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Brain Tumor Screening and Early Detection of Level Of Tumor And Survival Time Of Patient Using MRI Images Modality And Computational Tool.

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Abstract— Brain tumors are unwonted and unbounded multiplication of cells. Brain tumor reports for 85% to 90% of all primary Central Nervous System tumors. There is a need for bio-medical imaging computational tools that performs processing and extracting clinically relevant facts and figures from patient's brain MRI images. Magnetic resonance imaging (MRI) provides detailed information about brain tumor anatomy, cellular structure and vascular supply, making it an important tool for the effective diagnosis, treatment and monitoring of the disease. This paper presents a computer aided detection tool for brain tumor using brain MRI images and assists the neurologists to plan the further treatment. This tool automatically perform pre-processing of MRI images using Gabor filter, edge detection and feature extraction using Canny edge detector algorithm and finally classify the tumor using KNN classifier. In addition, this computational tool aids in classifying the stage of tumor and approximate survival time of patients. The experimental results of proposed technique shows better results with 93% accuracy compared to state of art methods.

Index Terms— Image processing, Computational tool, MRI images, Edge detection, Survival time, Brain tumor.

I. INTRODUCTION

In the stream of medical image processing the most burdensome task for medical specialists is scrutinizing the patient's brain MRI images by extracting indicative features and other clinical information. Brain tumour is an intracranial neoplasm that occurs in the brain. Detection of Brain tumor plays a vital role in effective diagnostic and treatment of encephalopathy diseases. Medical imaging modality used by specialist today are Magnetic Resonance Imaging (MRI), is a congenital medical imaging modality that uses a magnetic field and radio frequency waves to give images with high resolution and good contrast of internal soft tissues of the brain [1].To effectively measure and visualize the patient's brain anatomical structures many bio medical applications uses segmentation or edge detection of MRI images [2]. Techniques which are non-automatic are used in the earlier days which are time consuming and error prone. Based on region of interest of segmentation of MRI images are classified as pixel classification, edge based classification, model based techniques, region based, and threshold based.

Popular segmentation technique used in this work is canny edge detection algorithm. "Canny edge detection" algorithm is one of the most strictly defined methods that provide better and reliable methods [3]. Magnetic Resonance Images are classified based on repetition time (TR) and time to echo (TE).T1-weighted images are obtained by shorter TE and shorter TR whereas T2-weighted images are obtained by longer TR and longer TE [4]. T1 and T2 properties of brains are used to determine the brightness and contrast of scans. The human brain consists of tissues that has higher fat content and appears bright in MRI images. Dark MRI image is the part of the brain filled with fluid. In our research we used high resolution and good quality T1-weighted images.

In the past ten years there is a tremendous development in the field of brain MRI segmentation and edge detection to detect tumors [5], [6], [7], [8].Algorithms which are implemented in software packages are very expensive and only affordable to extravagant sanatoriums and are not does not have friendly and easy to use human interface. In this work we have developed and presented a free to use graphic mode computer executable software tools that run without human interference. It is packaged in a standalone independent GUI, which can load MRI images and perform automatic edge detection to detect tumor. This GUI enables user to perform various operations like preprocessing, edge detection and feature extraction and classify the stage of the tumor additionally it predicts survival time of patient.

Though there are many algorithmic calculations and ciphers that exists but are not effectual as executable packages or downloadable software. Those software packages that are put into practice are over-prized and are affordable to high end sanatoriums only and are not easy to use [11].The main objective of this work is to develop free of cost picturesque computational tool that spontaneously performs edge detection of brain MRI images and functions as a neuroscientists disease prognostic skeleton and tumor detection tool that also forecasts the level of tumor and approximate survival time of the patient.

The scope here is to benefit any medico, academician, experimenter, technologists, practitioner, neuroscientists or

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surgeon. Edge detection has various real time applications and implementations that assist to provide patient's information for pre-operative planning.

