Brain Tumour Segmentation and Stage Classification Using SVM Classifier and Notification Using GSM Module

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Abstract. A tumour is any unwanted growth of tissues in any part of the body. About 50% of the people affected by primary brain tumour die each year. The foremost aim of this paper is to put forth a method that not only identifies the tumour affected area in brain, but also indicates its stage and sends notification by means of messages and mails to the concerned people (relatives, guardian, friends or even the patient itself, if needed). Here MRI (Medical Resonance Imaging) images are used to detect the tumour affected brain region by SVM (Support Vector Machine) algorithm. The software output has been simulated using MATLAB software. Furthermore GSM (Global System for Mobile communication) is used to send messages and mails to the concerned people. The final extracted image will be sent through mail. The medications to be taken by the patient will be sent through messages (SMS). The entire procedure includes, pre-processing (RGB to gray conversion and noise removal) of the input image, feature extraction, Localization of tumour, Morphological operations (dilation and erosion), segmentation and finally information sharing using UART and GSM module.

1. Introduction
The development of imaging technology has grown up to an immense extent in the past few years. Several tools have been developed through researches. The various types of medical imaging techniques include MRI (Medical Resonance Imaging), CT (Computerized Tomography) scan, Ultrasound imaging, SPECT (Single Photon Emission computerized Tomography), PET (Positron Emission Tomography) and X-ray. When tumour occurs in limbs and other body parts, it can be cured to some extent or may be even completely. But when the same condition occurs in the human brain, it becomes a tedious task to diagnose. Detection of brain tumour in the early stage will ease the curing procedure to some extent.

2. Procedural Steps
The complete steps used in the proposed method are shown in the form of a flow diagram in Fig 1.

**Fig.1 Block diagram of proposed work**

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2.1 Image Acquisition

The input image used here are MRI brain scanned images. These scanned images should have pixels as its basic elements and should be exposed in matrices of two dimensions. Apart from MRI, there are several other imaging techniques to capture the brain images, namely, CT, X rays, Ultrasound and so on. Here we have considered MRI image as the source image since each imaging techniques have their own drawbacks. For example, CT scans and X rays use ionizing radiation which in turn is harmful to the tissues. Ultra sound waves cannot penetrate deep into the brain. Therefore by analysis, it was found that MRI images were best suited for detecting brain tumours. Thus it has been used in this paper as the source of input.

2.2 Pre-processing

Pre-processing includes removal of noise from the input data. In order to accomplish this step, initially the image has to be converted to gray scale from RGB. This is because gray scale images are easier to work with since they will have intensities raging only from 0 to 1. The values of the gray scale image would range from 0 to 255, where 0 represents total black color and 255 shows pure white colour. Anything in between shows a variety of values representing the intensities of gray color. The common types of noises in an image are impulse noise, speckle noise, poisson noise and guassian noise. Convolution filter is used here for removal of noise.
2.3 Feature extraction
Feature extraction is the transformation of input data into a set of features. The values represent correlation, energy, homogeneity and contrast in the image pixels.

Table 1. Features of image texture

| Feature    | Definition                              | range | Equation |
|------------|-----------------------------------------|-------|----------|
| Energy     | Measure of repetition of the pixel      | [0,1] |          |
| Contrast   | Contrast between the pixels             | [0,1] |          |
| Correlation| Correlation between neighbor pixels     | [-1,1]|          |
| Homogeneity| Closeness of distribution               | [0,1] |          |

\[
E = \sum_{i=0}^{N_{y}-1} \sum_{j=0}^{N_{x}-1} p(i,j)^2 \\
\text{Con} = \sum_{n=0}^{N_{y}-1} \sum_{l=0}^{N_{x}-1} \sum_{j=0}^{n} p(i,j)^2 \\
C = \frac{1}{\sigma_x \sigma_y} \sum_{l=0}^{N_{y}-1} \sum_{j=0}^{N_{x}-1} (i,j)p(i,j) \\
H = \sum_{l=0}^{N_{y}-1} \sum_{j=0}^{N_{x}-1} \frac{p(i,j)}{(1 + \text{mod}(i,j))} \\
\]

Fig. 4 Feature extraction values

2.4 Tumour localization and morphological operation
In the proposed approach, two morphological operations are used. Dilation is the process of adding pixels to the boundary of an image. The value of the output pixel is the maximum value of all the pixels in the input pixel’s neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1. Erosion deals with removal of pixels from an image. The value of the output pixels is the minimum value of the pixels in the input pixel’s neighborhood. In a binary image, if any of the pixels is to 0, the output pixel is set is set to 0.
2.5 SVM classifier
Support vector machine algorithm is widely used in MATLAB for classifying the image and for analysis of regression. MRI images taken for brain tumour detection, needs to take into account large variations in appearance and shapes of structures. SVM paves way in analysis and classification of such medical images effectively.

2.6 Segmentation and tumour extracted image
Image segmentation is used to detect the boundaries of the required area. In the proposed approach, gabor filter is used for image segmentation and edge detection. Each and every pixel in the image will be assigned with a label. The pixels with similarity in labels stake certain physiognomies. Gabor filter can also be used for texture segmentation, target detection, fractal dimension management, document
analysis, edge detection, retina identification, image coding and image representation. The segmented tumour image is indicated by colour green in fig 7. After the completion of segmentation, the tumour extracted image will be displayed separately. It is the output image after complete processing. It indicates the tumour affected part clearly. Further medications can be provided based on this image.

2.7 Stage detection
This involves identifying whether the tumour is chronic or acute. Acute tumour refers to the initial stage of the tumour whereas chronic indicates the severely affected stage. If the area of the tumour is less than 280 pixels, then it is said to be in early stage (Acute tumour). On the other hand, if the area of the tumour is greater than 280 pixels, then it is said to be in advanced stage (Chronic tumour).

2.8 GSM and UART
GSM stands for Global System for Mobile communication. It is capable of transmitting data at various frequencies namely 850 MHZ, 900 MHZ, 1800 MHZ, 1900 MHZ. Here it is utilized for sending messages over mobile phones to the medical practitioner. It can also send a screen capture of the image through the mail if necessary.
UART stands for Universal Asynchronous Receiver Transmitter. It is a cable used for connecting the module with the PC. It comes with a varying number of pins. Here, a 9 pin cable is used. It acts as the interface between the module and PC for communication of data. Any SIM card with a good network connection is inserted into the slot in the GSM. This paves way for the transmission of mails and messages. The mail id and the phone numbers for the mails and messages respectively, can be given through the proposed MATLAB coding. It can be changed if required and it is also capable of transmitting the data to multiple people simultaneously.
3. Conclusion
The proposed method is cheap and efficient approach for brain tumor detection. Early detection of brain tumor has got a very important role in the treatment and its cure. Brain tumour detection is a tedious job because of the complex structure of brain. MR Images provide an easier way to diagnose the tumor and plan the surgical approach for its removal. A unique feature of this project is providing both mail and message notifications regarding the stage and medications to be taken by the concerned patient by using MATLAB coding and GSM module respectively. Image processing plays vital role in today’s world. Nowadays the applications of image processing can be found in areas like electronics, remote sensing, bio-medical and so on. This project can be improved by using advanced algorithm which denotes the various types of tumour in the brain such as pilocytic astrocytoma, low-grade astrocytoma, anaplastic astrocytomas, gyioblastoma (GBM) etc.

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