Brain Tumour Detection Using MRI Images

Ms. Shubhangi Vaman Jondhale[1] Ms. Kanchan Damodhar Chavanke[2] Ms. Ashwini Ravindra Shinde[3] Ms. Vaishnavi Bhausaheb Aandhale[4] Prof. Narayan B. Vikhe[5]
[1,2,3,4]BE Student [5]Assistant Professor
[1,2,3,4,5]Department of Computer Engineering
[1,2,3,4,5]SVIT, Nashik, India

Abstract— Now a day's tumor is second leading cause of cancer. Due to cancer large no of patients are in danger. The medical field needs fast, automated, efficient and reliable technique to detect tumor like brain tumor. Detection plays very important role in treatment. If proper detection of tumor is possible then doctors keep a patient out of danger. The human brain is the major controller of the humanoid system. The abnormal growth and division of cells in the brain lead to a brain tumor, and the further growth of brain tumors leads to brain cancer. In the area of human health, Computer Vision plays a significant role, which reduces the human judgment that gives accurate results. CT scans, X-Ray, and MRI scans are the common imaging methods among magnetic resonance imaging (MRI) that are the most reliable and secure. MRI detects every minute objects. Our paper aims to focus on the use of different techniques for the discovery of brain cancer using brain MRI. In this study, we performed pre-processing using the bilateral filter (BF) for removal of the noises that are present in an MR image. This was followed by the binary thresholding and Convolution Neural Network (CNN) segmentation techniques for reliable detection of the tumor region. Training, testing, and validation datasets are used. Based on our machine, we will predict whether the subject has a brain tumor or not. The resultant outcomes will be examined through various performance examined metrics that include accuracy, sensitivity, and specificity. It is desired that the proposed work would exhibit a more exceptional performance over its counter parts. Convolutional neural network (CNN) architecture was developed for learning the intricate patterns in the Magnetic Resonance Imaging (MRI) scans for the detection of Brain Tumor. Therefore, the above approaches can provide a solid solution for the detection of Brain Tumor in the preliminary or early stage prediction of the Brain Tumor and can be able to increase the lifespan of the diseased patient with proper treatments and medications leads to peaceful life.

Keywords: Brain Tumor, Magnetic Resonance Imaging, Adaptive Bilateral Filter, Convolution Neural Network

I. INTRODUCTION

Brain tumor is one of the most rigorous diseases in the medical science. An effective and efficient analysis is always a key concern for the radiologist in the premature phase of tumor growth. Histological grading, based on a stereotactic biopsy test, is the gold standard and the convention for detecting the grade of a brain tumor. The biopsy procedure requires the neurosurgeon to drill a small hole into the skull from which the tissue is collected. There are many risk factors involving the biopsy test, including bleeding from the tumor and brain causing infection, seizures, severe migraine, stroke, coma and even death. But the main concern with the stereotactic biopsy is that it is not 100% accurate which may result in a serious diagnostic error followed by a wrong clinical management of the disease. Tumor biopsy being challenging for brain tumor patients, non-invasive imaging techniques like Magnetic Resonance Imaging (MRI) have been extensively employed in diagnosing brain tumors. Therefore, development of systems for the detection and prediction of the grade of tumors based on MRI data has become necessary. But at first sight of the imaging modality like in Magnetic Resonance Imaging (MRI), the proper visualization of the tumor cells and its differentiation with its nearby soft tissues is somewhat difficult task which may be due to the presence of low illumination in imaging modalities or its large presence of data or several complexity and variance of tumors-like unstructured shape, viable size and unpredictable locations of the tumor. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. The medical imaging processing refers to handling images by using the computer. This processing includes many types of techniques and operations such as image gaining, storage, presentation, and communication. This process pursues the disorder identification and management. This process creates a data bank of the regular structure and function of the organs to make it easy to recognize the anomalies. This process includes both organic and radiological imaging which used electromagnetic energies (X-rays and gamma), sonography, magnetic, scopes, and thermal and isotope imaging. There are many other technologies used to record information about the location and function of the body. Those techniques have many limitations compared to those modulates which produce images. An image processing technique is the usage of a computer to manipulate the digital image. This technique has many benefits such as elasticity, adaptability, data storing, and communication. With the growth of different image resizing techniques, the images can be kept efficiently. This technique has many sets of rules to perform in the images synchronously. The 2D and 3D images can be processed in multiple dimensions. The human body is made up of many organs and brain is the most critical and vital organ of them all. One of the common reasons for dysfunction of brain is brain tumor. A tumor is nothing but excess cells growing in an uncontrolled manner. Brain tumor cells grow in a way that they eventually take up all the nutrients meant for the healthy cells and tissues, which results in brain failure. Currently, doctors locate the position and the area of brain tumor by looking at the MR Images of the brain of the patient manually. This results in inaccurate detection of the tumor and is considered very time consuming. A Brain Cancer is very critical disease which causes deaths of many individuals. The brain tumor detection and classification system is available so that it can be diagnosed at early stages. Cancer classification is the most challenging tasks in clinical

