

Brain tumour detection using Image processing and sending tumour information over GSM

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Abstract: Tumour is an uncontrolled growth of cells in any part of the body. The tumour is of different types and they have different characteristics and different treatment. Brain tumour is one of the dangerous and life threatening disease, but can be operated if detected in the early stages. This project is to implement an efficient and accurate method for detection of brain tumour along with its position and area in the MRI Images of the Brain. MRI scanned image is taken for the entire process as it will not affect the human body. Initially the image is subjected to pre-processing stage to remove the noises present and for image resizing. Then it is subjected to segmentation by using two sophisticated algorithms namely K-Means clustering and Fuzzy C-means segmentation. Next the tumour cells and normal cells are separated and the area of the tumour is calculated. The stage of the tumour is assigned based on the area. Then the stage of the tumour is sent automatically to the registered mobile over the GSM.

Keywords: Brain Tumour, MRI, K means clustering, FCM clustering, Area calculation.

I. INTRODUCTION

One of the most dreadful disease existing in the whole world is Brain tumour. A common man actually fears when he hears the word Brain tumour. It is a life threatening disease. A brain tumour or intracranial neoplasm occurs when abnormal cells form within the brain. There are two main types of tumours: malignant or cancerous tumours and benign tumours. The symptoms of brain tumours may include severe headache, seizures, problem with vision, vomiting, and mental changes. The headache is normally accompanied by vomiting. The other symptoms are difficulty in walking, speaking and with sensation. As the disease progresses unconsciousness may occur. The disease is very fatal and severe and may lead to death if not diagnosed in the early stages.

A. Existing methods

The present techniques used for the brain tumour detection are not so advanced in terms of technology. The MRI image of the brain is taken and it is analysed manually by the doctor. The analysis may differ from doctor to doctor. Also the tumour cells can be confused with the normal brain cells. Then if any doubt arises regarding brain tumour, and then the brain cells of particular person are extracted for testing. This method is very risky process. Also this method is not free from errors and it is not automatic method.

B. Proposed method

The aim of the project is to develop a standard and automated procedure for detection of the brain tumour, wherein the MRI image is given as an input and all the detection steps are carried out. The result is displayed along with the position and stage of the tumour. The result is being sent automatically to the registered mobile to avoid the errors and also to reduce the human intervention.

II. BLOCK DIAGRAM

The main algorithm employed here is the K means clustering and the Fuzzy C means segmentation to find the position and area of the tumour. Then the stage of the tumour is transmitted using the GSM module and the 8051 microcontroller for the registered mobile.

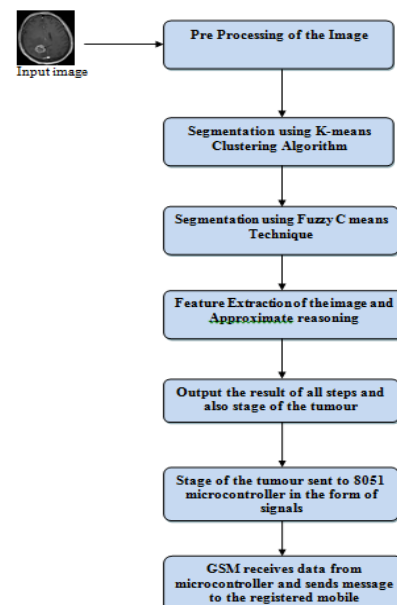


Fig. 1. Block Diagram of proposed system

III. SOFTWARE DESCRIPTION

A. Pre processing stage

Initially an MRI image of the brain is taken as an input. This image is subjected to the pre-processing stage. Pre-processing stage plays a very important role in all the

imageprocessing operations.The various process carried out in thisstage are,

- RGB to gray conversion.
- Image reshaping
- Median filter to remove the noises.
- Histogram equalisation

B. K means clustering

It is the heart of this project. The detection of brain tumour is mainly accomplished by the use of the K means algorithm. K-means segmentation groups the objects on the basis of features into knumber of group, k being a natural number. The clustering is done by minimizing the Euclidean distance between the data and the corresponding cluster centroid. K-means clustering treats each object as having a location in space. It finds partitionssuch that objects within each cluster are as close to each other as possible, and as far fromobjects in other clusters as possible. K-means clustering requires that the user to specifythe number of clusters to be partitioned and a distance metric to quantify how close twoobjects are to each other.

