A Project/Dissertation Review-2 Report

on

BRAIN TUMOR DETECTION USING (CNN)

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Signature of Project Coordinator **Signature of Dean**

Date: November, 2013
Place: Greater Noida

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Abstract

The brain tumors, are the most common and aggressive disease, leading to a very short life expectancy in their highest grade. Brain tumor is one of the most dangerous diseases which require early and accurately detection methods.
Thus, treatment planning is a key stage to improve the quality of life of patients. Generally, various image techniques such as computed tomography(CT), Magnetic Resonance Imaging(MRI)and ultrasound image are used to evaluate the tumor in a brain, lung, liver, breast, prostate…etc. Especially, in this work MRI images are used to diagnose tumor in the brain. Brain tumors, either malignant or benign, that originate in the cells of the brain. The conventional method of detection and classification of brain tumor is by human inspection with the use of medical resonant brain images. But it is impractical when large amounts of data is to be diagnosed and to be reproducible. And also the operator assisted classification leads to false predictions and may also lead to false diagnose. Medical resonance images contain a nose caused by operator performance which can lead to serious inaccuracies classification. In this work we used Brain tumor Detection Using Convolutional Neural Network(CNN).

Introduction

1.1 Overview

Medical imaging techniques are used to image the inner portions of a human body for medical diagnosis. And medical image classification is one of the most challenging & affluent topics in the field of Image Processing. Medical image classification problems, tumor detection, or detection of Cancer is the most prominent one. The statistics about the death rate from brain tumors suggest that it is one of the most alarming and critical cancer types in the Human body. As per the International Agency of Research on Cancer (IARC), more than 1,000,000 people are diagnosed with brain tumors per year around the world, with an ever-increasing fatality rate. It is the second most fatal cause of death related to cancer in children and adults younger than 34 years.

In recent times, physicians are following advanced methods to identify the tumor which is more painful for the patients. To analyze the abnormalities in different parts of the body, CT (Computed Tomography) scan and MRI (Medical Reasoning Imaging) are two convenient methods. MRI-based medical image analysis for brain tumor studies has been gaining attention in recent times due to an increased need for efficient and objective evaluation of large amounts of medical data. Analysis of this diverse range of image types requires sophisticated computerized quantification and visualization tools. So, automatic brain tumor detection from MRI images will play a crucial role in this case by alleviating the need for manual processing of huge amounts of data.

1.2 Brain Tumor

A brain tumor is a mass or growth of abnormal cells in your brain. Many different types of brain tumors exist. Some brain tumors are noncancerous (benign), and some brain tumors are cancerous (malignant). Brain tumors can begin in your brain (primary brain tumors), or cancer can begin in other parts of your body and spread to your brain as secondary (metastatic) brain tumors. How quickly a brain tumor grows can vary greatly. The growth rate, as well as the location of a brain tumor, determines how it will affect the function of your nervous system. Brain tumor treatment options depend on the type of brain tumor you have, as well as its size and location.

1.3 Classification of Brain Tumor

There are two types of brain tumor. One is Benign Tumor characterized as non-cancerous and the other one is a Malignant Tumor- also known as Cancerous Tumor.

1.3.1 Benign Tumor

Benign brain tumors are usually defined as a group of similar cells that do not follow normal cell division and growth, thus developing into a mass of cells that microscopically do not have the characteristic appearance of cancer. These are the properties of a benign tumor:

• Most benign tumors are found by CT or MRI brain scans.

• Grows slowly, does not invade surrounding tissues or spread to other organs, and often has a border or edge that can be seen on CT scans.

• It can be life-threatening because they can compress brain tissues and other structures inside the skull, so the term 'benign' can be misleading.

1.3.2 Malignant Tumor

Malignant brain tumors contain cancer cells and often do not have clear borders. They are considered to be life-threatening because they grow rapidly and invade surrounding brain tissues . These are the properties of a malignant tumor:

• Fast-growing cancer that spreads to other areas of the brain and spine.

• A malignant brain tumor is either graded 3 or 4, whereas grade 1 or 2 tumors are usually classified as benign or non-cancerous.

• Generally these are more serious and often more fatal threats to life.