diagnosis. This project deals with such a system, which uses computer, based procedures to detect tumor blocks and classify the type of tumor using Convolution Neural Network Algorithm for MRI images of different patients. Different types of image processing techniques like image segmentation, image enhancement and feature extraction are used for the brain tumor detection in the MRI images of the cancer-affected patients. Detecting Brain tumor using Image Processing techniques its involves the four stages is Image Pre-Processing, Image segmentation, Feature Extraction, and Classification. Image processing and neural network techniques are used for improve the performance of detecting and classifying brain tumor in MRI images.

A. Brain Anatomy:

The brain tumor is one all the foremost common and, therefore, the deadliest brain diseases that have affected and ruined several lives in the world. Cancer is a disease in the brain in which cancer cells ascends in brain tissues. Conferring to a new study on cancer, more than one lakh people are diagnosed with brain tumors every year around the globe. Regardless of stable efforts to overcome the complications of brain tumors, figures show unpleasing results for tumor patients. To contest this, scholars are working on computer vision for a better understanding of the early stages of tumors and how to overcome using advanced treatment options. Magnetic resonance (MR) imaging and computed tomography (CT) scans of the brain are the two most general tests to check the existence of a tumor and recognize its position for progressive treatment decisions. These two scans are still used extensively for their handiness, and the capability to yield high-definition images of pathological tissues is more. At present, there are several other conducts offered for tumors, which include surgery, therapies such as radiation therapy, and chemotherapy. The decision for which treatment relies on the many factors such as size, kind, and grade of the tumor present in the MR image. It's conjointly chargeable for whether or not cancer has reached the other portions of the body. Precise sighting of the kind of brain abnormality is enormously needed for treatment operations with a resolution to diminish diagnostic errors. The precision is often makeshift utilizing computer-aided diagnosis (CAD) systems. The essential plan of computer vision is to produce a reliable output, which is an associate estimation to assist medical doctors in image understanding and to lessen image reading time. These advancements increase the steadiness and correctness of medical diagnosis — however, segmenting an MR image of the tumor and its area itself a very problematic job. The occurrence of tumors in specific positions within the brain image without distinguishing picture intensities is an additional issue that makes a computerized detection of brain tumor and segmentation a problematic job.

B. Overview of Brain and Brain Tumor:

Main part in human nervous system is human brain. It is located in human head and it is covered by the skull. The function of human brain is to control all the parts of human body. It is one kind of organ that allows human to accept and endure all type of environmental condition. The human brain enables humans to do the action and share the thoughts and feeling. In this section we describe the structure of the brain for understanding the basic things.

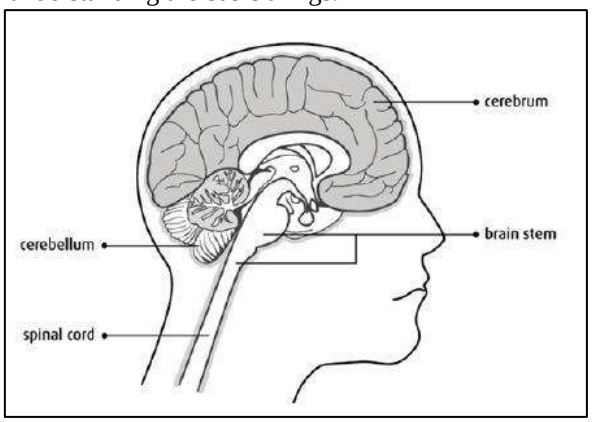


Fig. 1: Basic Structure of human brain

The brain tumors are classified into mainly two types: Primary brain tumor (benign tumor) and secondary brain tumor (malignant tumor).The benign tumor is one type of cell grows slowly in the brain and type of brain tumor is gliomas. It originates from non-neuronal brain cells called astrocytes. Basically primary tumors are less aggressive but these tumors have much pressure on the brain and because of that, brain stops working properly. The secondary tumors are more aggressive and quicker to spread into other tissue. Secondary brain tumor originates through other part of the body. These type of tumor have a cancer cell in the body that is metastatic which spread into different areas of the body like brain, lungs etc. Secondary brain tumor is very malignant. The reason of secondary brain tumor cause is mainly due to lungs cancer, kidney cancer, bladder cancer etc.