II. METHODOLOGY

A. *Pre-processing*

Pre processing is done once the image is uploaded. In this work we are using Gabor filter. The response of the filter is created by multiplying with a Gaussian function. The Gabor filter shows that this function minimizes the space and time uncertainty product. Gabor filter for 2-D MRI image is given as:

$$G_c(x, y) = B*\exp-((x^2 + y^2) / 2\sigma^2) \cos(2\pi f(x\cos\theta + y\sin\theta))$$

$$G_s(x, y) = C*\exp-((x^2 + y^2) / 2\sigma^2) \sin(2\pi f(x\cos\theta + y\sin\theta))$$

Real and imaginary component is given as:

$$G(x, y: \gamma, \sigma, \psi, \theta, \lambda) = \exp((-x'^2+\gamma^2y'^2)/(2\sigma^2)) \cos((2\pi(x'/\lambda))+\psi)$$

$$G(x, y: \gamma, \sigma, \psi, \theta, \lambda) = \exp((-x'^2+\gamma^2y'^2)/(2\sigma^2)) \sin((2\pi(x'/\lambda))+\psi)$$

Where

$x' = y\sin\theta + x\cos\theta$

$y' = y\cos\theta - x\sin\theta$

Where parameters λ, θ, ψ, represents wavelength, orientation, phase offset, standard deviation of Gaussian envelope and the parameter γ in the equation represents the spatial ratio.

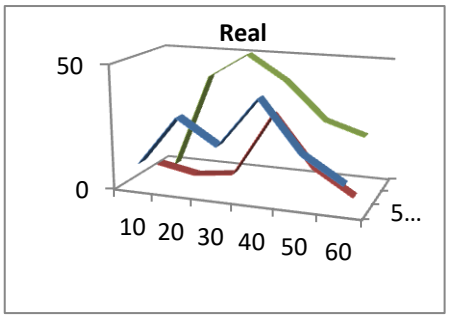

Fig.1. Real component of Gabor filter.

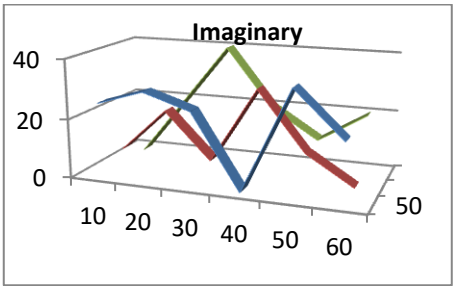

Fig.2. Imaginary component of Gabor filter.

B. *Edge detection*

The proposed technique is habitually cast off for edge detection totally depending upon the instantaneous variations in intensity.

1. Smooth the image and reduce the noise by applying Gaussian filter to the image.

$$g(m, n) = G_\sigma(m, n) * f(m, n)$$

$$G_\sigma = \frac{1}{\sqrt{2\pi\sigma 2}} \exp(-\frac{m2+n2}{2\sigma 2})$$

2. Calculate gradient of g (m, n)

$$M(n, n) = \sqrt{g^2_m(m, n) + g^2_m(m, n)}$$

$$\theta(m, n) = \tan^{-1}[gn(m, n) / gm(m, n)]$$

3. Threshold of M

$$M_T(m, n) = \begin{cases} M(m, n) & \text{if } M(m, n) > T \\ 0 & \text{Otherwise.} \end{cases}$$

4. To thin the edge ridges, overwhelm non-maxima pixels in the edges in M_T achieved, to do so check whether integral $M_T > \theta(x, y)$. If so, preserve $M_T(x, y)$ unaffected, else, set it to 0.
5. Two contrary thresholds given as *T1* and *T2*. To procure two binary images threshold the earlier outcomes of the given varying threshold.
6. Connected edge segments in T2 to make incessant uninterrupted to locate any boundary section in T1 to fill the opening till achieving further edge segment in T2.