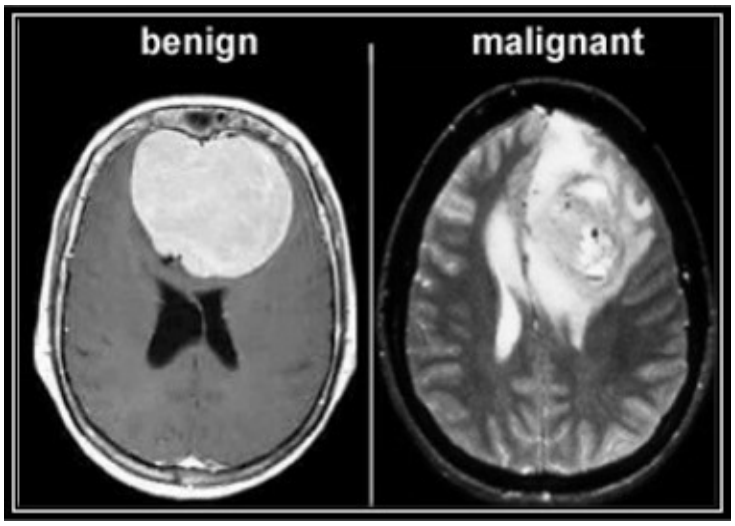


Figure 1.1: Benign Tumor (left) and Malignant Tumor (Right)

2. LITERATURE SURVEY

2.1 A survey of MRI-based medical image analysis for brain tumor studies

AUTHORS: S. Bauer et al

ABSTRACT: MRI-based medical image analysis for brain tumor studies is gaining attention in recent times due to an increased need for efficient and objective evaluation of large amounts of data. While the pioneering approaches applying automated methods for the analysis of brain tumor images date back almost two decades, the current methods are becoming more mature and coming closer to routine clinical application. This review aims to provide a comprehensive overview by giving a brief introduction to brain tumors and imaging of brain tumors first. Then, we review the state of the art in segmentation, registration, and modeling related to tumor-bearing brain images with a focus on gliomas. The objective in the segmentation is to outline the tumor including its sub-compartments and surrounding tissues, while the main challenge in registration and modeling is the handling of morphological changes caused by the tumor. The qualities of different approaches are discussed with a focus on methods that can be applied on standard clinical imaging protocols. Finally, a critical assessment of the current state is performed and future developments and trends are

addressed, giving special attention to recent developments in radiological tumor assessment guidelines.

2.2 The multimodal brain tumor image segmentation benchmark (BRATS)

AUTHORS: B. Menze et al.

ABSTRACT: In this paper we report the set-up and results of the Multimodal Brain Tumor Image Segmentation Benchmark (BRATS) organized in conjunction with the MICCAI 2012 and 2013 conferences. Twenty state-of-the-art tumor segmentation algorithms were applied to a set of 65 multi-contrast MR scans of low- and high-grade glioma patients - manually annotated by up to four raters - and to 65 comparable scans generated using tumor image simulation software. Quantitative evaluations revealed considerable disagreement between the human raters in segmenting various tumor sub-regions (Dice scores in the range 74%-85%), illustrating the difficulty of this task. We found that different algorithms worked best for different sub-regions (reaching performance comparable to human inter-rater variability), but that no single algorithm ranked in the top for all sub-regions simultaneously. Fusing several good algorithms using a hierarchical majority vote yielded segmentations that consistently ranked above all individual algorithms, indicating remaining opportunities for further methodological improvements. The BRATS image data and manual annotations continue to be publicly available through an online evaluation system as an ongoing benchmarking resource.

2.3 Brain Tumor Segmentation Using Convolutional Neural Networks in MRI Images

AUTHORS: Sergio Pereira, Adriano Pinto, Victor Alves, and Carlos A. Silva

ABSTRACT: Among brain tumors, gliomas are the most common and aggressive, leading to a very short life expectancy in their highest grade. Thus, treatment planning is a key stage to improve the quality of life of