C. Magnetic Resonance Imaging (MRI):

Raymond v. Damadian invented the first magnetic image in 1969. In 1977 the first MRI image were invented for human body and the most perfect technique. Because of MRI we are able to visualize the details of internal structure of brain and from that we can observe the different types of tissues of human body. MRI images have a better quality as compared to other medical imaging techniques like X-ray and computer tomography. MRI is good technique for knowing the brain tumor in human body. There are different images of MRI for mapping tumor induced Change including T1 weighted, T2 weighted and FLAIR (Fluid attenuated inversion recovery) weighted shown in figure.

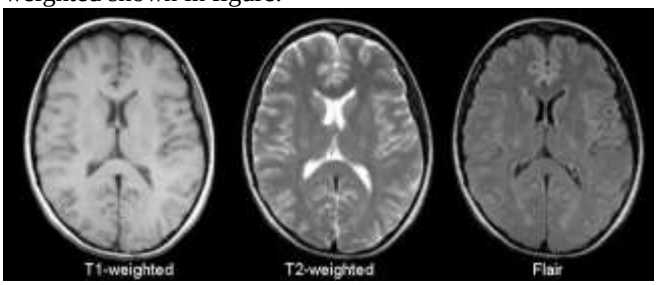


Fig. 2: T1, T2 and Flair image

The most common MRI sequence is T1 weighted and T2 weighted. In T1 weighted only one tissue type is bright FAT and in T2 weighted two tissue types are Bright FAT and Water both. In T1 weighted the repetition time (TR) is short in T2 weighted the TE and TR is long. The TE an TR

are the pulse sequence parameter and stand for repetition time and time to echo and it can be measured in millisecond(ms).

II. LITERATURE REVIEW

Many researchers have contributed to this field. Various combinations of existing technologies have been used.

1) Sivaramakrishnan et al. (2013) projected an efficient and innovative discovery of the brain tumor vicinity from an image that turned into finished using the Fuzzy Approach grouping algorithm and histogram equalization. The disintegration of images is achieved by the usage of principal factor evaluation is done to reduce the extent of the wavelet coefficient. The outcomes of the anticipated FCM clustering algorithm accurately withdrawn tumor area from the MR images. [1]
2) M. M. Sufyan et al. has presented a detection using enhanced edge technique for brain-tumor segmentation that mainly relied on Sobel feature detection. Their presented work associates the binary thresholding operation with the Sobel approach and excavates diverse extents using a secure contour process. After the completion of that process, cancer cells are extracted from the obtained picture using intensity values. [2]
3) Sathya et al. (2011), provided a different clustering algorithm such as K-means, Improvised K-means, C-means, and improvised C-means algorithms. Their paper presented an experimental analysis for massive dat=asets consisting of unique photographs. They analyzed the discovered consequences using numerous parametric tests. [3]
4) B. Devkota et al. have proposed that a computer-aided detection (CAD) approach is used to spot abnormal tissues via Morphological operations. Amongst all different segmentation approaches existing, the morphological opening and closing operations are preferred since it takes less processing time with the utmost efficiency in withdrawing tumor areas with the least faults. [4]
5) K. Sudharani et al presented a K- nearest neighbor algorithm to the MR images to identify and confine the hysterically full-fledged part within the abnormal tissues. The proposed work is a sluggish methodology but produces exquisite effects. The accuracy relies upon the sample training phase. [5]

III. PROBLEM STATEMENT

In most areas of clinical diagnosis, prevention is better than cure. Our study deals with automated brain tumor detection and classification. Normally the anatomy of the brain is analyzed by MRI scans or CT scans. The aim of the paper is tumor identification in brain MR images. The main reason for detection of brain tumors is to provide aid to clinical diagnosis. The aim is to provide an algorithm that guarantees the presence of a tumor by combining several procedures to provide a foolproof method of tumor detection in MR brain images. The methods utilized are filtering, erosion, dilation, threshold, and outlining of the tumor such as edge detection. The focus of this project is MR brain images tumor extraction and its representation in simpler form such that it is understandable by everyone. The objective of this work is to bring some useful information in simpler form in front of the users, especially for the medical staff treating the patient. The aim of this work is to define an algorithm that will result in extracted image of the tumor from the MR brain image. The resultant image will be able to provide information like size, dimension and position of the tumor, and its boundary provides us with information related to the tumor that can prove useful for various cases, which will provide a better base for the staff to decide the curing procedure. Finally, we detect whether the given MR brain image has tumor or not using Convolution Neural Network.

