

# Thyroid Cancer Detection Using Thermal Images

J.V. Vidhya, Amirtha Dasarathi and J.S. Lavannya

**Abstract---** *Thyroid cancer falls under the category of endocrine carcinomas. For many years, ultrasonography has been in use for the detection of thyroid cancer because of its good distinction between benign nodules and malignant nodules. Also, due to its better revealing of the pathological features, it has been preferred over CT and MRI scans. Despite this, the ultrasonography is not a very reliable method because of its dependency on Operator. With emerging trends, came the existence of Computer aided diagnosis (CAD). This method depends variably on the operator for resolving the subjective diagnosing problem. The objective of this project is to improve the accuracy of detection using various Image processing techniques, so that the tumor could be detected in early stage, preventing the delay in treatment and loss of life of the patient. The dataset that would be used for this process is Thermal images. Radiation in the long – infrared range of electromagnetic spectrum are detected using thermographic cameras and the resultant images are known as thermograms. The images would undergo pre-processing, segmentation and feature extraction to refine the input image, so that the tumor could be easily identified by the machine. After refining of the images, they would be subjected to classification process using Support Vector Machine to classify the input image as a malign cancer or benign cancer. This would result in determining the stage of cancer and thus eventually help in the further treatment process.*

**Keywords---** *Thyroid Cancer, Thermograms, Support Vector Machine, Median Filter, Feature Extraction.*

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## I. INTRODUCTION

Cancer India Organization has reported that about 2.25 million cases of cancer are registered in India and that, the count increases by about one hundred thousand new cases, every year. According to the estimation of “Indian Council of Medical research” (ICMR), there would be around 17 hundred thousand new cases and a death toll of about 8 hundred thousand people by the year 2020. With such an alarming increase in deaths, it is important of us to improve the methods of diagnosis. **Error! Reference source not found.**

Cost is one important factor when it comes to establishment of medical facilities in India. An *MRI machine* costs about Rs 3 crore, *CT Scan machine* costs nearly Rs 1 crore and Ultrasonography machine costs around Rs 10 Lakhs respectively in India. Due to these huge costs, many hospitals are not equipped with the equipment, devices and this in turn results with many cases being undetected. *Thermographic camera* costs about one five hundredth the price of CT scan machine. This makes it quite affordable for a common man to diagnose and undergo the respective medical treatment.

Thermography is a developing technique for imaging in hospitals. It is used for the diagnosis of various diseases based on heat variations in the body that are output in the form of signals in thermographic cameras. This research

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dwells upon the viability of using thermographic methods with Support vector machines to diagnose and treat thyroid cancer. For the purpose of this project, thermal images obtained from medical databases from internet are used **Error! Reference source not found.** The images are filtered for noise using median filtering algorithms. They, then undergo the segmentation process and are later subjected to feature extraction using grey level co-occurrence matrix. The result is then classified to depict whether the cancer is malign or benign.

## II. BACKGROUND

Every year, around 47,000 people are observed to be affected with Thyroid cancer and about 2000 of them die from the disease. It has been observed that females tend to have high probability of thyroid cancer as compared to men. American Cancer Association, with respect to the above findings have stated that more females under the age of 65 would be subjected to cancer by the end of 2014, quoting their range to be around 63,000 new cases. Another statistic also shows that around 0.46 % of the 3.31% registered new cases die due to thyroid cancer. The highest and lowest incidence of thyroid cancer are found in Asia and Oceania respectively. It has also been found that Thyroid carcinoma has been observed to be having the highest mortality rate as compared to the other cancers. Just like other types of Cancers, it is very important to detect thyroid cancer during early stages because it has the tendency to spread to the lymph nodes and sometimes throughout the body. Also, the average mortality rate has increased from 99 to 90 during the period of 1990 to 2010, thus making it more important to come up with a proper diagnosis method. From the above study, we can infer that, to prevent and diagnose thyroid carcinoma, it is better to have a good picture of the epidemiological features involved in thyroid cancer.**Error! Reference source not found.**

