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Empirical Study of MRI Brain Tumor Edge Detection Algorithms

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Abstract

A brain tumor refers to the abnormal growth of cells that can be found in the brain or the skull. MRI is a type of advanced medical imaging that provides detailed information about the anatomy of the human soft tissues. Medical experts perform tumor segmentation using magnetic resonance imaging (MRI) data, which is an essential part of cancer diagnosis and treatment. Tumor detection refers to the methods that are used to diagnose cancer or other types of diseases. Edge detection is also one of the common methods that come under the process of treating medical images. The main objective of edge detection is discovering information about the shapes, transmission, and reflection of images. In this paper, we investigated the performance comparison MRI brain tumor edge detection Algorithms. The Canny, and Prewitt are used for investigation. As result, Canny edge detection is better than Prewitt in term of clarity and visibility for the tumor.

Keywords: Brain Tumor; MRI; Edge Detection; Tumor Edge Detection; Canny algorithm; Prewitt algorithm.

1. Introduction

It is a fact that segmentation, detection and extraction of brain tumors using MR images is considered as one of the most significant concerns. However, it seems to be tedious to perform such a task and it is very intimidating for radiologists or clinical experts. The accuracy of such a task depends only on the experience of these professionals in respect with this part. The focus here is on the recent improvements that have taken place in this field and ways to improve them whether this is possible [1].

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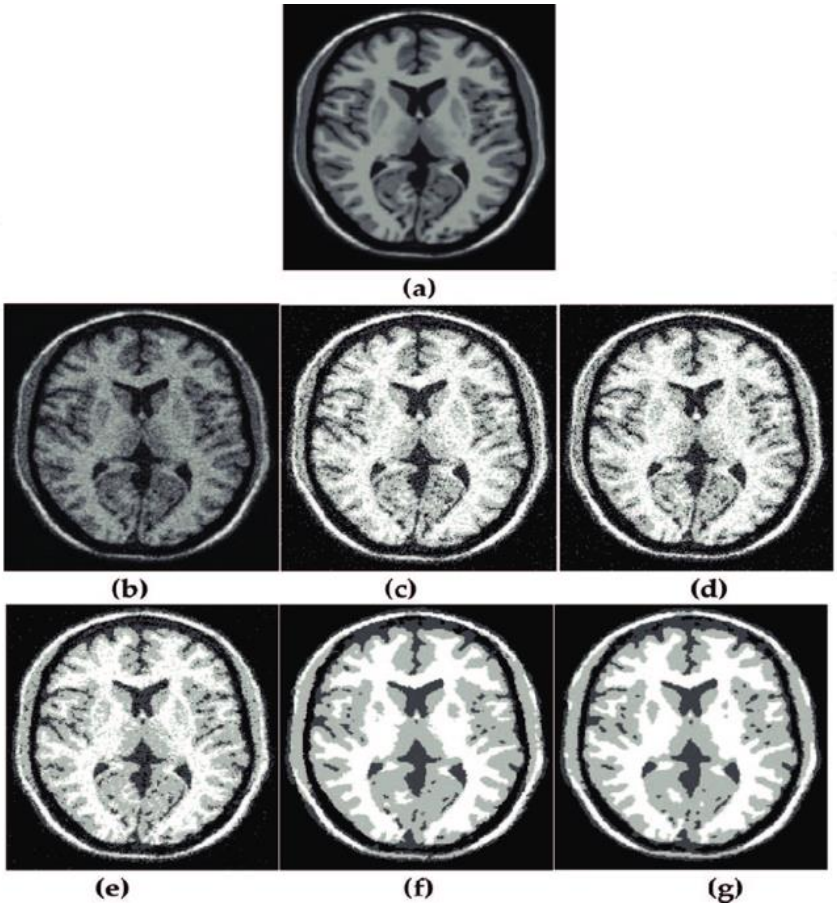

Figure 1: Segmentation and Clustering [2]

Brain tumors are one of the most common types of cancer all over the world. There are indications that there are 6.1 males and females per 100,000 who have brain tumors are increasing. If the appropriate technique is not selected for brain tumor visualization in that case Image may not contain a valuable information for doctor to make a correct decision. In this paper, we are empirically implementing and measuring the performance of recently popular brain tumor edge detection algorithm. Our motivation will help to do advanced level researcher in the area.