IV. OBJECTIVES

The objectives are as follows:

1) To discover this disease as early as possible.
2) If we discover this disease earlier, then the treatments are more likely to improve the quality life of the patients and their families.
3) Develop predictive models to differentiate between healthy people and people with Brain Tumor.
4) Study and analyses different deep learning models, including CNN.
5) To provide doctors good software to identify tumor and their causes.
6) Save patient's time.
7) Provide a solution appropriately at early stages.
8) Get timely consultation.

V. APPROACH

Pneumonia affects a large number of individuals, especially children, mostly in developing and underdeveloped countries characterized by risk factors such as overcrowding, poor hygienic conditions, and malnutrition, coupled with the unavailability of appropriate medical facilities. Early diagnosis of pneumonia is crucial to cure the disease completely. Examination of X-ray scans is the most common means of diagnosis, but it depends on the interpretative ability of the radiologist and frequently is not agreed upon by the radiologists. Thus, an automatic CAD system with generalizing capability is required to diagnose the disease. To the best of our knowledge, most previous methods in the literature focused on developing a single CNN model for the classification of pneumonia cases, and the use of the ensemble learning paradigm in this classification task has not been explored. However, the ensemble learning model incorporates the discriminative information from all the constituent base learners, allowing it to make superior predictions, and thus was implemented in this study. To handle the low amount of available biomedical data, transfer learning models were used as base learners, the decision scores of which were ensemble

VI. PROPOSED SYSTEM/ METHODOLOGY

Our aim is to develop an automated system for enhancement, segmentation and classification of brain tumors. The system can be used by neurosurgeons and healthcare specialists. The system incorporates image processing, pattern analysis, and computer vision techniques and is expected to improve the sensitivity, specificity, and efficiency of brain tumor

screening. The primary goal of medical imaging projects is to extract meaningful and accurate information from these images with the least error possible. The proper combination and parameterization of the phases enables the development of adjunct tools that can help on the early diagnosis or the monitoring of the tumor identification.

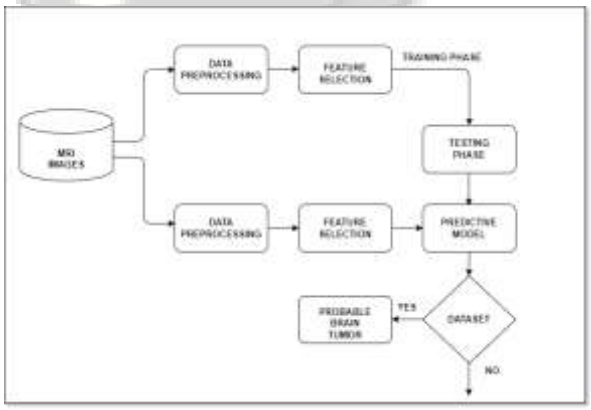
CNN models have been created from scratch and trained on Chest X-Ray Images (Pneumonia) dataset on Kaggle. Keras neural network library with Tensor Flow backend has been used to implement the models. Dataset consists of 5216 training images, 624 testing images and 16 validation images. Data augmentation has been applied to achieve better results from the dataset. The four models have been trained on the training dataset, each with different number of convolutional layers. Each model was trained for 20 epochs, with training and testing batch sizes of 32 and 1, respectively. The following sub-headings further explain the above stages in depth.

VII. ALGORITHM

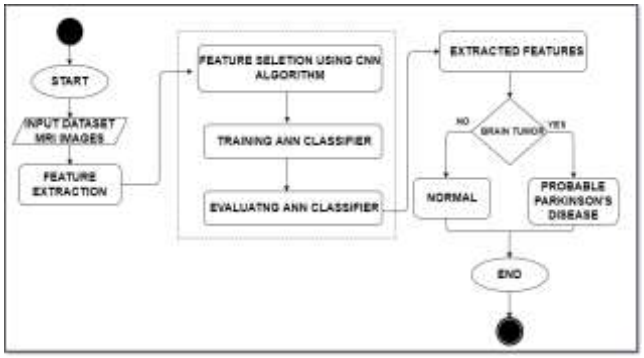
A. Convolutional Neural Network (CNN Model):

Convolutional Neural Network (CNN), is a highly effective machine learning algorithm potentially used in a variety of applications such as handwritten digit recognition, visual recognition, and image classification. It is a special kind of multi-layer neural network which extracts visual patterns from pixel images with minimal preprocessing. The architecture of CNN has been designed in a way such that it utilizes spatial relationships to encode certain properties and reduce the number of hyper parameters and thus improves general feed-forward back propagation training. CNN models combine weights into smaller kernel filters to simplify the learning model.

