BRAIN TUMOR CLASSIFICATION USING DEEP LEARNING AND MRI IMAGES

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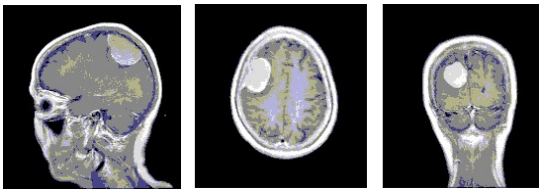
Abstract

Clinical information development is in medical services networks, precise investigation of clinical information facilitates early sickness discovery, patient consideration and local area administrations. Be that the examination of patients relies upon exactness of determination of disease and after that the treatment. Some unacceptable analyzed patients lead to deaths in constant sort sicknesses. Seeing the high danger, the requirement is that there is need of precise analysis help for persistent infections. So, we are proposing conclusive framework dependent on AI for giving promising arrangement with high precision. The proposed framework comprises of Brain tumor stages forecasts. High pace of passings occur because of persistent infections, for example brain tumor need to foster legitimate analysis framework which serves to specialists. Some unacceptable finding prompts human passings, so we really want to outstand at exact analysis of the sicknesses. Many works are as of now are for various infections however there isn't any encouraging arrangement found that gives exact conclusion across the board. We are attempting to foster framework for multi sickness discovery and stages forecasts gives early location and saves bunches of lives by diminishing passing rate by illnesses. We are recommending the precautions once disease diagnosed.

Keywords: Convolutional Neural Network, VGG-16

1. INTRODUCTION



Sagittal view Axial view Coronal view

Figure 1: Brain MRI slices captured from different directions.

1.1. OVERVIEW

Medical data growth in healthcare communities, accurate analysis of medical data benefit early disease detection, patient care and community services.
However, the analysis of patients is depending on the accuracy of diagnosis and then treatment as well.
The wrong diagnosed patients lead to deaths in diseases.
So, the high risk of diagnosis there is need of accurate diagnosis aid for lung cancer and brain tumor diseases.
So, we are proposing diagnosis system based on machine learning for giving promising solution with high accuracy.
The proposed system consists of many diseases such as brain tumor disease detections and stages predictions.

1.2 OBJECTIVE

To reduce death rate by diseases in the world
To give unique solution for multiple diseases.
To provide higher accuracy over previous research
To give most promising tool that can be acceptable by all the doctors.
Detection of disease tumor.

1.3 MOTIVATION

Reducing death rate by wrong diagnosis using giving accurate diagnosis.
To provide diagnosis system this helps to doctors.

Motive behind proposed work is to achieve higher accuracy over existing work by using machine learning. The desire to provide a better and accurate diagnosis.

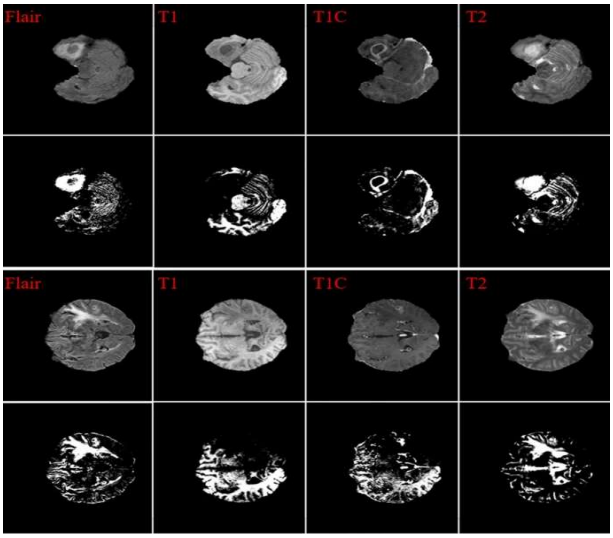


Figure 2. MRI Modalities.

