or in the anatomy of human body. The generalized block diagram of the biomedical image processing is given in Figure 4.

For the purpose of therapy or for the purpose of diagnosis, biomedical image processing is used. In biomedical image processing the. Images of the organs or the tissues are obtained to find out the current condition of the organs. Few of the good examples of biomedical images, RCT scan, ultrasound scan, PET scan, and etc. Biomedical image processing was introduced in early 20th centuries [7,8,9]. It has been evolved to a greater extent today. There are several advancements in the image processing that helps the physicians to analyse the internal structures. The basic steps of Biomedical Image Processing is mentioned in the figure 6.

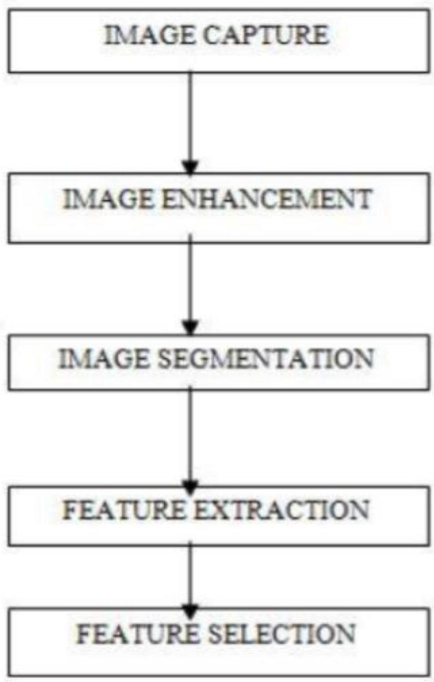


Figure 6: general Flow of biomedical image processing.

4. Existing System

Various modalities like light microscopy, X-ray, CT and MRI can be used for the detection and diagnosis of lung cancer. Each of these has its own advantages and disadvantages. Out of various modalities used for pre-screening, Sputum cytology images are best suited for pre-screening because of non-invasive nature and cost effectiveness.

Light or optical microscopy: The simplest type of microscope based on visible light which uses a system of lenses for magnifying biopsy or autopsy samples. This type of microscope can be modified to capture sample images in a digital format using a charged-coupled device (CCD) camera.

Electron microscopy: A type of microscope that uses electron beams instead of visible light which is used in ordinary optical microscopes [2]. The electrons' shorter wavelength as compared to visible light rays assists in achieving a higher linear magnification and resolving power (i.e. ability to distinguish fine details) exceeding one million, which is several hundred times the resolving power of an ordinary optical microscope [6].

Endos copy : A technique used for viewing the internal surface of an organ through the insertion of a rigid or flexible tube – containing a light source and lens system to visualize and transmit back images via a fiber optic system – into the body. Some are also equipped with surgical medical instruments to enable the removal of biopsies for external examination [3]. Recently a new endoscopic technique, called wireless capsule endoscopy (WCE), has been developed which can make the procedure of viewing in-vivo structures more pleasant and easier for patients [13].

Non-invasive Radiography: Can be defined as the use of an ionizing electromagnetic radiation, such as X-ray, for imaging internal body structures. Types of radiographic imaging [16]:

Projection X-ray: is the conventional type of X-ray imaging technique where static images are captured by projecting the generated X-ray energy from the X-ray tube on the body. Nowadays, the analog film is replaced by a digital sensor in order for images to be acquired and sent to a computer for viewing. Mainly used for examination of bone fractures [10].

Mammography: a type of projection X-ray where a specially designed X-ray machine projects X-ray beams on very high contrast and high resolution digital film for acquiring detailed images of breasts for diagnosis [12,17,19].

Fluoroscopy: an X-ray imaging technique that employs a continuous or a pulsing X-ray beam at a lower dose rate of radiation for producing real-time dynamic images of internal structures [20-25].

Computed Tomography: Computed tomography or computerized axial tomography (CT/CAT) is a cross-sectional improved X-ray technique that produces images of any part of the body. CT scans provide more detailed images compared to conventional X-ray, making it suitable to examine many body organs as brain, lungs, liver and kidney [5-9].