## III. RELATED WORK (LITERATURE SURVEY)

For the purpose of survey, we had gone through various research articles to understand the different technologies used. In one method, radioactive iodine scan of thyroid was adapted and with the help of Hill climbing algorithm, the images were classified as malign and benign.**Error! Reference source not found.** Active Contour and Multilayer perceptron algorithm were used in a process to categorize the nodules as smooth, define and irregular.**Error! Reference source not found.** A localization and diagnosis method based on FCN – Alexnet and transfer learning was proposed in a method, to process and classify the ultrasound thyroid images for lesions.**Error! Reference source not found.** In another method, variable background approach was used, which improved the detection of thyroid nodules producing an overlap value of approximately 80.9%.**Error! Reference source not found.**

In another method, Elastograms that are usually evaluated using two parameters clinically namely, color score and strain ratio, with color score being a qualitative measure and strain ratio, the quantitative measure were used. Minimum redundancy maximum relevant algorithm and “Support vector machine” was used in the classification of benign and malignant nodules.**Error! Reference source not found.** The ultrasound images were processed to identify if they are malign or benign through conventional feature extraction and image segmentation methods**Error! Reference source not found.** another method, a faster R – CNN, a detector perfect for detecting thyroid papillary carcinoma was used, where in a layer was added to the CNN, that was spatially constrained to increase the efficiency of the device.**Error! Reference source not found.**

Further methods suggested the use of enhancement and color differentiation techniques to improve the accuracy of diagnosis. **Error! Reference source not found.** Edge Detection method was used to separate the process nucleus from the background to obtain a clear and accurate view of the image and this particularly helped in effectively counting the number of cells causing thyroid cancer with the help of analysis of the microscopic slide. **Error! Reference source not found.** Another method involved the experimentation of 32 mice for thyroid nodules based on 5 QUS parameters namely, ESD (effective scatterer diameter), EAC (effective acoustic concentration),  $\mu$  parameter, K parameter and attenuation coefficient slope. Linear Discriminant Analysis was the classifier algorithm used. **Error! Reference source not found.**