oncological patients. Magnetic resonance imaging (MRI) is a widely used imaging technique to assess these tumors, but the large amount of data produced by MRI prevents manual segmentation in a reasonable time, limiting the use of precise quantitative measurements in the clinical practice. So, automatic and reliable segmentation methods are required; however, the large spatial and structural variability among brain tumors make automatic segmentation a challenging problem. In this paper, we propose an automatic segmentation method based on Convolutional Neural Networks (CNN), exploring small 3 ×3 kernels. The use of small kernels allows designing a deeper architecture, besides having a positive effect against overfitting, given the fewer number of weights in the network. We also investigated the use of intensity normalization as a pre-processing step, which though not common in CNN-based segmentation methods, proved together with data augmentation to be very effective for brain tumor segmentation in MRI images. Our proposal was validated in the Brain Tumor Segmentation Challenge 2013 database (BRATS 2013), obtaining simultaneously the first position for the complete, core, and enhancing regions in Dice Similarity Coefficient metric (0.88, 0.83, 0.77) for the Challenge data set. Also, it obtained the overall first position by the online evaluation platform. We also participated in the on-site BRATS 2015 Challenge using the same model, obtaining the second place, with Dice Similarity Coefficient metric of 0.78, 0.65, and 0.75 for the complete, core, and enhancing regions, respectively.

2.4 Brain tumor detection based on watershed transformation

AUTHORS: k. Ramya and L. K. Joshila Grace

ABSTRACT: In this paper, a watershed transformation technique is used with gradient magnitude with morphological open image and two important features is used as foreground and background to identify the tumor. First the Magnetic Resonance imaging (MRI) Scan of tumor is given as an input and it undergoes into watershed technique which is a topological boundary

dividing into two adjacent brain cells. With the gradient magnitude for segmentation technique the rate of inclination or declination of a tumor will be identified. To identify the foreground of the tumor, open the image morphological, thus it acquires clear idea about how the particular tumor will be closer to normal cells. With the background marker, the invisible tumor will be identified using threshold value. In the segmentation output finally, the intensity, size, shape of the tumor in the brain is displayed and can be analyzed.

2.5 An adaptive filtering technique for brain tumor analysis and detection

AUTHORS: MinuSamantaray ,MilleePanigrahi, K.C .Patra ,AvipsaS.Panda and Rina Mahakud

ABSTRACT: Brain tumor detection in an early stage is a difficult task, as the imaging is quite unclear. The necessity of automated brain tumor segmentation and detection is high. To obtain an accurate MRI image of the brain tumor is challenging. An MRI image has high contrast images indicating regular and irregular tissues that help in differentiating the overlap margins. But in case of an early brain tumor, the edges of the image are not sharp which causes the segmentation results to be inaccurate. Hence, this paper puts forth a method for detection and segmentation of the tumor. The method proposed here is a segmentation process of 2D MRI image using various filtering techniques. MATLAB has been used for the implementation.

3.SYSTEM ANALYSIS

3.1 EXISTING SYSTEM:

In the existing technique, the Support Vector Machine (SVM) based classification is performed for brain tumor detection. It needs feature extraction output. Based on feature value, the classification output is generated and accuracy is calculated. The computation time is high and accuracy is low in SVM based tumor and non-tumor detection.

3.1.1 DISADVANTAGES OF EXISTING SYSTEM:

- Accuracy is low.
- More time is required to classify the result.

3.2 PROPOSED SYSTEM:

- In the proposed CNN based classification doesn't require feature extraction steps separately. The feature value is taken from CNN itself. The classified result of Tumor and Non-tumor brain image. Hence the complexity and computation time is low and accuracy is high. The output of brain tumor classification accuracy is given. Finally, the classification results as Tumor brain or non-tumor brain based on the probability score

value. The normal brain image has the lowest probability score. The tumor brain has the highest probability score value, when compared to normal and tumor brain.

3.2.1 ADVANTAGES OF PROPOSED SYSTEM:

The usage of CNNs is motivated by the fact that they can capture/are able to learn relevant features from an image at different levels similar to a human brain. This is feature learning.

3.3 SYSTEM REQUIREMENTS:

HARDWARE REQUIREMENTS:

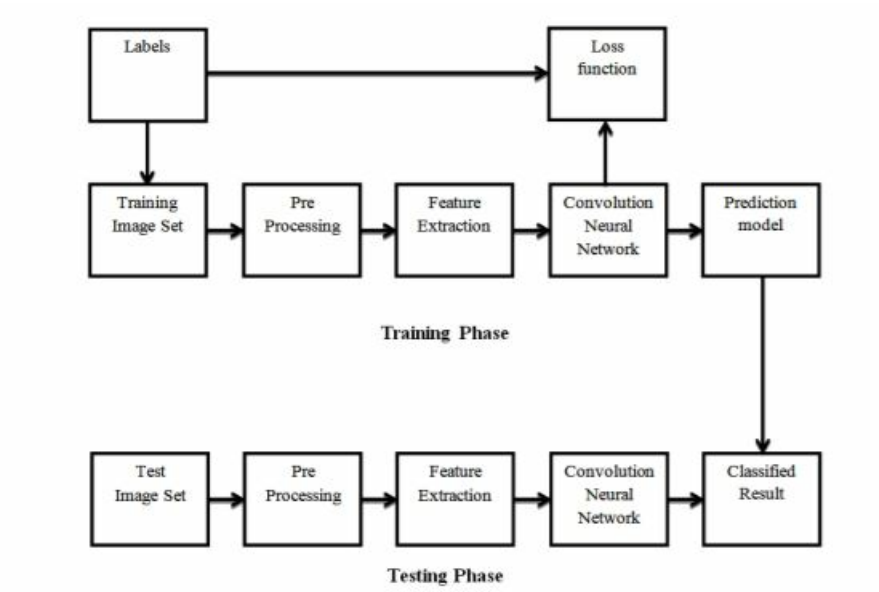
- System : Pentium IV 2.4 GHz.
- Hard Disk : 40 GB.
- Floppy Drive : 1.44 Mb.
- Monitor : 15 VGA Colour.
- Mouse : Logitech.
- Ram : 512 Mb.

SOFTWARE REQUIREMENTS:

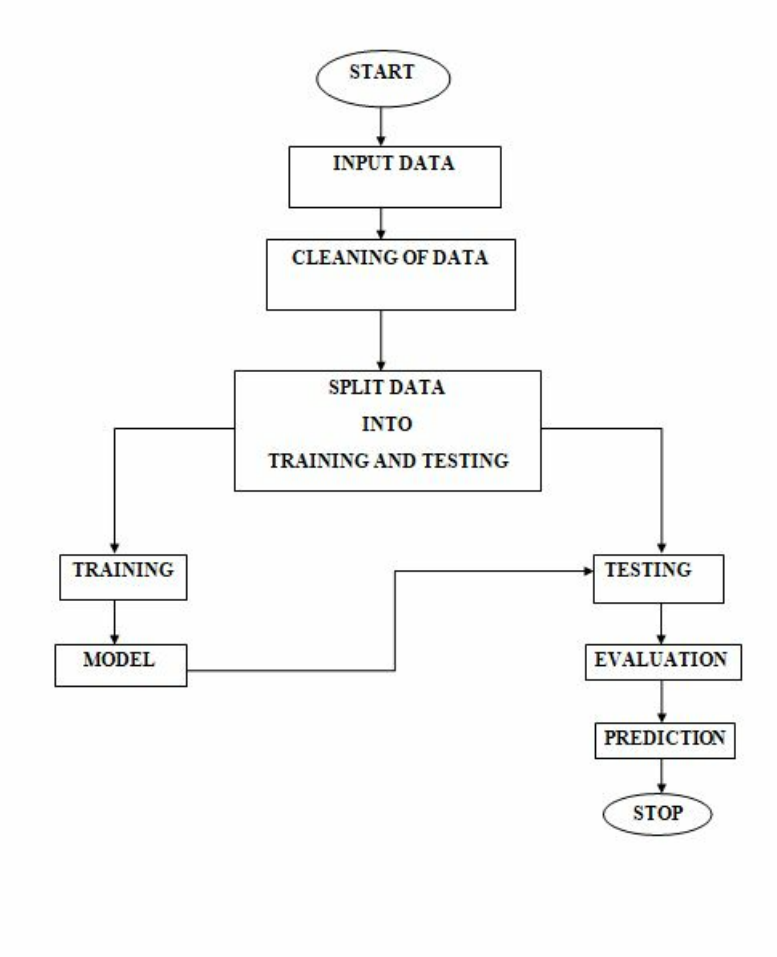
- **Operating System:** Windows
- **Coding Language**: Python 3.7

4. SYSTEM DESIGN

4.1 SYSTEM ARCHITECTURE:



Block Diagram:



4.2 DATA FLOW DIAGRAM:

1. The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.
2. The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process, an external entity that interacts with the system and the information flows in the system.
3. DFD shows how the information moves through the system and how it is modified by a series of transformations. It is a graphical technique that

depicts information flow and the transformations that are applied as data moves from input to output.

