

Brain Tumor Detection and Classification using Convolutional Neural Network

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Abstract— When it comes to controlling humanoids, nothing beats a human brain. This disproportionate expansion to the development and division of brain cells, which results in a brain tumor, and finally to brain cancer. A recent study came to the conclusion that in order to determine an individual's current health status, "Computer Vision plays a major role, reducing the need for human judgement to arrive at reliable conclusions." This statement is based on the findings of the aforementioned study. Other options include: Imaging using a magnetic resonance scanner is yet another option (MRI). There are also some alternatives available to consider. An MRI scanner has the potential to detect objects as tiny as a pinhead. Our study's primary objective is to develop a battery of brain MRI techniques for the early detection of malignant brain tumors. The MR images used in this investigation were preprocessed using a bilateral filter to lessen the amount of noise in the pictures (BF). Convolutional neural network (CNN) segmentation and binary thresholding were then used to determine the tumor's location. Validating, testing, and training are three different activities that, in order to be successful, need to make use of datasets. The likelihood that this person has a malignant brain tumor will be calculated using our machine learning algorithm. Validating, testing, and training are three distinct activities that, in order to be successful, need to make use of datasets. Validation, testing, and training all require the use of datasets. All three phases—validation, testing, and training—require the utilization of datasets. At each and every stage of the validation, testing, and training processes, the utilization of datasets is an absolute requirement." The outcome of this work is anticipated to be superior to previous attempts at the same.

Keywords— Brain tumor, Magnetic resonance imaging, Adaptive Bilateral Filter, Convolutional Neural Network etc.

I. INTRODUCTION

Creating images of the inside of a human body for diagnostic and therapeutic uses are what we call "medical imaging," which encompasses both the process and the technology involved. When it comes to diagnosing and treating illness, medical imaging aims to unearth structures normally concealed by the skin and bones. In addition to establishing a baseline for normal anatomy and physiology, medical imaging also aids in the detection of anomalies.

Computerized image processing is what we mean when we talk about medical imaging. Multiple methods and procedures, such as acquiring, storing, displaying, and sharing images, are involved in this processing. "The method is intended for use in both disease diagnosis and treatment. By creating a catalogue of "normal" organ anatomy and physiology, this method facilitates the detection of anomalies.

This method incorporates a wide range of imaging modalities, from sonography and magnetic scopes to X-rays and gamma radiation, as well as thermography and isotope imaging. A wide variety of different technologies are used to document bodily locations and functions. When compared to image-generating modulates, such methods have several drawbacks.

Using a computer to make adjustments to a digital photo is an example of an image processing approach. This method's numerous advantages include its malleability, flexibility, data storage, and ability to facilitate dialogue. Different picture scaling algorithms have advanced, allowing for effective image storage. This method involves executing several sets of rules in the pictures simultaneously. Multidimensional processing of the 2D and 3D pictures is possible.

II. BRAIN ANATOMY

Brain tumors are among the most prevalent causes of death in the developed world due to the devastating effects they have on the brain. Brain cancer occurs when malignant tumor cells spread across the brain and impede normal cell growth. A recent cancer research estimates that over a hundred thousand patients are diagnosed with brain tumors each year. Brain tumor patients continue to face dismal outcomes despite constant attempts to reduce their symptoms. Scholars are combating this by utilizing computer vision to learn more about cancers' earliest phases and how to beat them with cutting-edge therapies.

The most common diagnostic tools for determining whether or not a tumor exists and pinpointing its location for informed treatment planning are "imaging techniques using magnets and electrons (brain MR imaging and CT scans)". Because of their portability and capacity to provide high-definition pictures of diseased tissues, these two scans continue to see widespread usage. Surgery, radiation treatment, and chemotherapy are only some of the current options for treating tumors. Multiple characteristics of the tumor shown on an MR image—its size, kind, and grade—contribute to deciding on the most effective treatment plan. As an added bonus, it reveals whether or not the cancer has spread to other body parts.