Magnetic Resonance: In MRI, unlike CT, a non-ionizing radiation is applied for generating cross-sectional images of body soft tissues. Since hydrogen is the most abundant atom in the body nearly two-thirds of the human body consists of water – the nuclear magnetic resonance of protons (i.e. nuclei of hydrogen atoms) are used to produce proton density images [10-12]. magnetic field is focused from the MRI magnet on the body to align the protons in a parallel formation, which are then exposed to a strong but harmless pulse of radio waves that will scatter back this alignment to the initial random pointing position [23-29].

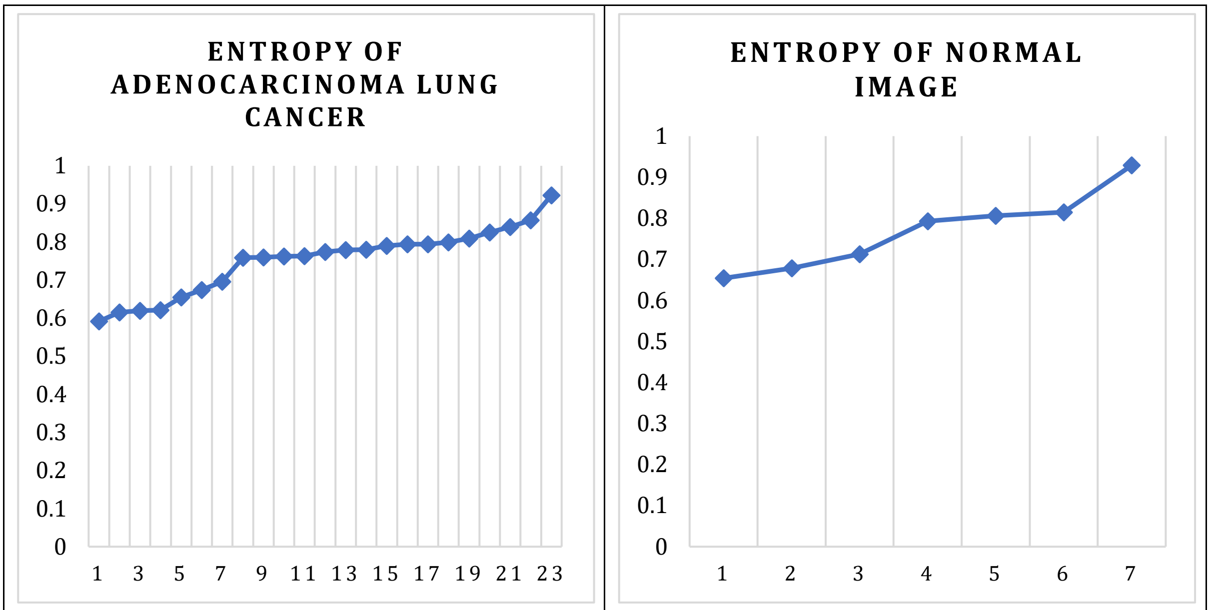
5. Results and Discussion

Classification	Entropy	Contrast	Energy
Adenocarcinoma Lung Cancer	0.696	1.961	0.619
Adenocarcinoma Lung Cancer	0.62	2.028	0.674
Adenocarcinoma Lung Cancer	0.794	1.195	0.549
Adenocarcinoma Lung Cancer	0.674	1.723	0.654
Adenocarcinoma Lung Cancer	0.923	2.49	0.485
Adenocarcinoma Lung Cancer	0.615	2.147	0.678
Adenocarcinoma Lung Cancer	0.839	2.456	0.537