4. DFD is also known as bubble chart. A DFD may be used to represent a system at any level of abstraction. DFD may be partitioned into levels that represent increasing information flow and functional detail.

UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed and was created by, the Object Management Group. The goal is for UML to become a common language for creating models of object-oriented computer software. In its current form, UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing, and documenting the artifacts of a software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

GOALS:

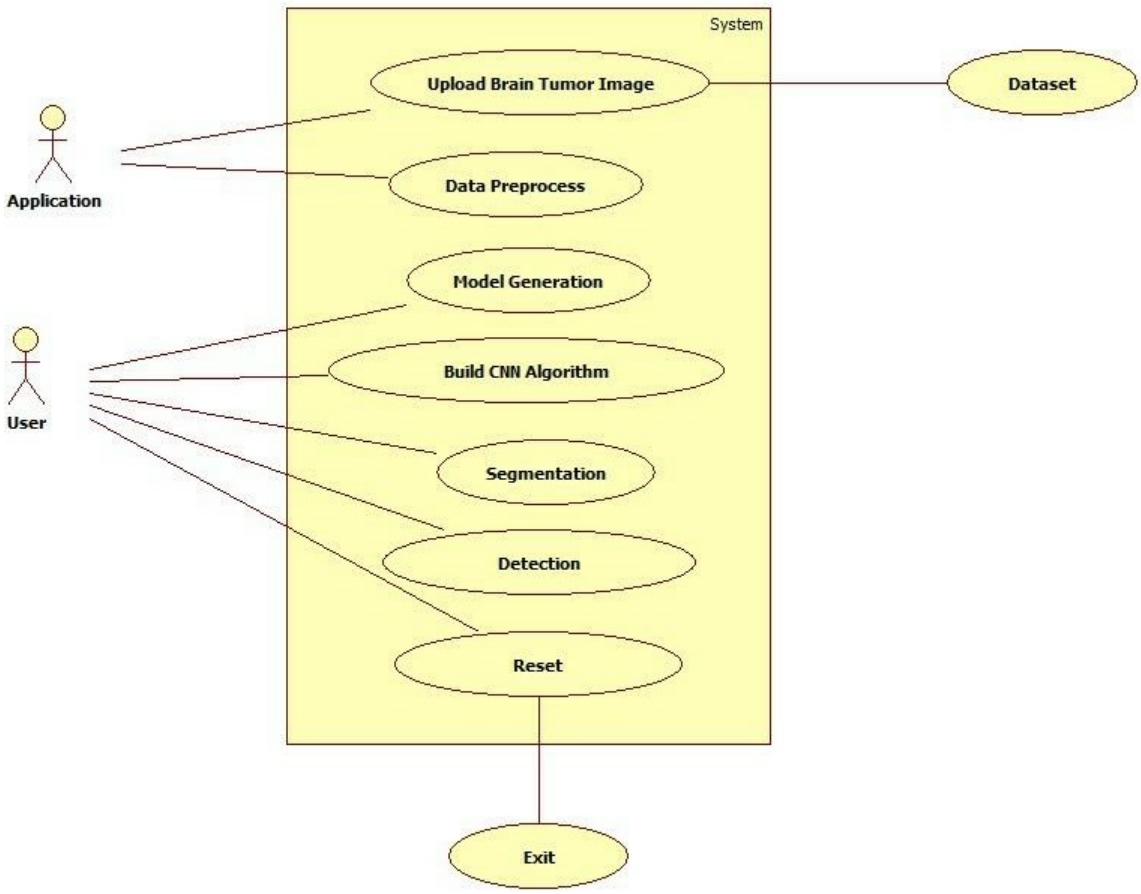
The primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.

3. Be independent of particular programming languages and development processes.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.
6. Support higher level development concepts such as collaborations, frameworks, patterns and components.
7. Integrate best practices.