B. System Architecture:



Flow chart of algorithms:



Methods or Phases Sequentially:

Phase 1:

1) Give Training Dataset And Testing Dataset.
2) Take MRI Images Dataset as a input.
3) Data preprocessing step contains data cleaning process.

Phase 2:

1) Divide dataset is two parts
2) Dataset for training.
3) Dataset for testing.
4) Training of data contains feature extraction and algorithm work.
5) Testing phase contains predictions of Brain Tumor and accuracy check.
6) Show Result.

VIII. MATHEMATICAL MODEL

A. System Description:

S= I, O,F,DD,NDD, Failure, Success

Where,
S=System
I= Input
O=Output
F=Failure
S=Success
I is Input of system

Input I = set of Inputs

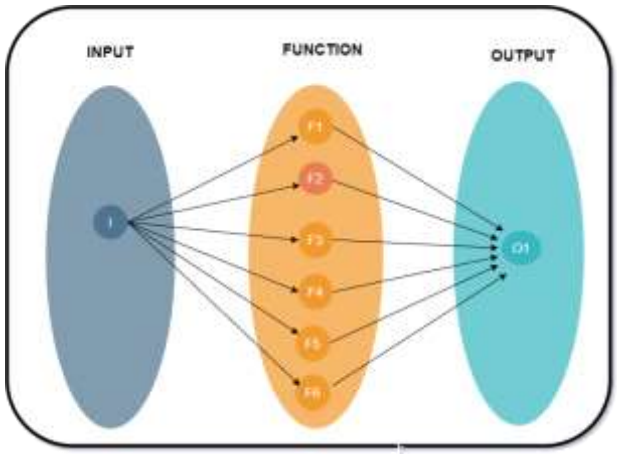
Where,
I= {MRI Images}
F is Function of system

F = set of Function

Where,
F1= {Input Dataset}
F2= {Data Preprocessing}
F3= {Train Dataset}
F4= {Test Dataset}
F5= {Feature Selection}
F6= {Feature Extraction}
F7= {Predictive Model Building}
F8= {Feature Matching}
F9= {Decision Making}
F10={CNN}
O is Output of system
Output O1 = {Brain tumor Prediction}

- Success Conditions: Product working smoothly. Early stage Brain tumor Prediction successfully.
- Failure Conditions: if internet connection Unavailable.

B. Venn diagram:



Where,

I= {Image File}
F1= {Browse Image or X-Ray}
F2= {Feature Extraction}
F3= {Train Dataset}
F4= {Feature Matching}
F5= {Test Dataset}
F6= {CNN}
O = {Pneumonia Detection}

C. Software/Hardware required-

1) Hardware Requirements-

1) Processor – i3
2) Hard Disk – 5 GB
3) Memory – 1GB RAM

2) Software Requirements-

1) Operating System: Windows XP and later versions
2) Front End: HTML,CSS
3) Programming Language: Python
4) Dataset: MRI Images
5) Domain: Deep Learning
6) Algorithm: Convolutional Neural Network (CNN)

D. Development Environment:-

We are developing application in .net framework. Web cam will be used for video capturing frames from video taken for face detection and recognition, if missing face matched then we will generate notification to police.

1) Testing Environment:

OS: Windows 7, 8 & RAM: 2 GB

E. Advantages &disadvantages:

Advantages:

1) It is used over feed forward neural networks as it can be trained better in case of complex images to have higher accuracies.
2) It reduces images to a form which is easier to process without losing features which are critical for a good prediction by applying relevant filters and reusability of weights
3) It can automatically learn to perform any task just by going through the training data i.e. there no need for prior knowledge
4) There is no need for specialized hand-crafted image features like that in case of SVM, Random Forest etc.

Application Areas:

1) The main aim of the applications is tumor identification.
2) The main reason behind the development of this application is to provide proper treatment as soon as possible and protect the human life which is in danger.
3) This application is helpful to doctors as well as patient.
4) The manual identification is not so fast, more accurate and efficient for user. To overcome those problem this application is design.
5) It is user friendly application.

IX. CONCLUSION

In this Paper, we discussed the concepts of Convolutional Neural Network while we outlined their application in Brain Tumor. We proposed a computerized method for the segmentation and identification of brain tumor using the Convolution Neural Network. The included studies showed that MRI analysis was performed for the detection of Brain Tumor using convolutional neural network has significant impact on early detection of Brain Tumor with high accuracy rate. However, most of the proposed methods are still in development and not tested in a clinical setting. Our work is mainly focused on advancement of predictive models to achieve good accuracy in predicting valid disease outcomes using deep learning methods. Prediction, based on Convolutional Neural Network (CNN). In this paper, using CNN techniques were proposed for the prediction of Brain Tumor in early stage.

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