2. USER INTERFACE

Python

Python interface is being actively developed right now. There are many algorithms and many functions that compose or support those algorithms. Open CV is written natively in C++ and has a template interface that works seamlessly with STL containers.

2.1. Hardware Interfaces

To run our project, we required a hardware system which is feasible for our project like Intel I3 processor, 2 GB RAM, 20GB Hard disk. We also need standard keyboard, Mouse, LED Monitor.

2.2 Software Interfaces

The system can use Microsoft as the operating system platform. System also makes use of certain GUI tools. To run this application, we need PyCharm and above as python platform. To store data, we need SQLite database.

2.3 Communication Interface:

- Disease Classification System
- User brain tumor image dataset
- Pre-processing unit
- Tumor classification is done by Vgg16
- Precautions recommendation is done by using Vgg16 algorithm.
- Open-CV for image processing
- Tensorflow for deep learning model.

3. SYSTEM REQUIREMENTS

3.1 Database Requirements
Database : SQLite3

3.2 Software Requirements (Platform Choice)
Operating System : Windows
Front End : Python3x
Database : SQLite3
IDE : PyCharm

3.3 Hardware Requirements
Processor : Intel I5
Speed : 2.0 GHz
RAM : 4 GB (min)
Hard Disk : 40 GB
Camera : System Camera
Keyboard : Standard Windows Keyboard
Mouse : Two or Three Button Mouse

3.4 ANALYSIS MODEL
Waterfall Model:

The waterfall model is a sequential model that is used in the software development processes, where the process is seen flowing steadily downwards through the phase of Requirement Gathering and Analysis, System Design, Implementation, Testing, Deployment and Maintenance.

3.5 Requirement analysis:

Here requirements are gathered means which kind of dataset is required. Then what are functional requirement of system. Document is prepared, and then use cases are designed. In our system we gather all information of Admin and user and functionality of each module.

3.6 System Design:

In this stage, hardware and software requirement to design the system is decided. It uses above mentioned hardware and software requirements. We design the of Admin and user module. Design the according to functionality of each module.

3.7 Implementation:

In this stage, system is developed module wise. This system consists of mainly 2 modules namely,
1. Admin

2. User

3.8 Testing:

In this stage, all developed software's are installed, and they are tested in different ways against the system requirements. In this stage we check all this module is working properly or not with proper authentication. Face prediction based on hand drawn sketch proper or not as well as stage prediction proper or not.