First, in paper, I will discuss the Introduction paper. It should consist of introduction to brain tumor detection, motivation of work, and organization of the paper. Second, I will discuss the related work. Focus on very recent research papers from good journals. The review summarizes the work done by previous authors then makes a comparative study of the existing state-of-the-art methods. Then would include investigated algorithms, description, and flow chart. I will discuss MATLAB programs. After that, will include result and description for the investigated algorithm, pros and cons. Finally, the conclusion.

2. Related Work

To be able to have a further step in the research, it was necessary to look at the past related works related to the heart of the topic. Below is an overview about the related works that discussed the MRI image segmentation

techniques. It also discusses the contributions and developments that have been performed in this area to have a better overview about the new possible improvements that can be added for now or the future.

Reference [1] A. T. S. Kalvakolanu, Brain Tumor Detection and Classification from MRI Images, 2021. Biopsy is capable of detecting brain tumors after performing a brain surgery. Machine learning and other technology advancements could help in diagnosing tumors without any aggressive measures. A deep learning-based approach is used to detect and classify tumors. A classification accuracy reached over 95% for all results [3].

Reference [2] A. H. Abdel-Gawad, L. A. Said and A. G. Radwan, "Optimized edge detection technique for brain tumor detection in MR images," *IEEE Access,* vol. 8, pp. 136243-136259, 2020.The paper proposes an optimized edge detection technique which is based on genetic algorithms. Genetic algorithms are mainly used as optimum solutions for eliminating the gene strings with the worst fitness. A training dataset was implemented and which contained simple images for this technique to be applied. BCET technique was applied for improved image features to provide better outcomes of the medical images. Later, the GA edge detection method was implemented with the proposed training dataset [4].

Reference [3] C. L. Choudhury, C. Mahanty, R. Kumar and B. K. Mishra, "Brain tumor detection and classification using convolutional neural network and deep neural network," in *In 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA),* 2020.Accurate and early detection of brain tumors are the key elements for a successful treatment of a disease. Machine learning algorithms have proven their essentiality in processing medical imagery and generating information in comparison with manual diagnosis of tumors. The research includes an approach of deep neural network and it incorporates a Convolutional Neural network (CNN) for better tumor detection results and it showed 96.08% accuracy result [5].

Reference [4] Z. Stosic and P. Rutesic, "An improved canny edge detection algorithm for detecting brain tumors in MRI images," *International Journal of Signal Processing,* p. 3, 2018. This paper discusses a detection algorithm that can be integrated with MRI techniques for detecting brain tumors. The paper includes some approaches known as LoG filer, magnitude and kernel gradient. The approaches are based on the traditional Canny algorithm. It was noted through the research that the results produce more detailed edge detection [6].

Reference [5] A. Lakshmi, *Performance analysis of brain tumor Segmentation and classification in brain MRI using soft computing techniques,* Kalasalingam University, 2017. Image processing is known as a dynamic research zone that includes a very difficult field known as image processing. The methods of medical imaging are used to utilize internal segments of the human body and are used for restorative diagnosis. The research proposes a segmentation of cerebrum MRI utilizing rough-fuzzy clustering algorithm taken after a morphological separating that keeps away from mis-clustered areas [7].

Image processing algorithms are the techniques used for computer vision. Digital images represent a matrix of numerical values. Images can come in different forms of pixels, averages of single value and all this is represented in a matrix format. Image segmentation is the practice of classifying the various image pixels.

3. Brain Tumor Algorithms

Brain Tumors refer to abnormal masses that occur in or on the brain. There is no obvious cause about why such tumors occur for patients. Some of the known causes of brain tumors are related to the exposure of large volumes of radiation from x-rays or due to past cancer treatments [8]. Edge detection is also one of the standard methods that come under the process of treating medical images. The main objective of edge detection is discovering information about the shapes, transmission, and reflection of images, as shown in figure (2).