Adenocarcinoma Lung Cancer	0.799	2.089	0.569
Adenocarcinoma Lung Cancer	0.79	2.69	0.559
Adenocarcinoma Lung Cancer	0.763	2.23	0.592
Adenocarcinoma Lung Cancer	0.857	2.344	0.526
Adenocarcinoma Lung Cancer	0.763	2.752	0.574
Adenocarcinoma Lung Cancer	0.809	2.867	0.545
Adenocarcinoma Lung Cancer	0.592	2.118	0.688
Adenocarcinoma Lung Cancer	0.759	2.259	0.584
Adenocarcinoma Lung Cancer	0.779	2.144	0.576
Adenocarcinoma Lung Cancer	0.774	2.603	0.569
Adenocarcinoma Lung Cancer	0.78	2.429	0.556
Adenocarcinoma Lung Cancer	0.621	1.897	0.66
Adenocarcinoma Lung Cancer	0.655	2.228	0.626
Adenocarcinoma Lung Cancer	0.795	2.416	0.547
Adenocarcinoma Lung Cancer	0.75866	2.831	0.582
Adenocarcinoma Lung Cancer	0.825	1.983	0.567
Normal Image	0.654	1.836	0.647
Normal Image	0.678	1.687	0.658
Normal Image	0.713	1.773	0.642
Normal Image	0.929	0.493	0.535
Normal Image	0.806	1.897	0.565
Normal Image	0.793	2.406	0.548
Normal Image	0.814	0.98	0.578

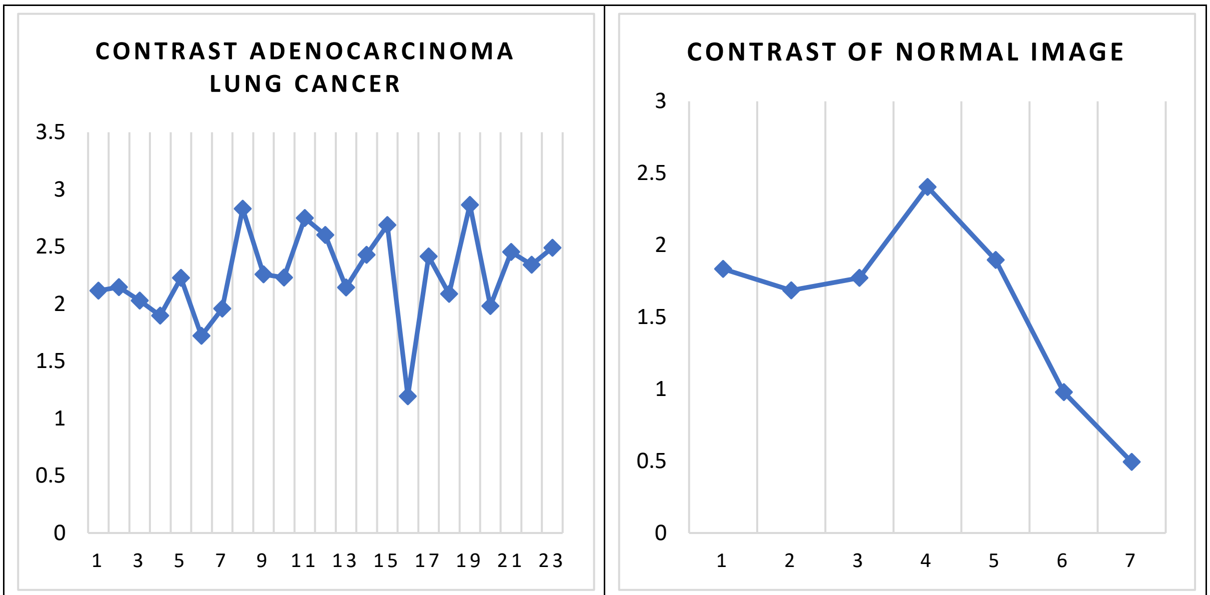
The table 1.1 shows the tabulation of entropy, contrast and energy of MRI scans. Among the random images that have been selected first 23 images are categorised under adenocarcinoma lung cancer. The next 7 have been found as normal images. The range of entropy for normal images is from 0.654 to 0.929, The range of contrast is 0.4 to 2.426, And the energy changes from 0.535 to 0.658. The images that have been classified for adenocarcinoma lung cancer, the range of entropy is 0.59171 to 0.92261, the range of contrast is 1.1947 to 2.8666 and 0.48537 to 0.68838 is the range of energy.