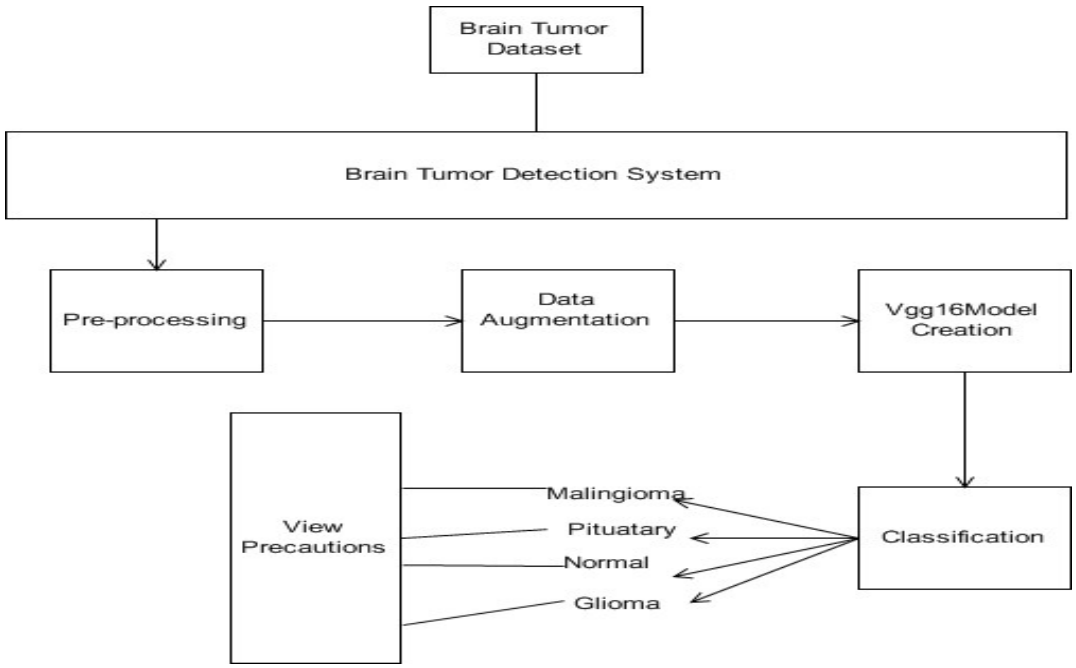


Figure 3: Overview of the Architecture

4. METHODOLOGY

Constituents of Glioma as seen in MRI Sequences:

- Edema: Collection of Fluid or Water. Best seen in FLAIR and T2 weighted sequence. Fingerlike Projection.
- Necrosis: Accumulation of dead cells. Best seen in T1 post contrast sequence.
- Enhancing Tumor: Indicate breakdown of blood brain barrier. Seen in T1c post contrast sequence.
- Non-Enhancing Tumor: Regions that are neither of above mentioned.

- Most spectral clustering algorithms have been implemented on artificial networks, and accuracy of the community detection is still unsatisfactory. Also, it takes large time for training purpose. It is not useful in real time testing, because it fails to handle unknown decision which is mostly occur in real time.

Steps:

- Gathering and Analysis of Dataset
- Pre-processing and Feature extraction
  - Data Augmentation
  - Model Creation and Training
  - Model Testing and Accuracy

4.1 DATA FLOW DIAGRAM

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modelling its process aspects. A DFD is often used as a preliminary step to create an overview of the system without going into detail, which can later be elaborated. DFDs can also be used for the visualization of data processing (Structured design).

A DFD shows what kind of information will be input to and output from the system, how the data will advance through the system, and where the data will be stored. It does not show information about process timing or whether processes will operate in sequence or in parallel, unlike a traditional structured flowchart which focuses on control flow, or a UML activity workflow diagram, which presents both control and data, flows as a unified model.

DFD Levels:

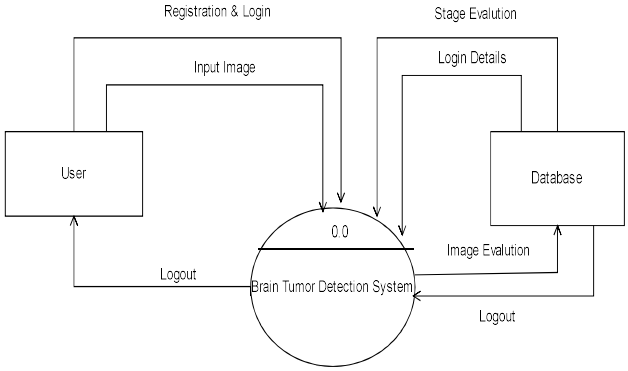


Figure 4: DFD level 0

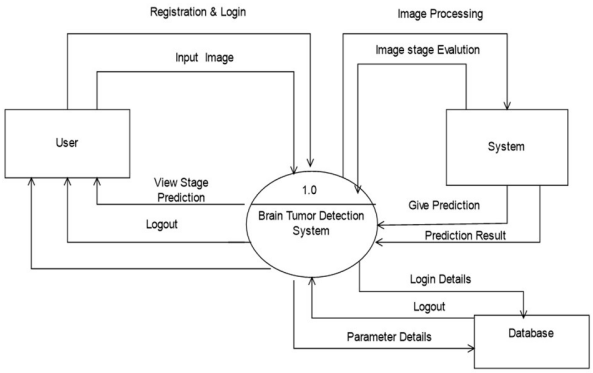


Figure 5: DFD Level 1

4.2 ENTITY RELATIONSHIP DIAGRAM

An entity–relationship model (ER model for short) describes interrelated things of interest in a specific domain of knowledge. A basic ER model is composed of entity types (which classify the things of interest) and specifies relationships that can exist between instances of those entity types.