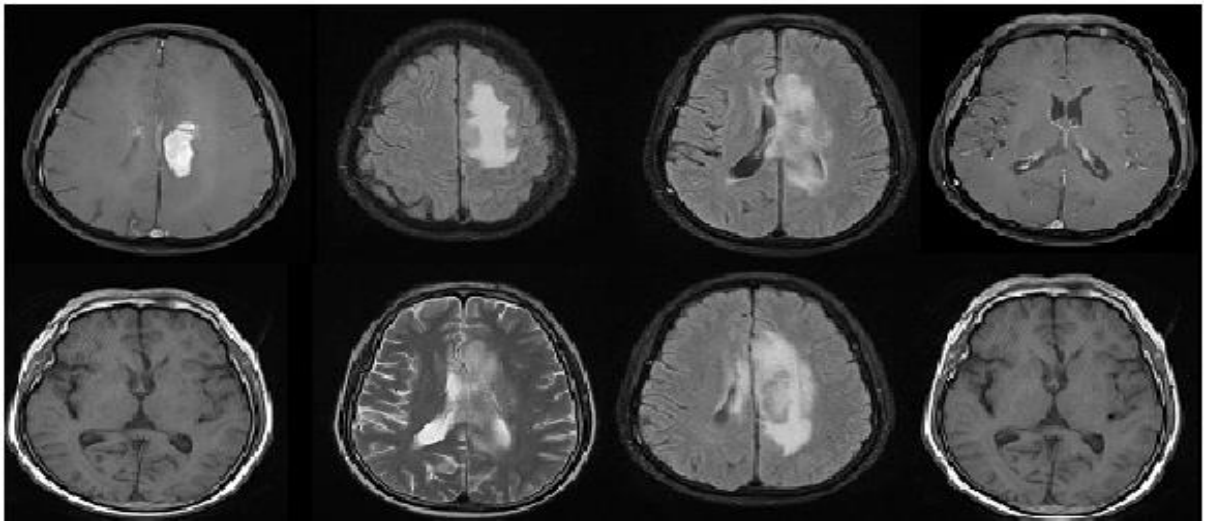

Figure 2: Brain Tumor Detection [9]

In this project, we investigate the visibility evaluation of the following two tumor edge detection algorithms:

- Prewitt Algorithm
- Canny Algorithm

According to these algorithms, they have a very advanced presence of Gaussian filter allows removing any certain noise found in the images. The details of images in ideal cases include a set of connected curves that indicate to the boundaries of objects, which facilitates viewing and analyzing the images for further diagnosis.

3.1. Prewitt Edge Detection Algorithm

Following are the main steps involved in prewitt edge detection algorithm:

- To begin with process first will clear all variable in workplace to ensure everything at the initial value.
- we import all the data which is DCM files, if the data dose not exists, we will repeat first step otherwise we complete.
- Then we display the image.
- We chose prewitt edge detection filter.

- We store a default threshold.
- Then we multiply it by fudge factor (enhancement algorithms).
- Then we apply this filter with the appropriate fudge factor.

○ createFilter makes a line in 3x3 matrix rotated 90 degrees

○ createFilter makes a line in 3x3 matrix not rotated at all

- Display edges.
- Then we use enhancement algorithms called “dilate” to rase the gap between the edges.
- Then display the overlay resulting enhance edges image, as shown in figure (3):