#### IV. ARCHITECTURE DIAGRAM

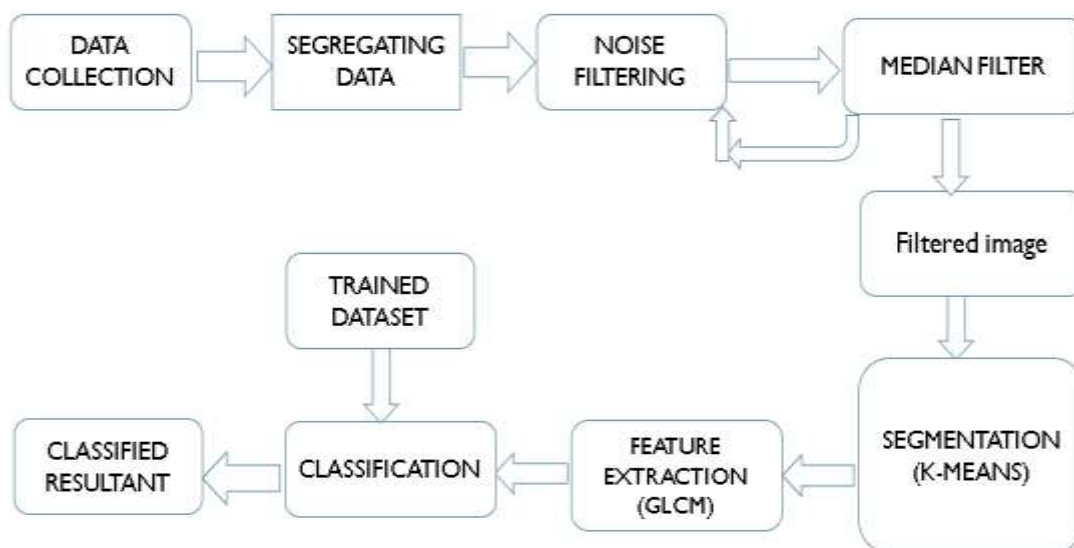


Figure 1: Architecture Diagram

The thermal images dataset is initially pre-processed to remove any noise present in the images. Naturally all images contain some amount of noise. But it is difficult to denoise this, as we are not aware of the existing noise in the image. Thus, we add a simulated noise, so that we could understand better the process of de-noising. In our case, we add salt and pepper noise, as our images are sensitive in nature and salt & pepper noise can be easily de-noised. For the purpose of de-noising, we use median filter, that is effectively paired with it, as it helps in preserving of the edges.

The pre-processed and filtered image [Figure 2] then undergoes various types of segmentation techniques namely, region-based segmentation, K-means clustering [Figure 5] and edge detection segmentation [Figure 4]. Out of the above three techniques, K-means clustering, and edge detection offers good results as they provide a clear visibility of the thyroid region and good differentiation between the surrounding regions of the image. The chosen technique, K-means clustering taking the value of  $k=5$ , is clustered and the segmentation process is complete. This value is generally obtained through 'Elbow method', that is used to determine the optimal value of K-means

clustering algorithm. As 'K' increases, the number of clusters in an image increase while the number of elements within the cluster decrease. This means that a certain cluster that is supposed to have 'n' elements now has only about half of its elements and the rest half are distributed among other clusters. This results in a decrease in distortion value. Thus, the point where there is an effective decline in the distortion values is known as "Elbow point."**Error! Reference source not found.**

The required features are then extracted using Grey-level-co-occurrence matrix method. They are then finally classified using Support vector machine to depict if the image is cancerous or non-cancerous in nature.

#### **A. Image Pre-Processing**

Salt and Pepper noise also known as impulsive noise is one form of noise that is caused due to sudden and impulsive disturbances occurring in the image. The medical databases are very sensitive in nature and it is very important to preserve as much data of the image when pre-processing, so as to obtain good accuracy in the end. For this case, salt and pepper noise acts as a good source, with it being effectively paired with median filter.

"Median filtering" is used to reduce "salt and pepper noise" during image processing. It is a non-linear operation and is more effective than convolution, the generally used technique when we aim at reducing the noise and simultaneously preserving the edges of the image. Since, we are dealing with sensitive medical data, it is advisable for us to use median filter as the chances of losing the edges of the tumorous region is minimized. In this stage, "salt and pepper noise" is added to the image and this image is filtered of all existing noises to produce a pre-processed image.