In software engineering, an ER model is commonly formed to represent things that a business needs to remember in order to perform business processes. Consequently, the ER model becomes an abstract data model, that defines a data or information structure which can be implemented in a database, typically a relational database.

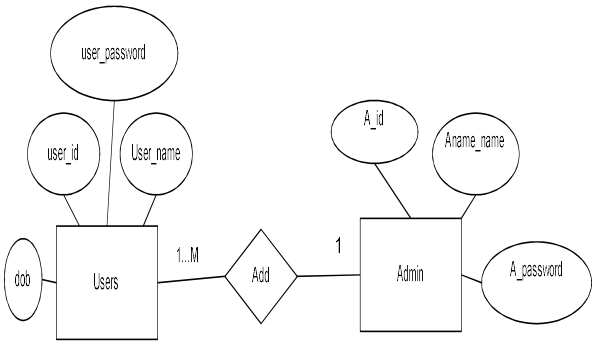


Figure 6: ER - Diagram

4.3 UML DIAGRAMS

4.3.1 Use case diagram

A use case diagram is a graphical representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can show the different types of users of a system and the various ways in which they interact with the system. Use case diagrams are used to gather the requirements of a system including internal and external influences. These requirements are mostly design requirements. So when a system is analyzed to gather its functionality use cases are prepared and actors are identified. The purposes of use case diagrams can be as follows:

- Used to gather requirements of a system.
- Used to get an outside view of a system.
- Identify external and internal factors influencing the system.
- Show the interaction among the actors.

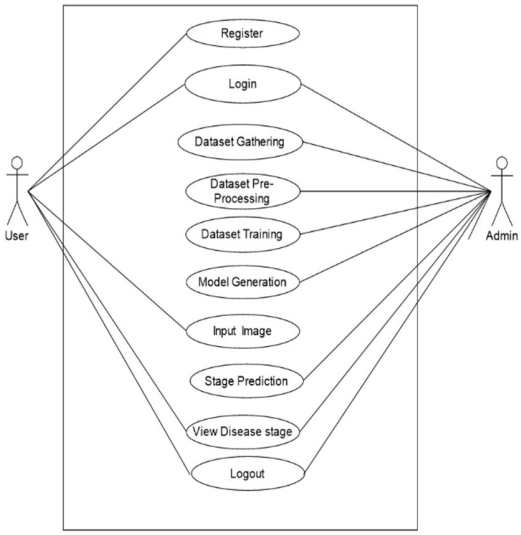


Figure 7: Use Case Diagram

4.3.2 Activity diagram

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modelling Language, activity diagrams are intended to model both computational and organizational processes (i.e. workflows). Activity diagrams show the overall flow of control. Activity diagrams are constructed from a limited number of shapes, connected with arrows. The most important shape types:

- Rounded rectangles represent actions
- Diamonds represent decisions
- Bars represent the start (split) or end (join) of concurrent activities
- A black circle represents the start (initial state) of the workflow
- An encircled black circle represents the end (final state)

Arrows run from the start towards the end and represent the order in which activities happen. Hence, they can be regarded as a form of flowchart. Typical flowchart techniques lack constructs for ex-pressing concurrency. However, the join and split symbols in activity diagrams only resolve this for simple cases; the meaning of the model is not clear when they are arbitrarily combined with decisions or loops.