When using a CAD system, accuracy is typically improvised. The primary goal of computer vision is to generate a trustworthy result, an associate estimate to aid physicians in picture comprehension and cut down on diagnostic errors.

A period of time allotted for reading a picture. These developments improve the reliability and accuracy of medical diagnoses, however it remains challenging to segment an MR picture of the tumor and its surrounding region. Brain tumors

often appear in isolated spots with similar brightness, making it difficult for computers to detect and segment them.

III. LITERATURE REVIEW

A. Sivaramakrishnan et al. (2013): Accurate and ground-breaking identification of the brain tumor area in an image was achieved using "the Fuzzy C-method grouping algorithm and histogram equalization.". The tumor region in the MR images was correctly extracted using the FCM clustering algorithm's predicted results [1].

M. M. Sufyan et al: Has shown the use of an edge-enhanced detection method for tumors in the brain, with the Sobel feature detection serving as the primary determinant of tumor classification. In the work they've presented, they combine the Sobel method with binary thresholding to dig areas of varying sizes and shapes with confidence. Afterward, the acquired image is processed again, this time utilizing intensity values to isolate cancer cells [2].

Sathya et al. (2011): Clustering algorithms may include K-means, Improved K-means, C-means, and Improved C-means. In their study", they demonstrated an experimental evaluation of large datasets characterized by individual images. Parametric tests were used extensively to assess the results they had found [3].

B. Devkota et al: have suggested using a "CAD" strategy to identify aberrant tissues utilizing Morphological procedures. When compared to other segmentation methods, morphological opening and closing procedures are preferable due to their low computational cost and high accuracy when extracting tumor regions [4].

Jaskirat Kaur et al. (2012): segmentation clustering processes were devised, and an evaluation of several segmentation clustering approaches was carried out. Kaur proposed a system to evaluate certain clustering methods according on their unwaveringness in the face of very compelling bids. Various tests for performance metrics including sensitivity, specificity, and accuracy were also specified [5].

J.T. Kwok et al: provided wavelet-based picture fusion enabling" easy object recognition across all focal lengths, since many vision-related processing tasks are simplified when all image constituents are well-lit. Kwok et al. conducted research using many datasets, demonstrating that the given work is more accurate than previous methods since it is immune to the effects of evenness at varying levels of activity [7].

Kumar and Mehta: In this study, we present a texture-based method. Specifically, they emphasized segmentation's benefits in cases when the borders of tumor tissue aren't very sharp. Those corners might have a negative impact on the efficiency of the suggested technology. The MATLAB environment was used for both texture analysis and the seeded area method [8].

Dalia Mahmoud et al: A model using ANNs for tumor identification in brain imaging was reported. Using ANNs, they built a computerized MR imaging recognition system. When comparing the Elman community's performance to that of other ANNs systems, it was found that its employment during the recognition system resulted in both a shorter training duration

and higher accuracy. The sigmoid shape of this neural network improved the precision with which tumors were segmented [8].

L. Marroquin et al: Shown a completely automated 3D segmentation of brain MRI pictures. A brain atlas is used to develop a flexible way of mapping the typical brain. When used to brain-nonbrain tissue segmentation, this transformation allows for automated setup of the segmentation process, computation of prior probabilities, and ultimately the application of the MPM-MAP method to determine optimum segmentation. The study's main results demonstrate that the MPM-MAP approach is more error-resistant than EM when calculating the posterior marginal. The MPM-MAP approach is the most efficient one for effective segmentation, and it only requires the solution of linear systems [10].

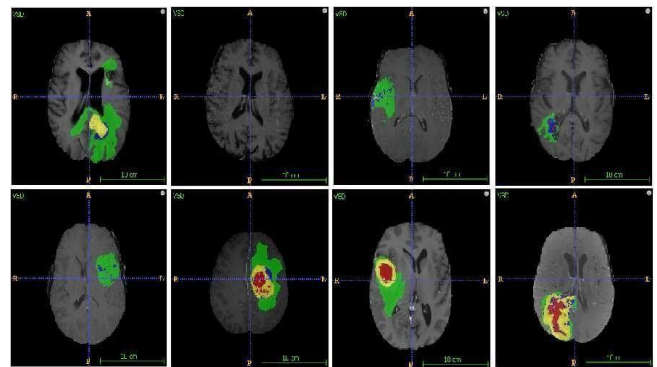


Figure 1. Tumor localization in 8 different images.