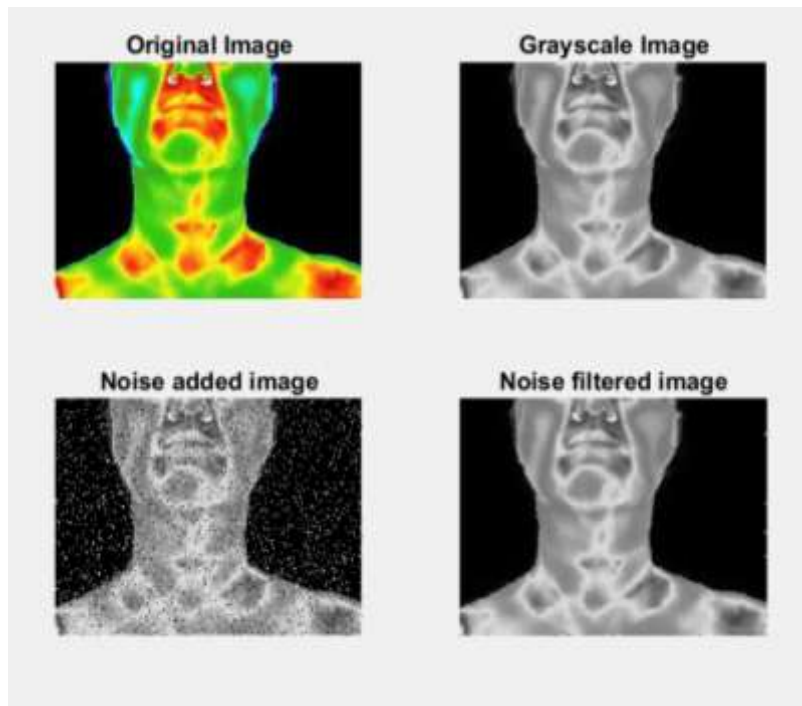


Figure 2: Filtering

## **B. Segmentation**

“Segmentation” is the process of partitioning a given image into several parts called ‘segments’. Most of the images are not uniform in nature. They have certain regions that contain no information and certain regions constituting our region of interest. By dividing the image into segments, we make sure of using only those regions that hold importance to the process. As we know that an image is nothing but a collection of pixels. So, the pixels with similar attributes are grouped together in image segmentation techniques.

### **a) Region Based Segmentation**

More the number of objects in an image, higher is the chance of a color contrast within an image. Thus, higher are the number of segments within an image. In such cases, a threshold value is set and the pixel values that are falling below or above the threshold are classified categorically. This process is popularly called as threshold segmentation.

If there is only a single object and background in an image, then we can divide the image into two regions using global threshold value. On the other hand, if there are multiple objects in an image along with a background, multiple threshold values are used to segment the image. This is known as local threshold.

In the proposed method, the local threshold value is used to differentiate the regions in the thyroid thermal images. It is a simple method, where in the neighboring pixels are examined to that of initial centered points. They are then thought upon, to be added to the existing region of centered points or create a new region. This is further iterated till the entire image is processed.

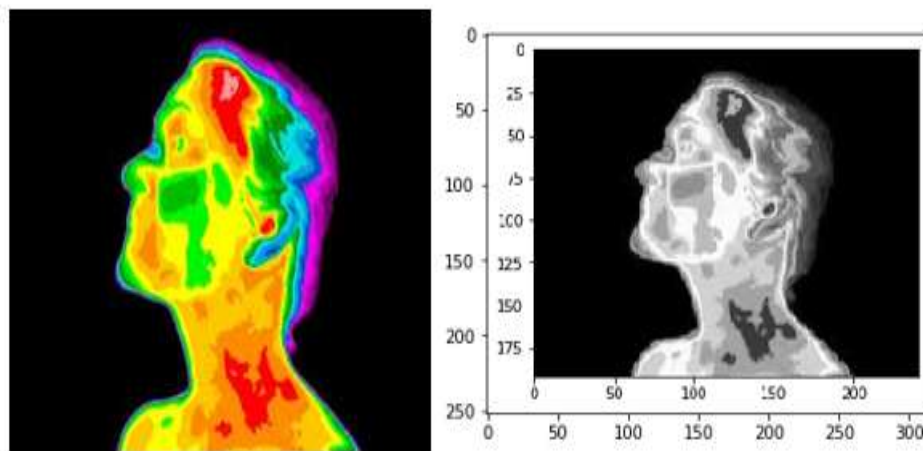


Figure 3: Region Based segmentation

### **b) Edge Detection**

There is always an edge between two varying intensity pixels. When an edge is detected, the machine understands that there are 2 different regions with varying grey scale (pixel) values. This discontinuity can be used to define the boundaries of objects in an image and thus, identify the shape of the objects present in it.

In the proposed method, the sobel filter is used for processing the image.