Mathematically it can be described as,Given a set of observations (x1, x2, ,xn), each observation is a d-dimensional real vector, k-means clustering aims to partition the nobservations into k (n) sets S = S1, S2, , Sk so as to minimize the within-cluster sum of squares (WCSS) (sum of distance functions of each point in the cluster to the K center):

$$\arg \min_S \sum_{i=1}^k \sum_{x \in S_i} \|x - \mu_i\|^2$$

The actual working of the K means can be described in terms of flow chart as below:

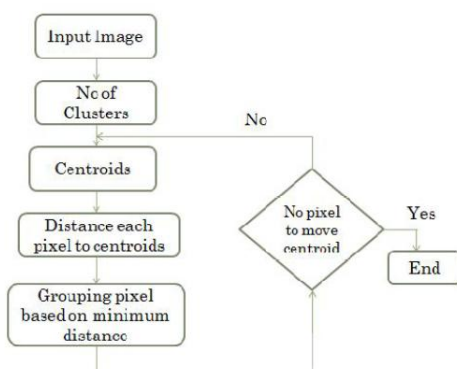


Fig.2:Flow chart of K means segmentation

The algorithmic approach of the algorithm can be described as :

Step 1: The initial partitions are chosen by getting the R, G, B values of the pixels.

Step 2:Every pixel in the input image is compared against the initial partitions usingthe Euclidian Distance and the nearest partition is chosen and recorded.

Step 3:Then, the mean in terms of RGB color of all pixels within a given partition isdetermined. This mean is then used as the new value for the given partition.

Step 4:Once the new partition values have been determined, the algorithm returns toassigning each pixel to the nearest partition.

The advantages of the K means algorithm over other algorithms are:

1. The execution time for K-means Clustering and is very less compared to the other clustering methods.
2. Regarding the number of tumor pixels, K-means clustering and Hierarchicalclustering gave a better result than the other methods.
3. K-means and Hierarchical clustering achieved about 95 percent result. The othersachieved less than 80 percent.
4. This system considers the color and luminosity parameters for tumor detection.

C. Fuzzy C means segmentation

In order to remove the background disturbances after the K means clustering and to achieve 100% accuracy, the Fuzzy C means segmentation is used after the image is subjected to the K means clustering.

It is a way of processing the data by assigning the partial membership value for every pixel in the image. The membership value of the fuzzy set is ranges from 0 to 1.

Fuzzy clustering is a multi valued logic which allows intermediate values memberof one fuzzy set can also be members of other fuzzy sets in the same image. There is noabrupt transition between full membership and non-membership.

The membership function defines the fuzziness of an image and the information present in the image.. They are supported Boundary. The core is a full member of the fuzzy set. The support is a non-membership value of the set. The boundary is the intermediate or partial membership with value between 0 and 1. The FCM segmentationworks on reducing the following function.

The update of membership Mij and the cluster centers R are given as described. Thedimension center of the cluster Rj with degree of membership X in the cluster j for the dataxi is calculated by the equation,

$$R_j = \frac{\sum_{i=1}^N x_i \cdot M_{ij}^m}{\sum_{i=1}^N M_{ij}^m}$$

The process reaches completion when:

$$\max_{ij} \{ |M_{ij}^{(k+1)} - M_{ij}^{(k)}| \} < \delta$$

D. Feature Extraction

The feature extraction is meant for extracting the cluster, which shows the predicted tumour at theFCM (Fuzzy C-means) output. The extracted cluster is given to the threshold process. Itapplies a binary mask over the entire image. In the approximate reasoning step the tumourarea

is calculated using the binarization method. It makes the dark pixel become darker and white become brighter. Each transform coefficient is compared with a threshold in threshold coding. If it is smaller than the threshold value, then it is taken as zero. If it is larger than the threshold, it will be taken as one.