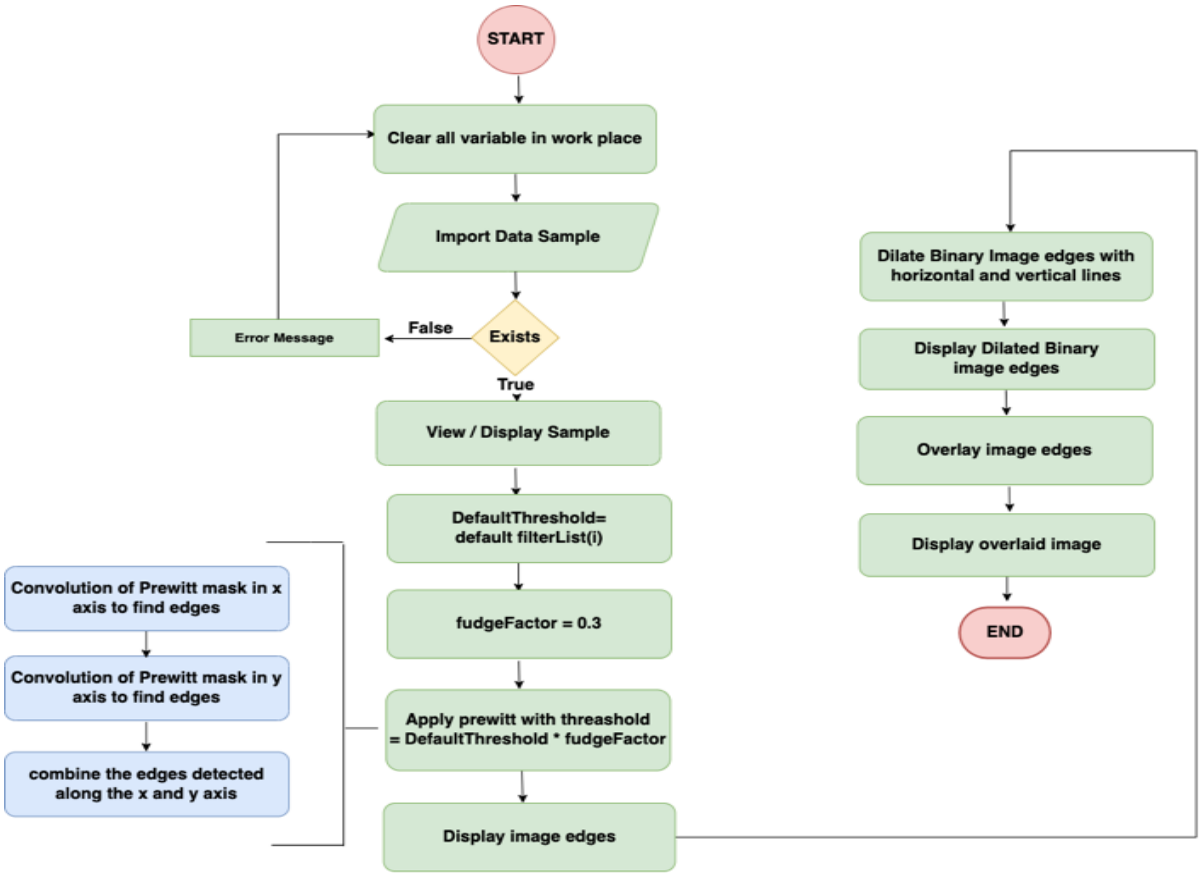

Figure 3: Prewitt Flow Chart

Following are the Pros and Cons for prewitt edge detection algorithm:

- **Pros:**

1. A good performance in terms of detecting both horizontal and vertical edges.
2. It is known as the best operator for detecting the orientation of images.

- **Cons:**

1. Diagonal direction points are not always preserved.
2. The coefficient magnitude is fixed, and it is not possible to change it.

3.2. Canny Edge Detection Algorithm

The second algorithm, following are the main steps involved:

- To begin with process first will clear all variable in workplace to ensure everything at the initial value.
- we import all the data which is DCM files, if the data dose not exists, we will repeat first step otherwise we complete.
- Then we display the image.
- We chose Canny edge detection filter:

○ createFilter makes a line in 3x3 matrix rotated 90 degrees
○ createFilter makes a line in 3x3 matrix not rotated at all
○ then we try to less from noise reduction
○ calculating the gradient image
○ apply non-maximum suppression to turn thins out the edges from the image.
○ After that we use double threshold
○ Finally, we apply edge tracking by hysteresis to transformation weak pixels
○ into strong.

- We store a default threshold
- Then we multiply it by fudge factor (enhancement algorithms)
- Then we apply this filter with the appropriate fudge factor
- Display edges
- Then we use enhancement algorithms called “dilate” to rase the gap between the edges.
- Then display the overlay resulting enhance edges image, as shown in figure (4):