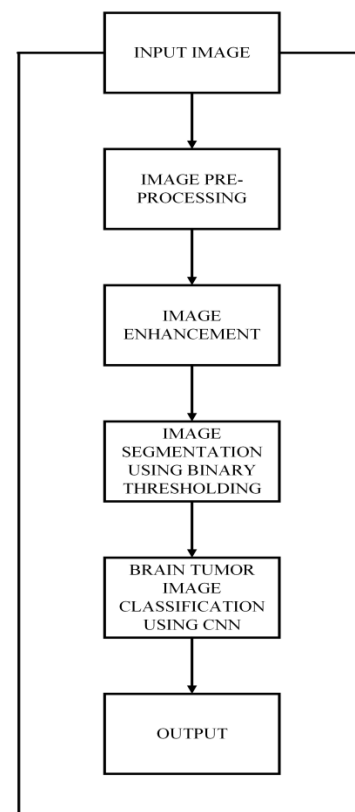


Figure 2. Module Division

IV. MODULE 1 IMAGE PROCESSING AND IMAGE ENHANCEMENT

A. Image Preprocessing:

Brain MRI images from Kaggle were downloaded. About 1900 MRI scans, some of which are normal, some of which are benign, and some of which are cancerous, make up the MRI dataset. When starting the process, these MRI scans are used as input. The quality of the brain MRI Image may be greatly enhanced by first doing the pre-processing. Important pre-processing actions include shrinking the picture and eliminating sudden sounds. The first thing to do is convert the MRI brain scan to grayscale. Adaptive bilateral filtering is used to reduce the background noise and restore the original brain image. An increase in the proportion of correctly diagnosed and classified cases is achieved through this.

B. Image Classification Using Convolutional Neural Network:

If you need to identify anything in an image, such as a medical scan, classification is the way to go. All classification techniques rely on the assumption that a picture has characteristics that may be predicted to belong to one of many classes. Convolutional Neural Network (CNN) will be employed as an automated and trustworthy classification approach since its sturdy structure allows for the identification of even the smallest of information. When given an image as input, Convolutional Neural Networks (ConvNets) can prioritise various features and objects within the image and classify them accordingly. When compared to other classification strategies, ConvNet requires significantly less setup time. While filters in primitive approaches are often hand-engineered, a well-trained ConvNet may pick up on these filters and other properties on its own. The use of proper filters allows a ConvNet to correctly capture spatial and temporal correlations in a picture.

V. EXPERIMENTAL ANALYSIS AND RESULTS

A. Prerequisites for Hardware and Software in a System:

Windows : Python 3.6.2 or above, PIP and Numpy 1.13.1

B. Python:

Guido Van Rossum created Python and released it to the public for the first time that year (1991). To make its code more human-readable, this high-level, general-purpose programming language makes significant use of whitespace. Its object-oriented structure and language features are meant to facilitate the development of readable, well-considered code for a wide range of tasks, from the simplest to the most involved. Python's dynamic typing and garbage collection make it a powerful programming language. It works with many different types of code, including procedural, object-oriented, and functional.

C. Pip:

Installing and managing Python software packages is done using the Python Package Index (Pip).

D. Numpy:

NumPy can be used for many different kinds of array processing jobs. In other words, it provides you with a highly

effective object for working with multidimensional arrays and the tools to control them. This module is required if you plan on using Python for any kind of serious calculation. The aforementioned are only a few of the numerous helpful characteristics it possesses:

E. Pandas:

When working with data, the most common Python library to use is Pandas. All of the backend source code was written in C or Python for maximum performance optimization. With Pandas, a data-analysis tool, we can see data frames.