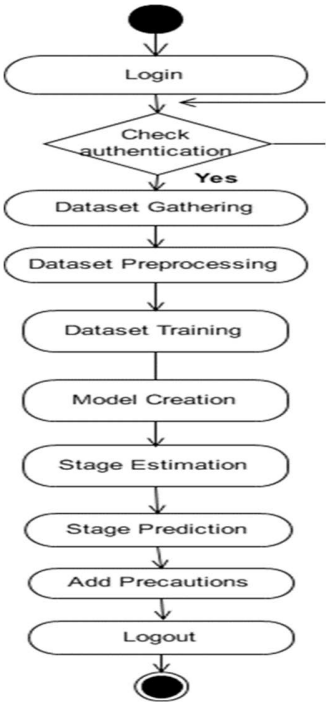


Figure 8: User Activity Diagram

3.3 Class Diagram

The class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing and documenting different aspects of a system but also for constructing executable code of the software application. The class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modelling of object-oriented systems because they are the only UML diagrams which can be mapped directly with object-oriented languages. The class diagram shows a collection of classes, interfaces, associations, collaborations and constraints. It is also known as a structural diagram. The purpose of the class diagram is to model the static view of an application.

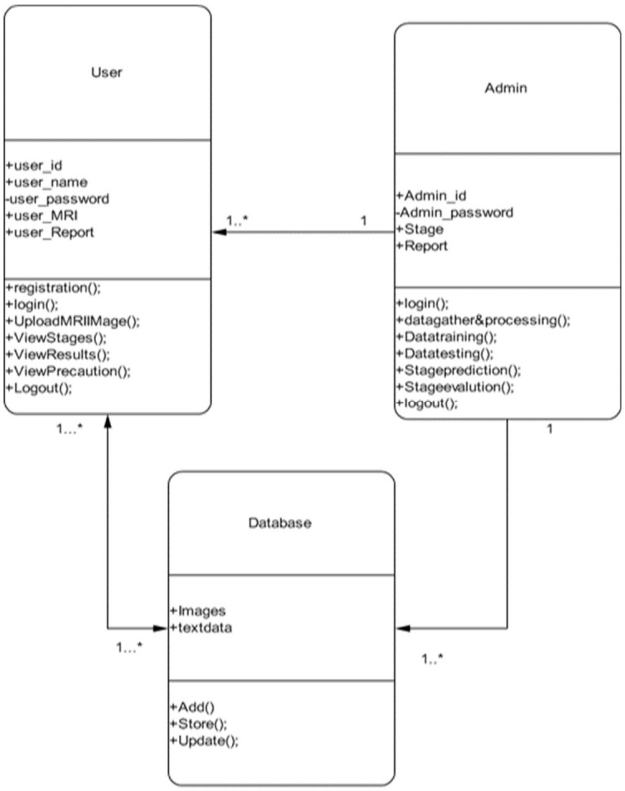


Figure 9: Class Diagram

4.3.4 Sequence Diagram

A Sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged

between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios.

4.3.5 Component Diagram

A Component Diagram displays the structural relationship of components of a software system. These are mostly used when working with complex systems that have many components. Components communicate with each other using interfaces. The interfaces are linked using connectors.

4.3.6 Deployment Diagram

Deployment diagrams are used to visualize the topology of the physical components of a system where the software components are deployed. So deployment diagrams are used to describe the static deployment view of a system. Deployment diagrams consist of nodes and their relationships.

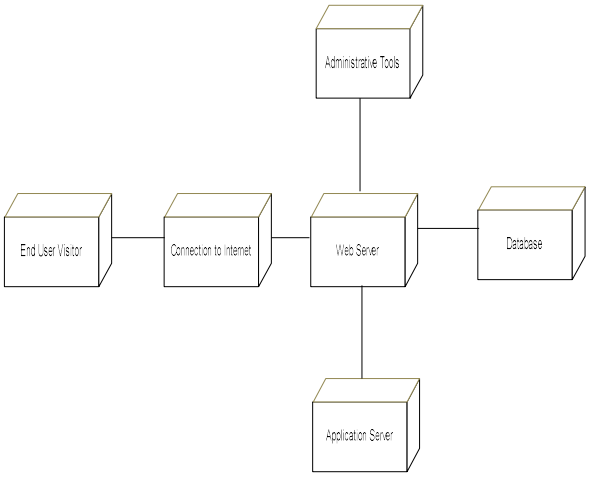


Figure 10: Deployment Diagram

4.3.7 State Diagram

A state diagram is a type of diagram used in computer science and related fields to describe the behavior of systems. State diagrams require that the system described is composed of a finite number of states; Sometimes, this is indeed the case, while at other times this is a reasonable abstraction.