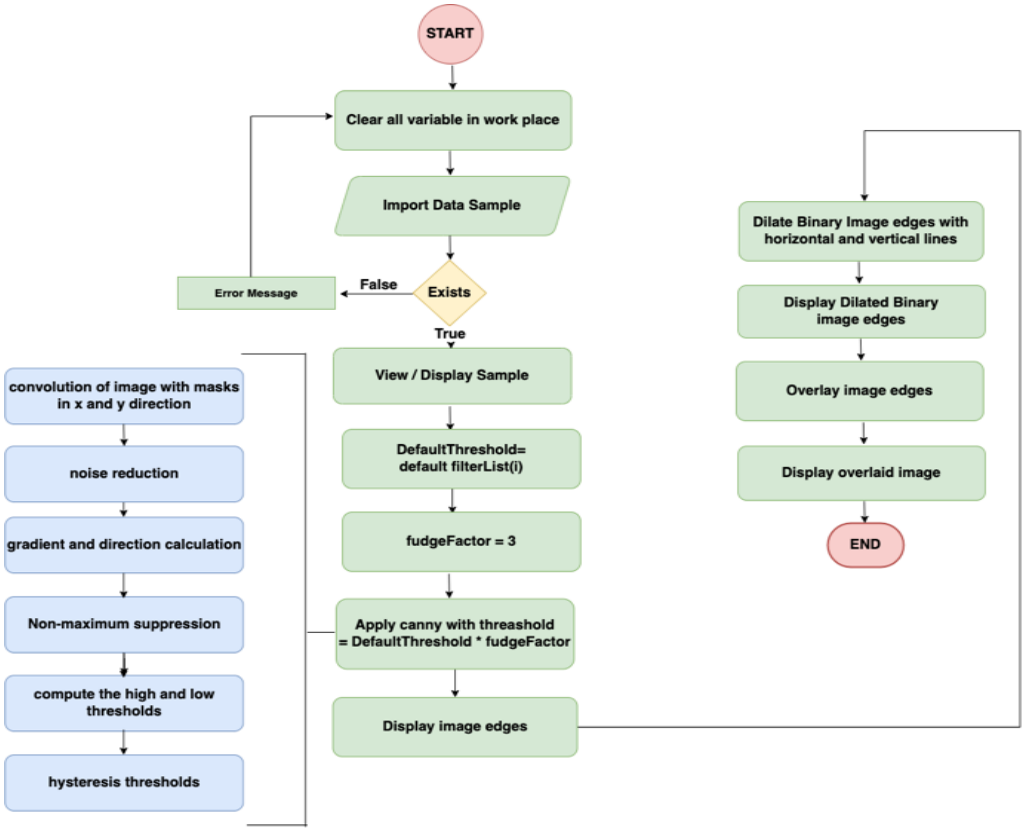

Figure 4: Canny Flow Chart

Following are the Pros and Cons for Canny edge detection algorithm:

- **Pros:**

1. Outputs contain much less noise due to the Gaussian blurring step at the beginning, as well as hysteresis double thresholding.
2. Edges are enhanced by a lot compared to other edge detection filters because of the non-maximum suppression step.
3. Little to no post-processing required to get the edges.

- **Cons:**

1. Execution time is higher than almost all other edge detectors.
2. Difficult to optimize for faster execution without losing its accuracy

4. Experimental Setup

Diagnosing brain tumors generally starts with using the magnetic resonance imaging (MRI) MRI is used in such scenarios to show whether there are tumors in the brain or not. One of the most common ways to address the

types of brain tumors is by looking at the outcome in the form of images [8].

The most recent advancement in MRI technology has focused only on the software side. There have been many studies that discussed the other technologies, techniques and algorithms. However, there was no study to be mentioned related to the performance of the algorithms for different types of MRIs [9].

4.1.Format of Image and description

DCM file formats can be described as digital images that are used for medical purposes. DCM or DICOM are the initials of 'Digital Imaging and Communication in Medicine'. CT scans, MRIs and ultrasound results are stored within these format images. They also store information related to patients who have a medical record in a health center for example [10].

5. Result and Description

In this section will be little discussion about the results obtained with proposed algorithms. First step, we will Read image from user then Display RGB image, as shown in figure (5a). Second step, find the reflection of the original for Canny algorithms. Then compare the original and reflected image. Apply Canny Mask, as shown in figure(5d). Third step, now find the location of the tumor. apply Canny Edge algorithm, as shown in figure (5b). Fourth step, apply enhancement algorithms called "Dilated". As comparing with third steps, these images have more details, edges are clearer and contain a lot of information for detecting the edges. Apply Canny, as shown in figure (5c).