F. Anaconda:

With the stated objective of making package management and deployment easier for scientific computing, Anaconda is a free, open-source installation of the Python and R computer languages. Conda is a package management system that controls the multiple versions of installed packages.

Notebook in Jupyter:

Included in the Anaconda distribution is the conda package and virtual environment manager, in addition to 1,500 hand-picked packages from PyPI. In addition to the standard command line interface, the graphical user interface (GUI) Anaconda Navigator is included (CLI). As JSON documents that adhere to a versioning standard, Jupyter Notebook files (often saved as ".ipynb") have an ordered collection of input/output cells that may contain code, text mathematics, graphs, and rich media.

G. Tensor Flow:

Dataflow and differentiable programming are just two of the many applications for Tensor Flow, an open-source software library. It is a machine learning library used for things like neural networks, and it is a symbolic math library. At Google, it's put to use in both R&D and actual product creation.

H. Keras:

Conda is a package management system that controls the multiple versions of installed packages. With the stated objective of making package management and deployment easier for scientific computing, Anaconda is a free, open-source installation of the Python and R computer languages. Conda is a package management system that controls the multiple versions of installed packages.

I. Open CV:

"Open CV (Open source computer vision) provides a library of methods for working with images in real time", which may be accessed by programmers who specialize in computer vision. Intel, Willow Garage, and Itseez worked together to build (which was later acquired by Intel). Due to its distribution under the BSD license, this library is both freely distributable and open source. They say the Open Vision Capsule is the best option for consumers because it can be taken anywhere and is compatible with any other format.