The thresholding method is an adaptive method where only those coefficients whose magnitudes are above a threshold are retained within each block. Let us consider an image f that have the k gray level, an integer value of threshold T , which lies in the grayscale range of k . The thresholding process is a comparison where each pixel in f is compared to T . Based on which, binary decision is carried out. That defines the value of the particular pixel in an output binary image.

$$g(n) = \begin{cases} 0 & \text{if } f(n) \geq T \\ 1 & \text{if } f(n) < T \end{cases}$$

E. Approximate Reasoning

In the approximate reasoning step the tumour area is calculated using the binarization method. That is the image having only two values either black or white (0 or 1). Here 256x256 JPEG image is a maximum image size. The binary image can be represented as a summation of total number of white and black pixels. It calculates the size of the tumour by calculating the number of white pixels (digit 0) in binary image. The stage of the tumour is based on the area of tumour. The area of the tumour is calculated by the following expression, where P is the number of white pixels.

$$S = [(\sqrt{P}) * 0.264] \text{ mm}^2$$

IV. HARDWARE ARCHITECTURE

The stage of the tumour has to be transferred to the registered mobile automatically as soon as the processing is completed. This is achieved by the use of following components:

1. GSM sim 300 module.
2. 8051 Microcontroller.(ATMEL 89C51).
3. LCD display.
4. Relay circuit.

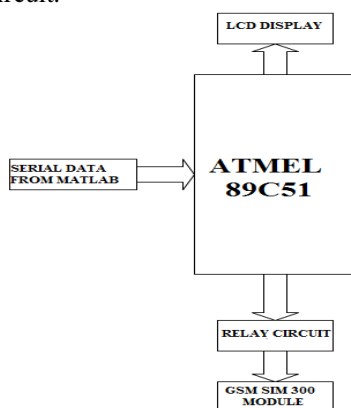


Fig. 3:Hardware block diagram

A. 8051 Microcontroller

The microcontroller used in this project is the ATMEL 89C51 microcontroller on which the code is downloaded using the Keil Microvision software. It is a 40 pin IC with 4 ports .

The features of this microcontroller are:

1. 8K byte of in system re-programmable flash memory.
2. Endurance: 1000 write / Erase cycle.
3. Level program memorial clocks.
4. 256 X 8 bit internal RAM.
5. 32 programmable I/O Line.
6. 3-16 bit timer/Counter.

B. LCD display and Relay

A liquid crystal display (LCD) is a flat panel display, electronic visual display, based on Liquid Crystal Technology. A liquid crystal display consists of an array of tiny segments (called pixels) that can be manipulated to present information.

A 16*2 character LCD is connected to PORT 0 and PORT 2 of a programmed microcontroller. The 16 pins are connected according to the LCD pin specification. Its D0-D7 data pins get the ASCII messages data from P0 (PORT 0) pin number 32-39 of the microcontroller. A display control pin of LCD is connected to a preset 10kΩ.

The register select (RS) pin number 4 and enable pin of LCD are connected to PORT2 of microcontroller respectively. The display backlight control is driven from +5V regulator supply. The microcontroller is loaded with program to initialize and activate a LCD. The microcontroller is loaded with program to initialize and activate a LCD.

The function of the relay circuit in this interface is to control the switching action between the microcontroller, GSM and the serial data from the MATLAB. The relay here is an optional one.

C. GSM interface

GSM stands for Global System for Mobile Communications. This is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (or "2G") digital cellular networks. SIM300 is a Tri-band GSM/GPRS engine from SIMCOM Ltd., that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz. SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 40mm x 33mm x 2.85 mm, SIM300 can fit almost all the space requirement in an application, such as Smart phone, PDA phone and other mobile device.

The circuit of interfacing GSM to AT89C51 microcontroller mainly consists of GSM modem and 8051 family microcontroller. GSM has RS232 interface for serial communication. In between the GSM module and the

microcontroller MAX232 IC is connected. MAX232 IC is used for converting the logic levels. RS232 logic levels of GSM are converted to the TTL logic levels of the microcontroller using this MAX232 IC. MAX232 IC has 16 pins. Interfacing of GSM to AT89C51 microcontroller uses only one transmitter and receiver. The transmitter pin T1IN of max232 is connected to the transmitter pin of the microcontroller. The receiver pin R1out of the max232 is connected to the receiver pin of the microcontroller. The T1out pin of the IC is connected to the transmitter pin of the GSM modem. The R1IN pin of the IC is connected to the receiver pin of the GSM modem.