The following plots shows the different entropy contrasts and energy variations in the collected 30 images. Figure 6 (a) and Figure 6(b), shows the entropy plot of Adenocarcinoma lung cancer and normal image respectively. The figure 7(a) and figure 7(b) is the plot of contrast of Adenocarcinoma lung cancer and normal image respectively. The plots of energy obtained from Adenocarcinoma lung cancer and normal image are mentioned in the Figure 8(a) and Figure 8(b).



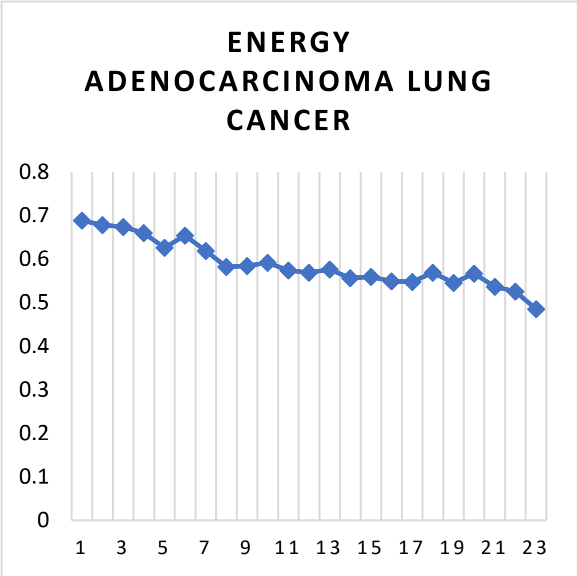
(a) (b)

Figure 6 (a): Entropy of images diagnosed with Adenocarcinoma lung cancer and 6(b) Entropy of images diagnosed with normal Images

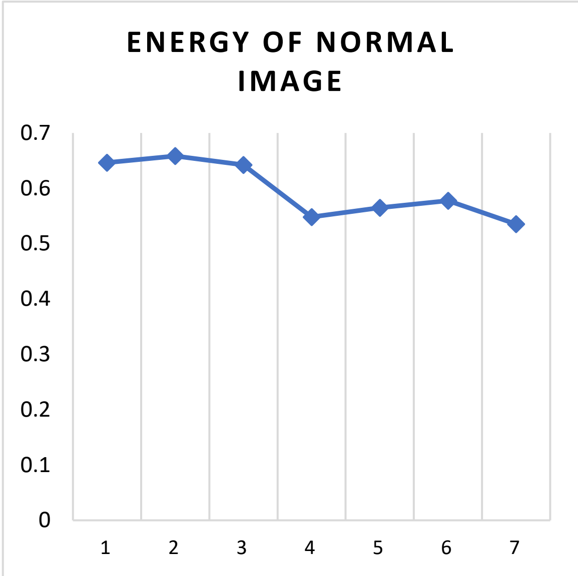


(a) (b)

Figure 7 (a): Contrast of images diagnosed with Adenocarcinoma lung cancer and 7 (b) Contrast of images diagnosed with normal Images



(a)



(b)

Figure 8 (a): Energy of images diagnosed with Adenocarcinoma lung cancer and 8 (b) Energy of images diagnosed with normal Images

For instinct, a sample from the Adenocarcinoma lung cancer and the Normal MRI scan Image is mentioned in the below figure 9(a) and 9(b).

(a)

(b)

Figure 9 (a): MRI Image recognition of Adenocarcinoma lung cancer (b) MRI Image recognition of normal Lung Image.

6. Conclusion

In the present research work, the predominant discrimination between the lung cancer and normal person is carried out with the proposed algorithm for better classification on the MRI image database with different samples with the usage of the various digital image processing methodology considered as working models. At the initial stage of the article it is defined with the clear distinction with the COVID-19 and lung cancer disorders for the suitable assistance for the medical experts. With the obtained results and comparative graph with the parameters such as Contrast, Entropy and Energy it can be noted that the clear variations with respect to the normal and lung cancer samples. As an future enhancement it can be extended to other disorders related to respiratory system of the human beings.

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