VI. SAMPLE CODE AND RESULTS

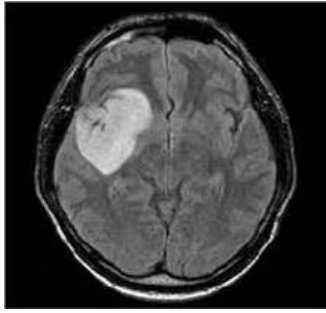


Figure 3: Input Image

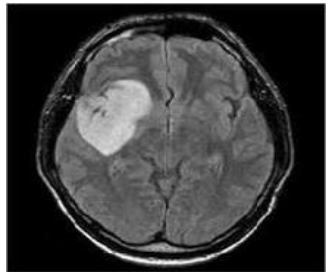


Figure 4: Gray-Scale Image

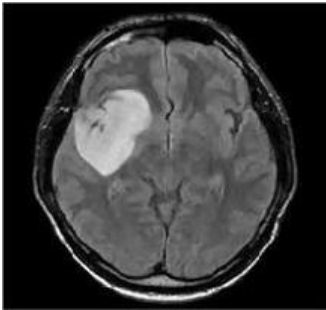


Figure 5: Filtered Image

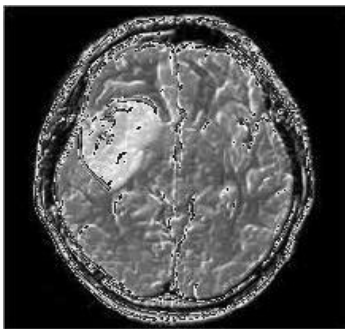


Figure 6: Image after edge detection



Figure 7: Threshold and Binary Image

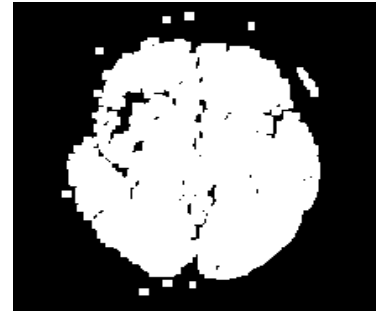


Figure 8: Morphological Image

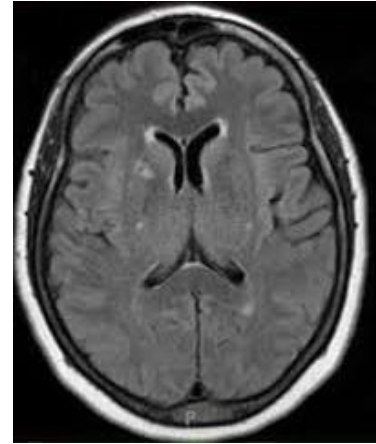


Figure 9: Dilated Image

VII. EXPERIMENTAL SETUP

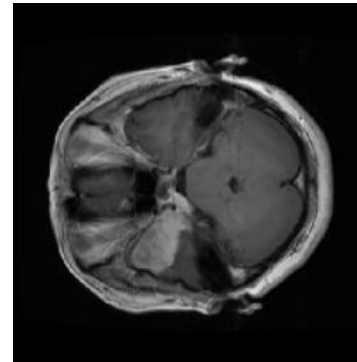


Figure 10: Sample Input
Predicted Output: Yes



Figure 11: Sample Input
Predicted Output: No

VIII. PERFORMANCE MEASURES AND PERFORMANCE EVALUATION

Table 1. An example of the proposed method's true positive, true negative, false positive and false negative values for a variety of images”.

TABLE 1.

Different set of Images	True Positive (%)	True Negative (%)	False Positive (%)	False Negative (%)
128*128 Images	83.7	84.7	16.3	15.5
256*256 Images	82.4	82.4	17.6	15.9
512*512 Images	82.1	83.7	17.9	16.3

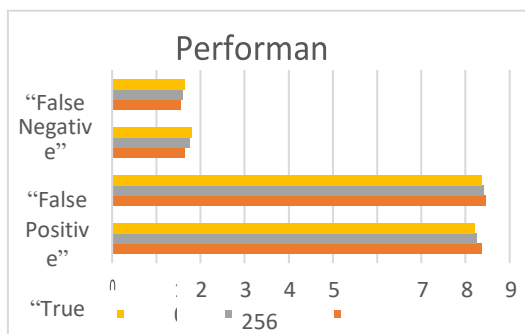


Figure 12. CNN performance evaluation

The proposed method's accuracy, recall, and false-negative rate for various image types are summarised in Table 2.

TABLE 2

Different set of Images	Accuracy (%)	Sensitivity (%)	Specificity (%)
128*128 Images	84.1	84.4	83.8
256*256 Images	83.3	83.4	82.7
512*512 Images	82.9	83.3	82.4

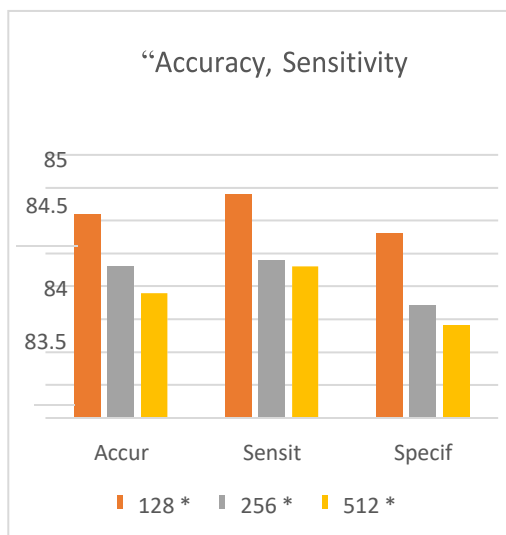


Figure 13: Shows the effectiveness of the proposed CNN.

IX. CONCLUSION

We suggested a computational technique, based on the Convolution Neural Network, for detecting and segmenting a brain tumor. From the specified local device and file location, MR pictures are read and grayscaled for input. To remove unwanted noise from the original picture, an adaptive bilateral filtering approach is used in this first processing step. After applying binary thresholding to the denoised image, the MR images are segmented with the aid of a Convolution Neural Network, all with the goal of pinpointing the tumor. Using the proposed model resulted in an 84% success rate with no failures and a significant reduction in required processing time without sacrificing quality. Extensive testing has demonstrated that the proposed method necessitates a sizable training dataset in order to yield accurate results; this is especially problematic given the difficulty and time commitment involved in collecting medical data for use in medical image processing. The suggested method must be sufficiently resilient in all such situations. The proposed method can be enhanced by using either self-learning algorithms, which boost accuracy and reduce processing time, or weak trained algorithms, which can spot the outliers with limited input data.