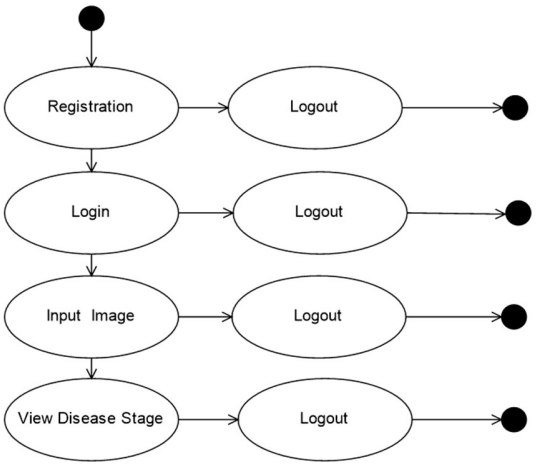


Figure 11: User State Diagram

5. PROJECT ESTIMATES

5.1.1 Reconciled Estimates

Cost Estimate:

Objective of project is to create cost effective precautions recommendation based on tumor image system, hence as compared to other image base system proposed system is more cost effective.

5.1.2 Project Resources

We elected to use precautions recommendation based on tumor image using Vgg16 for its affordability, availability, and specialized hardware.

5.2 RISK MANAGEMENT

It is related to the future harms that could be possible on the system due to some minor or non-noticeable mistakes in software development project.
NP Complete problems are Hardest in NP.
If any NP Complete Problem is P time Solvable, then All Problems in NP are P time solvable.
Here Mathematical Model gives calculates values in NP time and it shall be reduced NP Hard time
Hence, we can say the project modes in NP Complete
Hardware Related Risks will be possible
Project allows user to interact via precautions recommendation based on tumor image. However more formal investigations are necessary to determine which text are more natural to our users.

5.2.1 Risk Identification

While making interaction of social website with the

machine at start up, the relative position of the web Remotes to each other and to the artefact is unknown. In Short initial positions of the data, points are not perfectly determined.

5.2.2 Risk Analysis

Based on time and quality there are certain risk factors which needs to be analyzed.

ID	Risk Description	Probability	Impact		
			Schedule	Quality	Overall
1	Aspect Resolution	Low	Low	High	Low
2	Calibration of System	Low	Low	High	High

Table 3: Risk Analysis

5.2.3 Overview of Risk Mitigation, Monitoring, Management

Following are the details for each risk.

Risk ID	1
Risk Description	Aspect Resolution
Category	Display Compatibility
Source	Hardware requirement Specification
Probability	Low
Impact	High
Response	Mitigate
Strategy	Install Required System Drivers
Risk Status	Solvable

Risk ID	2
Risk Description	Feature Extraction of Text Data
Category	Testing Requirements
Source	Software Resources Required
Probability	Low
Impact	High
Response	Mitigate
Strategy	Re-calibration
Risk Status	Identified

Table 4: Risk Mitigation

5.2.4 OVERVIEW OF PROJECT MODULES

We propose a new Vgg16 based tumor classification and precautions recommendation based on Vgg16 machine model with higher accuracy. We are going to solve accuracy issue in classification of tumor image with accurate stage predictions. We also work on precautions suggestion by machine learning algorithm.

In proposed system consists mainly 2 modules.
Admin and users are two modules include in our system. Admin first gather the information about tumor images in the form of images. After gathering of information like pre-processing on the data, training of the data, model generation according to the features of the data.