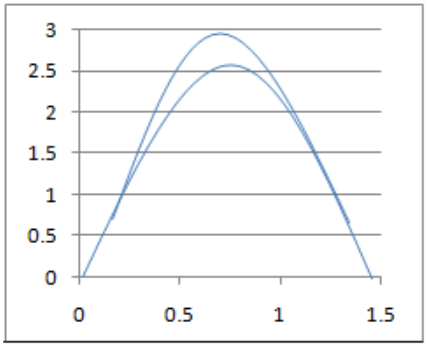

Fig.3. Edge detection feature.

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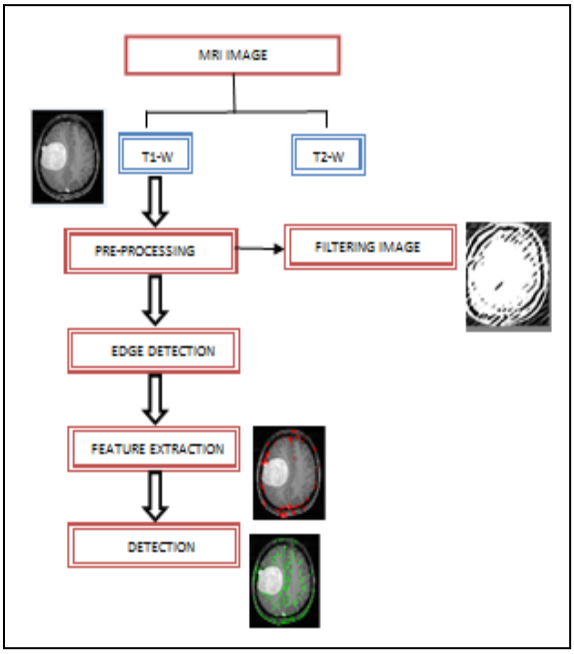

Fig.4. System architecture.

C. K nearest neighbor classifier (KNN)

The classification is based on the most instance based method called KNN classifier. "Euclidean distance" formula is used to find the distance to the closet instance. Every instance has an attribute associated with it. Let us take the arbitrary instance in the sample as x. let x be the feature vector.

$$(a_1(x), a_2(x), a_3(x),\ldots\ldots\ldots\ldots a_n(x))$$

Where $a_n(x)$ denotes the nth attribute for the instance.

$$d\,(x_i,\, x_j) \equiv \sqrt{\sum_{r=1}^{n} \quad (a_r(x_i) - a_r(x_j))^2}$$

Let x_q be the query point around which we have to find the k-nearest points. Following is the algorithm.

- Training

  For each training example *(x, f(x))* add all the examples to the list of training examples. Where *x* is the instance and *f(x)* is the target function.

- Classification

  Classify the query instance x_q as

  Let $x_1 \ldots\ldots\ldots x_k$ are the k number of occurrences from the given teaching example which are nearby to the query instance x_q.

  Return

$$f\,(x_q) \longleftarrow \text{argmax} \sum_{i=1}^{i} \quad \delta(v, f(x_i))$$

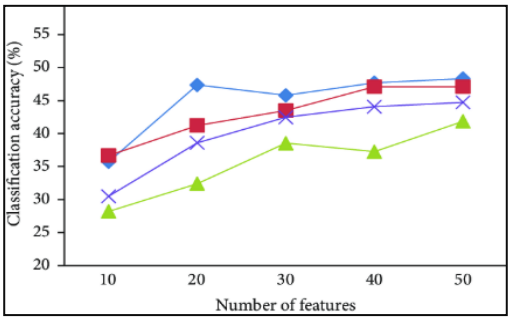

Fig.5. KNN classifier versus feature graph.

III. RESULT AND ANALYSIS

The GUI has different buttons for different processing actions. The system takes MRI image of the patient as input, enhancing the image and suppressing the noise is performed using Gabor filter, edge detection is carried out by the Canny edge detection algorithm, based upon this, it classifies the MRI images using KNN algorithm. Depending upon the level of tumor it classifies and predicts the survival time of the patient.