The intensity function of any image can be known only at certain discrete points. The main purpose of this filter is to look through the 3x3 region of the image and identify the edge using the variation in intensities between light and dark colors. This is done iteratively through every point of the image and an approximate value of gradient is obtained. It effectively uses a Laplacian kernel to compute both the horizontal and vertical edges of an image using a matrix, that stores the inherent pixel values. **Error! Reference source not found.**

```
function sobel (A : as two dimensional image array)
```

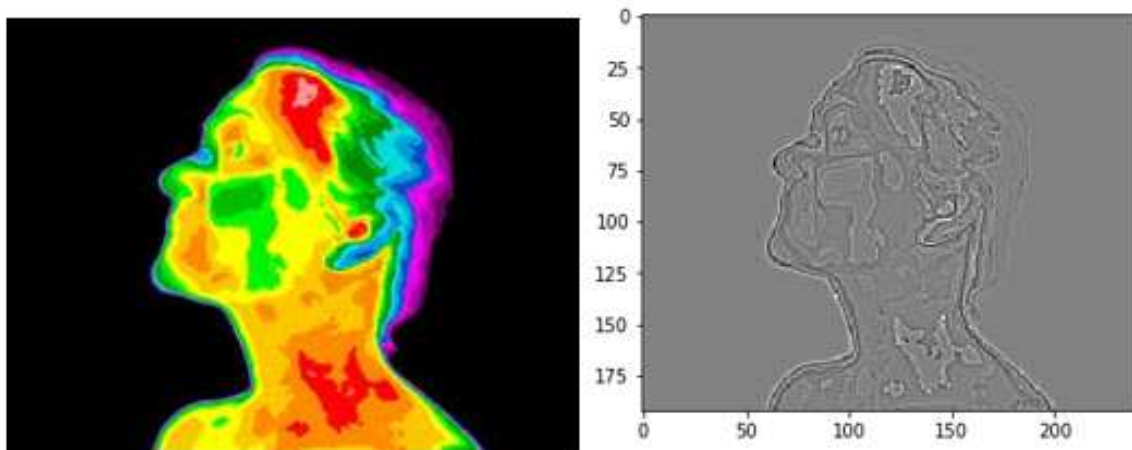


Figure 4: Edge Detection

### c) *K-Means Clustering*

Clustering refers to the process of division and grouping of similar pixels in any given image and the group of pixels are called as clusters. K-means clustering is the most common method that is used for image segmentation, when it comes to small datasets. ‘K’ refers to the number of clusters being assigned.

In the proposed method, K value of 5 is used to perform clustering. This value has been decided as, any value below 5 leads to non-recognizance of the thyroid region and any value above 5 causes variance of colors in the image, thus making it difficult for the machine to classify. Initially the rgb coded image is read into the system. This rgb color spaced image is then converted into “L\*a\*b color space”, that helps in visualizing minute color differences in any image. Here, L stands for luminosity, a for chromaticity layer indicating red-green axis and b for chromaticity layer blue-yellow axis.

The image is converted into “L\*a\*b color space” using “rgb2lab function” as shown below.

$$\text{Lab\_he} = \text{rgb2lab}(\text{he})$$

Since the entire color information is stored in “a\*b\* color space”, the objects of identification are pixels with “a\*” and “b\*” values. Imsegkmeans function is used to cluster the objects into 3 clusters. **Error! Reference source not found.**

```
Pixel_labels = imsegkmeans(ab, nColors, 'NumAttempts', 3)
```

For every object in the inputted image, `imsegkmeans` returns a label corresponding to the given cluster and these labels are named using the `pixel_labels` variable.