REFERENCES

- [1] Sivaramakrishnan And Dr.M.Karnan “A Novel Based Approach For Extraction Of Brain Tumor In MRI Images Using Soft Computing Techniques,” International Journal Of Advanced Research In Computer And Communication Engineering, Vol. 2, Issue 4, April 2013.
- [2] Asra Aslam, Ekram Khan, M.M. Sufyan Beg, Improved Edge Detection Algorithm for Brain Tumor Segmentation, Procedia Computer Science, Volume 58,2015, Pp 430-437, ISSN 1877-0509.
- [3] B.Sathya and R.Manavalan, Image Segmentation by Clustering Methods: Performance Analysis, International Journal of Computer Applications (0975 – 8887) Volume 29– No.11, September 2011.
- [4] Devkota, B. & Alsadoon, Abeer & Prasad, P.W.C. & Singh, A.K. & Elchouemi,A.. (2018). Image Segmentation for Early Stage Brain Tumor Detection using Mathematical Morphological Reconstruction. Procedia Computer Science. 125. 115- 123. 10.1016/j.procs.2017.12.017.
- [5] K. Sudharani, T. C. Sarma and K. Satya Rasad, "Intelligent Brain Tumor lesion classification and identification from MRI images using k-NN technique," 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Kumaracoil, 2015, pp. 777-780. DOI: 10.1109/ICCICCT.2015.7475384
- [6] Kaur, Jaskirat & Agrawal, Sunil & Renu, Vig. (2012). A Comparative Analysis of Thresholding and Edge Detection Segmentation Techniques. International Journal of Computer Applications.vol. 39.pp. 29-34. 10.5120/4898-7432.
- [7] Li, Shutao, JT-Y. Kwok, IW-H. Tsang and Yaonan Wang. "Fusing images with different focuses using support vector machines." IEEE Transactions on neural networks 15, no. 6 (2004): 1555-1561.
- [8] M. Kumar and K. K. Mehta, "A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method," International Journal o Computer Technology and Applications, ISSN: 2229-6093, Vol. 2, Issue 4, PP. 855-859 August 2011.
- [9] Mahmoud, Dalia & Mohamed, Eltaher. (2012). Brain Tumor Detection Using Artificial Neural Networks. Journal of Science and Technology. 13. 31-39.
- [10] Marroquin J.L., Vemuri B.C., Botello S., Calderon F. (2002) An Accurate and Efficient Bayesian Method for Automatic Segmentation of Brain MRI. In: Heyden A., Sparr G., Nielsen M., Johansen P. (eds) Computer Vision — ECCV 2002. ECCV 2002.Lecture Notes in Computer Science, vol 2353. Springer, Berlin, Heidelberg.
- [11] Minz, Astina, and Chandrakant Mahobiya. "MR Image Classification Using Adaboost for Brain Tumor Type." 2017 IEEE 7th International Advance Computing Conference (IACC) (2017): 701-705.
- [12] Monica Subashini.M, Sarat Kumar Sahoo, "Brain MR Image Segmentation for TumorDetection using Artificial Neural Networks," International Journal of Engineering and Technology (IJET), Vol.5, No 2,

Apr-May 2013.

- [13] S. Li, J.T. Kwok, I.W Tsang, and Y. Wang, —Fusing Images with Different Focuses using Support Vector Machines, Proceedings of the IEEE transaction on Neural Networks, China, November 2007.
- [14] H. Yu and J.L. Fan, —Three-level Image Segmentation Based on Maximum Fuzzy Partition Entropy of 2-D Histogram and Quantum

Genetic Algorithm, Advanced Intelligent Computing Theories, and Applications. With Aspects of Artificial Intelligence. Lecture Notes in Computer Science, Berlin, Heidelberg 2008.