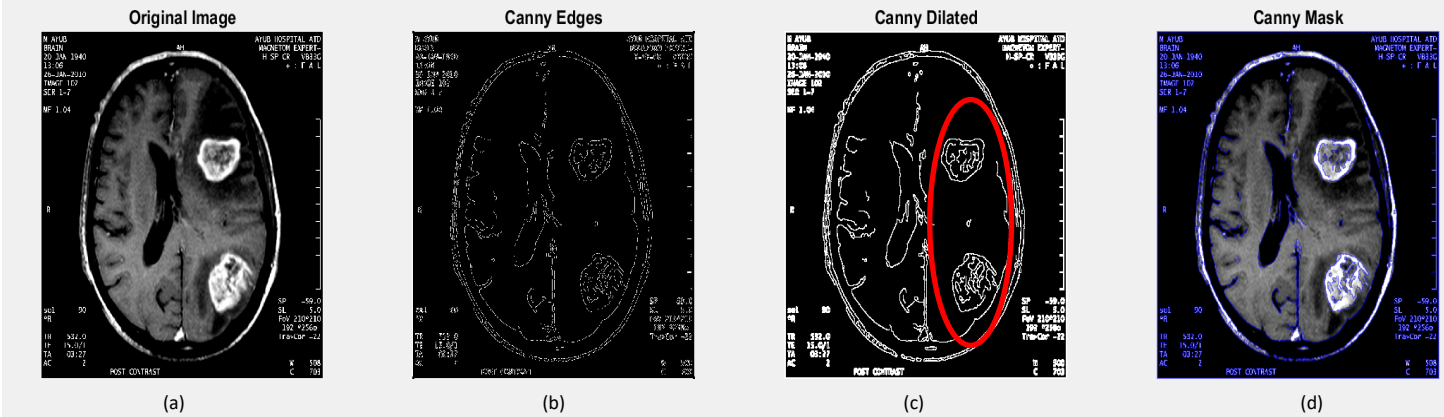

Figure 5: Canny Flow Chart

We will Read image from user then Display RGB image, as shown in figure (6a). Second step, find the reflection of the original for Canny algorithms. Apply Canny Mask, as shown in figure(6d). Then compare the original and reflected image. After that we start find the location of the tumor. Then apply Canny Edge algorithm, as shown in figure (6b). Fourth step, apply enhancement algorithms called "Dilated", as shown in figure (6c). As comparing with figure(b6) these images have more details.

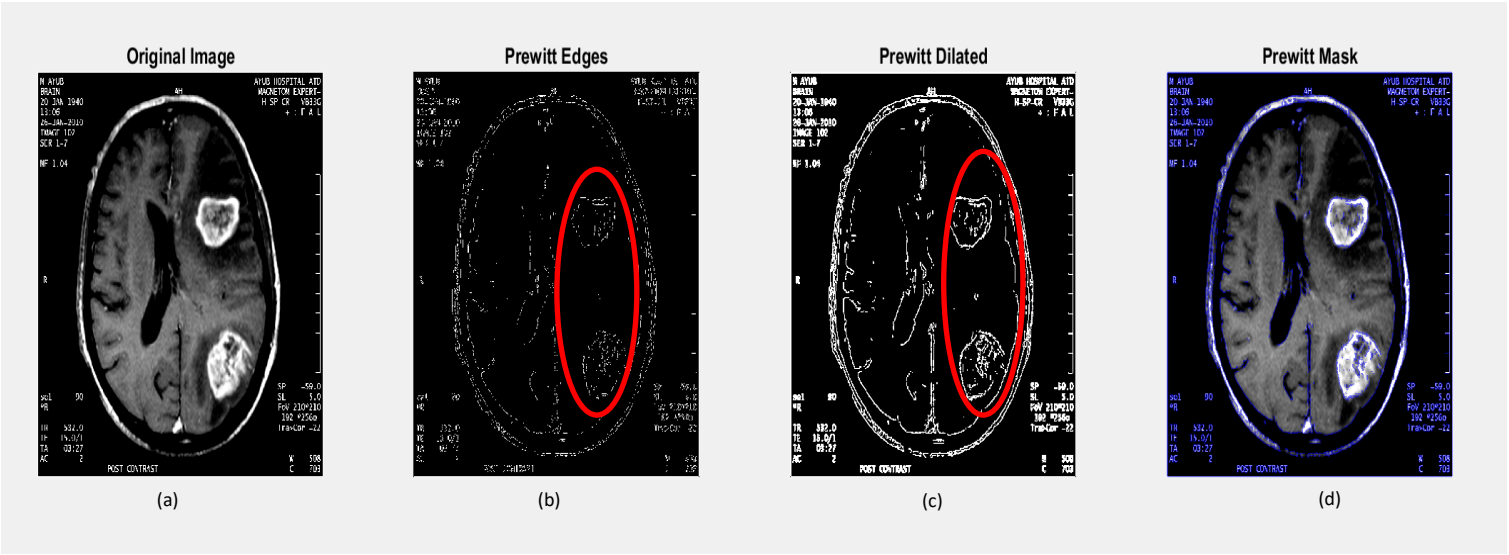

Figure 6: Prewitt Flow Chart

6. Conclusion

In conclusion, the proposed approaches may detect tumors/abnormalities on either the right or left side, and they can even detect multiple cancers. We implement two algorithms that are most commonly used these two algorithms is showing by enhancement. Tumor detection refers to the methods that are used to diagnose cancer or other types of diseases. Edge detection helps in many other image segmentation processes and data extraction, such as computer vision, machine vision, and image processing. We investigate Canny and Prewitt edge detection algorithms. As result, Canny was better than Prewitt by clarity and visibility.

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