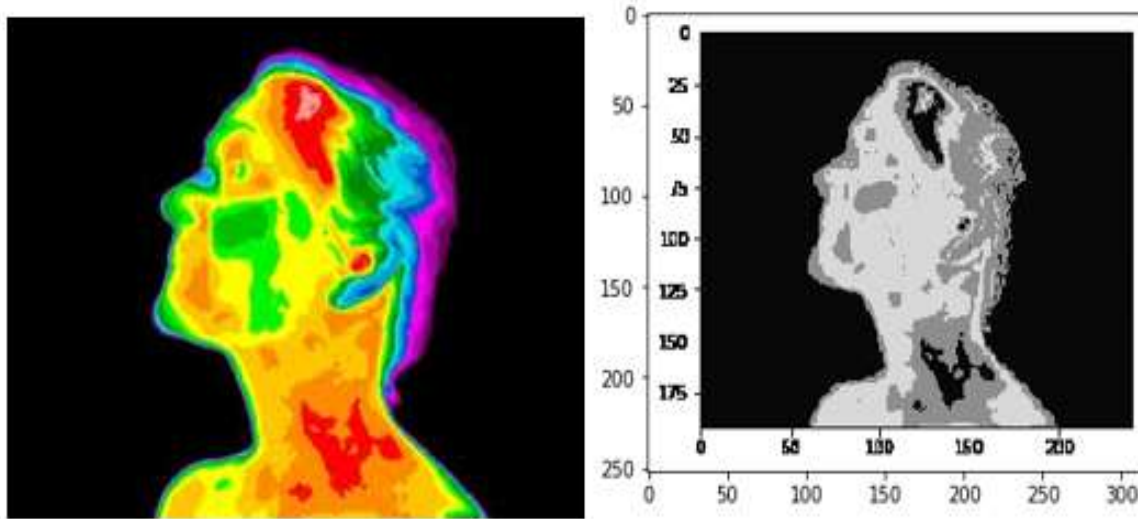


Figure 5: K-Means Clustering

### C. Feature Extraction

After the process of segmentation, the required features to carry out classification process is obtained using grey level co-occurrence matrix (GLCM). It is one form of texture analysis where in the required features are values of different types of textures in an image. **Error! Reference source not found. Error! Reference source not found.**

There a total of ten properties of GLCM (grey – level – co-occurrence matrix), whose specified statistics are calculated using the function **Error! Reference source not found.**

```
Stats = graycorps (glcm, properties);
```

The properties used in this method are explained below:

- Contrast:

This is a measure of intensity and refers to the differences in intensities of pixels in the neighboring regions.

$$\sum_{i,j} |i - j|^2 p(i, j)$$

- Correlation

This determines how close each region resembles with the other regions of the image. It can be called as the resemblance factor.

$$\sum_{i,j=0}^{N-1} P_{ij} \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

- Energy

This can be termed as the uniformity of an image and finds the value of uniformity in distribution.

$$: \sum_{i,j=0}^{N-1} (P_{ij})^2$$

Apart from the above important properties, the other useful properties to extract the features are as follows:

- Mean

$$\mu = \frac{1}{N} \sum_{i=1}^N A_i.$$

- Standard Deviation

$$S = \sqrt{\frac{1}{N-1} \sum_{i=1}^N |A_i - \mu|^2},$$

- Entropy

$$H = - \sum_k p_k \log_2(p_k)$$

The values of some of the properties of two sample images in the category of benign and malign tumor can be seen in the following table, where the values of benign cancerous image are higher than that of malign cancerous image. [Table 1]

Table 1: GLCM features of benign and malign tumor

Properties	Benign	Malign
Energy	181.2476	165.0332
Contrast	0.9670	0.9590
Correlation	0.4789	0.5246
Homogeneity	11.0390	10.6735

#### D. Classification

After the features are extracted from the images, they are subjected to classification process. The thermal images dataset is loaded for training. They are then classified using Support Vector Machine (SVM). Support vector machine works using 2 variables namely X and Y. Y is the output, or the predicted feature and X is the set of features extracted during the experiment that are fed to the machine. In our case X refers to the values belonging to



the set of 10 features and Y refers to the output of experiment namely the status of cancer. The resultant is a classified output depicting if the inputted image is malign (cancerous) or benign (non-cancerous) in nature. Benign images have the characteristics of less chance of developing into tumor stages in later days, while malign images spread very quickly to neighboring parts of the body.