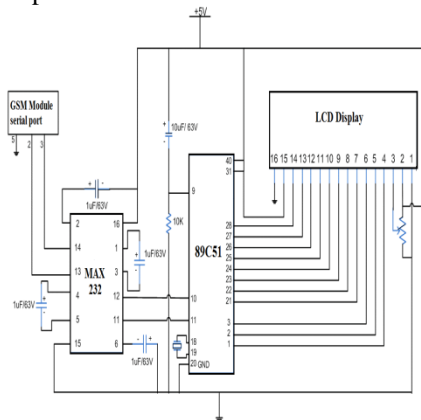


Fig. 4: Hardware Interface circuit

The microcontroller input port is taken as PORT 1. The RS and Enable pin of LCD are connected to the PORT 2. The display backlight is driven by the +5V power supply. An LCD module is connected to the port 0 and port 2 of the microcontroller. Here LCD is used for displaying whether the message is sent successfully. It acts like an acknowledgement.

V. OUTPUT

After the execution of all the above mentioned process, The area of the tumour is assigned to the corresponding stage of the tumour. The stages of the brain tumour are considered according to the medical standards. If the image is a healthy image and no tumour is present in it, then NoTumour message is displayed. The results of all the process along with the stage of the tumour is displayed. The output window is as follows:

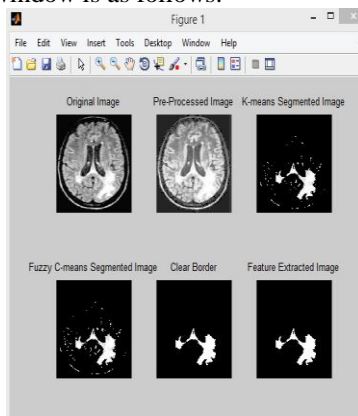


Fig. 5: Output of all the stages

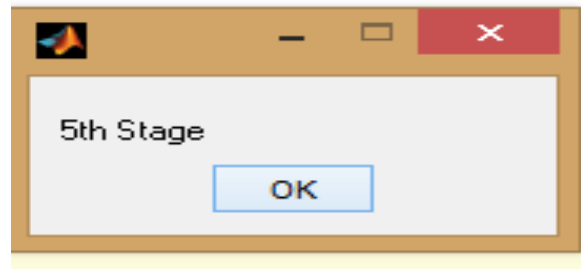


Fig. 6: Output message

VI. ADVANTAGES AND FUTURE SCOPE

The advantages of the proposed system are as follows:

- This is a completely automated system for detection of Brain Tumour. and It is an Error free method.
- It considers the color and luminosity parameters for tumour detection.
- The execution time is very fast.
- The report generated is directly sent to experts i.e. Doctors reducing the manual work.
- It is one of the most advanced method for detection of brain tumour.
- It has a very wide future scope. The same detection scheme can be extended to all types of the tumour. And also along with the tumour stage, the image of the affected area can be transmitted.

VII. CONCLUSION

In this work, we have proposed a computer aided system for brain MRI image segmentation for detection of tumour location using K-means clustering algorithm followed by transmission of the observed report through GSM. The proposed algorithm i.e. K means algorithm has been tested and it has the highest performance ratio compared to other algorithms as shown below:

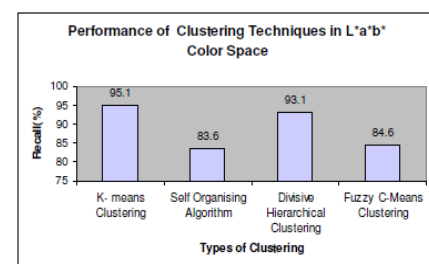
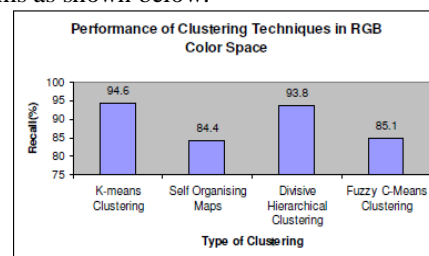


Fig. 6: Performance of K means Clustering

Segmentation of the brain image is of high importance in surgical planning and treatment planning in the field of medicine. This proposed method is of great advantage in

the field of the Medical Electronics. It can be extend to all types of tumour. Indeed it can save the lives of many people by initial detection of the brain tumour.

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