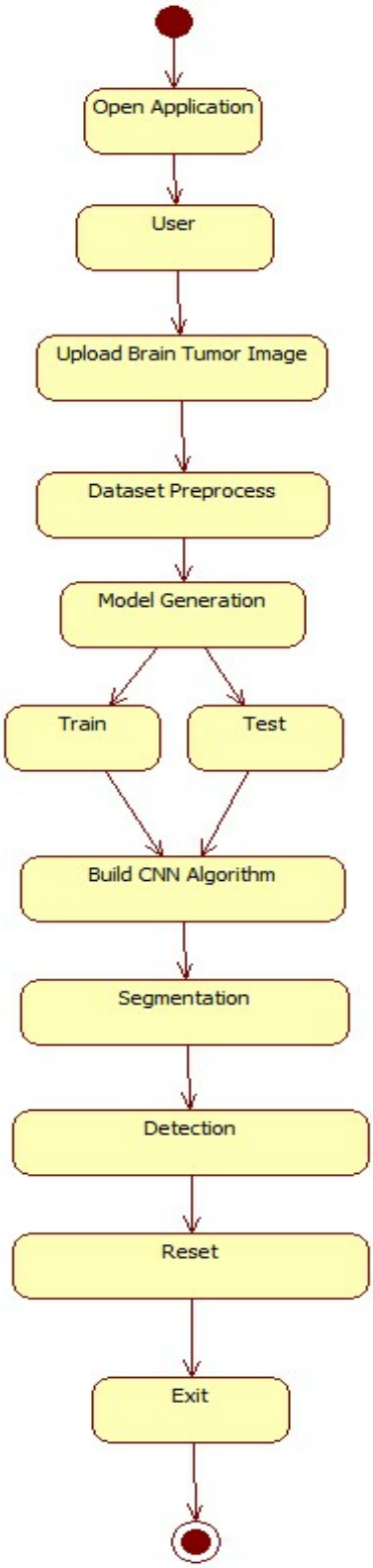
Use case diagram:

The use case diagram is used to identify the primary elements and processes that form the system. The primary elements are termed as "actors" and the processes are called "use cases." The use case diagram shows which actors interact with each use case.



State diagram:

A state diagram, as the name suggests, represents the different states that objects in the system undergo during their life cycle. Objects in the system change states in response to events. In addition to this, a state diagram also captures the transition of the object's state from an initial state to a final state in response to events affecting the system.



4.3 IMPLEMENTATION:

1. Upload Brain Tumor Image

In this module user uploads image.

2. Data Preprocess

In this module image data is take place preprocessed here.

3. Model Generation

In this module, there will be model generation for classifying the image dataset.

4.Build CNN Algorithm

In this module Build CNN classifier takes place.

5.Segmentation

Here image segmentation is take place.

6.Detection

In this module prediction of brain tumours is detected.

7.Reset

In this module data is clear.

8. Exit

In this module, application is closed here.

5.SYSTEM TEST

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked.

The organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

Unit Testing

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Test Cases

USER REQUIREMENTS:

1. Home

Home:

Use case ID	Brain Tumor Detection Using Convolutional Neural Network (CNN)
Use case Name	Home button
Description	Display home page of application
Primary actor	User
Precondition	User must open application
Post condition	Display the Home Page of an application
Frequency of Use case	Many times
Alternative use case	N/A
Use case Diagrams	
Attachments	N/A

Conclusion & Future Works

6.1 Conclusion

Performance analysis of automated brain tumor detection from MR imaging and CT scan using basic image processing techniques based on various hard and soft computing has been performed in our work. Moreover, we applied six traditional classifiers to detect brain tumor in the images. Then we applied CNN for brain tumor detection to include deep learning method in our work. We compared the result of the traditional one having the best accuracy (SVM) with the result of CNN. Furthermore, our work presents a generic method of tumor detection and extraction of its various features.

In the context of the full dataset, it is necessary to parallelize and utilize high-performance computing platform for maximum efficiency. We tried our best to detect the tumors accu- rately but, nevertheless we faced some problems in our work where tumor could not be detected or falsely detected. So, we will try to work on those images and on the complete dataset. Hence, we will try to apply other deep learning methods in the future so that we can get a more precise and better result.

6.2 Limitations

There are some limitations of our thesis work that we have listed in this section which we are leaving to improve in our future works.

The BRATS dataset has only 241 images

Worked only on 2D images.

We could have tried more traditional classifiers to increase the accuracy.

Types of the tumor could not be classified

6.3 Future Works

There are more opportunities for improvement or research on our work in the future.

- Firstly, the number of images can be increased. The bigger the number of the images is, the better the model is trained.

Secondly, we want to work on 3D images in future.

Thirdly, more traditional classifiers can be applied to get more increased accuracy.

- Fourthly, we will try to classify the tumor if its benign or malignant after the detection of the tumor.
- Last but not the least, more variations of deep learning methods can be tested in future.