## V. CONCLUSION AND FUTURE INFERENCE

Based on the above survey, it has been observed that ultrasound images, though easy to process are not very effective in the detection of Thyroid Cancer. Due to more involvement of Operators and less computerized techniques, we can process using thermograms. Radiation in the long – infrared range of electromagnetic spectrum are detected using thermographic cameras and the resultant images are known as thermograms or thermal images. Due to the easy visibility of cold and hot nodules in a thermal image, we can infer that the accuracy of detection would be better than the previous methods. Thermograms being a quite affordable medium of diagnosis can be made available in hospitals across the country and improve the diagnosis of cancer. Further, to improve the efficiency of detection, various enhancements could be applied.

## REFERENCES

- [1] Ding, J. (2011). A novel quantitative measurement for thyroid cancer detection based on elastography. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/6100576>
- [2] Franitta, E. L. (2018). Thyroid Nodule Classification Based on Characteristic of Margin using Geometric and Statistical Features. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/8534944>
- [3] Goodrazi, E. (2019). Epidemiology, incidence and mortality of thyroid cancer and their relationship with the human development index in the world: An ecology study in 2018.
- [4] Jena, S. R. (2019). Feature Extraction and Classification Techniques for the Detection of Lung Cancer: A Detailed Survey. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/8822164>
- [5] Leung, C. (2002). Thyroid cancer cells boundary location by a fuzzy edge detection method. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/902933>
- [6] Li, H. (2018). An improved deep learning approach for detection of thyroid papillary cancer in ultrasound images. Retrieved from NCBI: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5920067/>
- [7] Maraoulis, D. (2005). Computer-aided thyroid nodule detection in ultrasound images. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/1467702>
- [8] Montero, M. L. (2014). Evaluation of classification strategies using quantitative ultrasound markers and a thyroid cancer rodent model. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/6931744>
- [9] Nagesh Singh Chauhan. (2019). Introduction to Image Segmentation with K-Means clustering. Retrieved from Towards Data science: <https://towardsdatascience.com/introduction-to-image-segmentation-with-k-means-clustering-83fd0a9e2fc3>
- [10] Priyambada, B. (2019, February). WORLD CANCER DAY 2019: CANCER IS A WAR THAT CAN BE WON IF YOU KNOW WHAT TO LOOK FOR. Retrieved from ICMR: [https://www.icmr.nic.in/sites/default/files/ICMR\\_News\\_1.pdf](https://www.icmr.nic.in/sites/default/files/ICMR_News_1.pdf)
- [11] Rajesh, P. (2016). Thyroid Disorder Detection Using Image Segmentation in Medical Images. Retrieved from IJSDR: <http://www.ijedr.org/papers/IJSDR1606041.pdf>
- [12] Saraf, J. (2017). Thyroid Cancer Detection using Image Processing. Retrieved from IJRSI: <https://www.rsisinternational.org/IJRSI/Issue45/75-77.pdf>
- [13] Sobel operator. (2020, 02 06). Retrieved from Wikipedia: [https://en.wikipedia.org/wiki/Sobel\\_operator](https://en.wikipedia.org/wiki/Sobel_operator)
- [14] Sun, J. (2018). Automatic Diagnosis of Thyroid Ultrasound Image Based on FCN-AlexNet and Transfer Learning. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/8631796>
- [15] Torab-Miandoab, A. (2017). Image processing technique for determining cold thyroid nodules. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/7965547>
- [16] Vas, M. (2017). Lung cancer detection system using lung CT image processing. Retrieved from IEEE: <https://ieeexplore.ieee.org/document/8463851/authors#authors>
- [17] Zheng, X. (2018). Image segmentation based on adaptive K-means algorithm. Retrieved from Springer Link: <https://link.springer.com/article/10.1186/s13640-018-0309-3>
- [18] Lab, Visual. (2016). Retrieved from Visual Lab: [http://visual.ic.uff.br/en/thyroid/trabalhos\\_realizados.php](http://visual.ic.uff.br/en/thyroid/trabalhos_realizados.php)