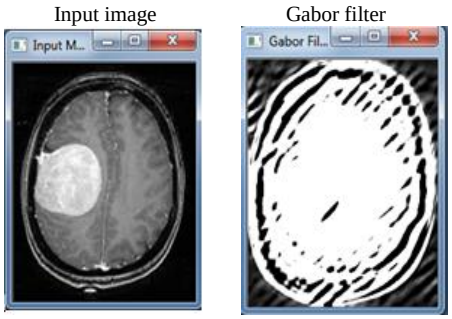

Fig. 6. Input and Pre-processed image.

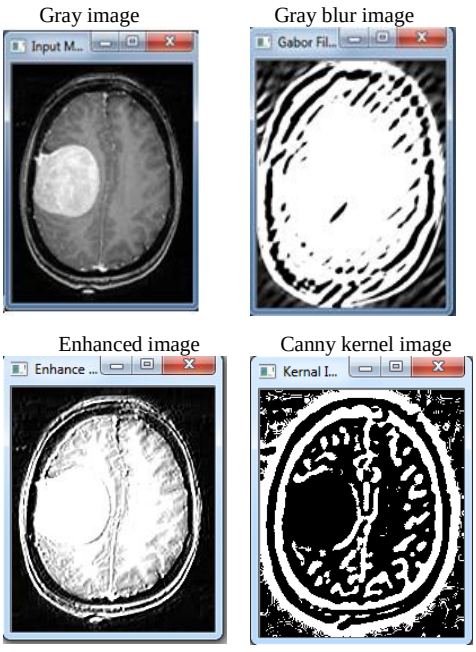

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Fig. 7. Processed images after implementing Canny algorithm.

Dataset of 37 MRI images of patients from UCI machine learning repository have been taken and found the following results as shown in the graph. Depending upon the intensity and level of tumor system calculates the approximate survival time. The depicted MRI is classified as high level tumor and estimates ± 2 years survival time. The computation time for the proposed work is very less than state of arts methods. The accuracy of the proposed system is better than existing systems.

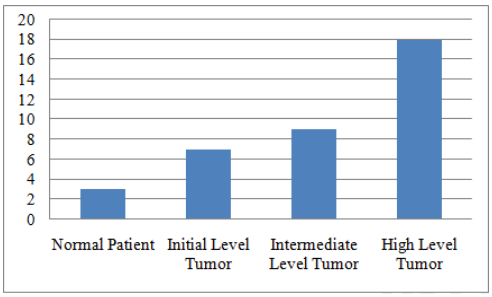

Fig.8. Patients MRI image and classification of tumor level.

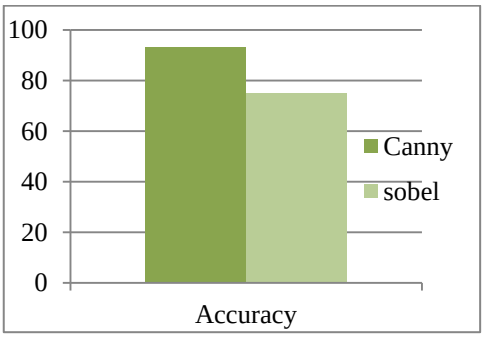

Fig.9. Comparison between existing method (Sobel) with proposed method (Canny) for 37 patients.

IV. CONCLUSION

There is a tremendous development in the field of bio-medical image processing and detecting brain tumor is the major field of work. This research work presents a computational tool works for the Magnetic Resonance Imagining modality. This computational tool automatically detects the brain tumor using edge detection technique. Earlier manual detection is applied which is error prone and very time consuming methodologies. Though there are many technical tools available but are accessible to high end hospitals. Presented computational tool work solely on edge detection technique that spontaneously detects the brain tumor with good accuracy in predicting the level of tumor and survival time of the patients. This tool can be employed in many hospitals and can be used by researchers, academies, and majorly by neuroscientist for automatically detecting brain tumor. The experimental results of proposed technique (Canny) have achieved 93% accuracy compared to the existing method (Sobel) 75%. In addition to this it saves the time of many neurologists by avoiding the former manual tracing method.

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