Users insert the tumor type image for checking tumor type and based on those precautions recommend. We are trying to develop system for tumor classification and precautions suggestion stages predictions gives early detection and it helps to the doctors.

5.2.5 TOOLS AND TECHNOLOGIES USED

- Anaconda (Jupyter notebook)
- PyCharm (Python IDE)
- IPython[all]
- Tensorflow
- Keras
- Numpy
- OpenCV
- Matplotlib
- Django

6. ALGORITHM

6.1 VGG-16

Vgg16 are a kind of Artificial Neural Networks that are known to be tremendously strong in the field of distinguishing proof just as picture order.
Four main operations in the Vgg16 are shown as follows:

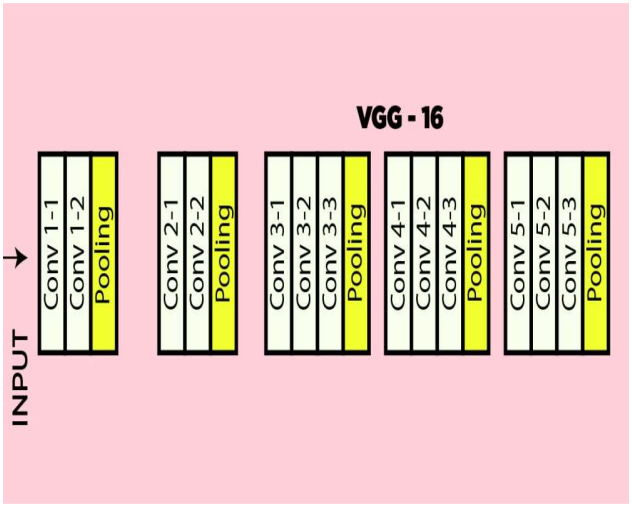
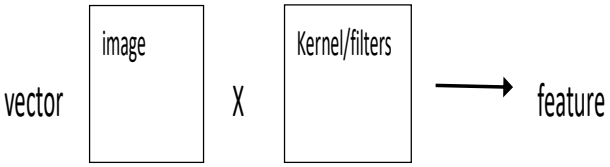


Figure 12: VGG-16 Architecture

6.2 Convolution

The principal utilization of the Convolution activity if there should be an occurrence of a CNN is to recognize fitting highlights from the picture which goes about as a contribution to the primary layer. Convolution keeps up the spatial interrelation of the pixels This is finished by fulfilment of picture highlights utilizing miniscule squares of the picture. Convolution equation. E very picture is seen as a network of pixels, each having its own worth. Pixel is the littlest unit in this picture grid. Allow us to take a 5 by 5(5*5) framework whose qualities are just in twofold (for example 0 or 1), for better agreement. It is to be noticed that pictures are by and large RGB with upsides of the pixels going from 0 - 255 i.e., 256 pixels.



6.3 ReLU

ReLU follows up on a rudimentary level. All in all, it is an activity which is applied per pixel and overrides every one of the non-positive upsides of every pixel in the component map by nothing.

6.4 Pooling or sub-sampling

Spatial Pooling which is likewise called subsampling or down sampling helps in lessening the elements of each element map yet even at the same time, holds the most important data of the guide. After pooling is done, in the long run our 3D element map is changed over to one dimensional component vector.

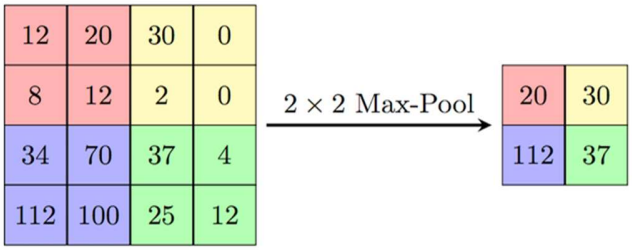


Figure 14: Max-Pooling Layer

6.5 Fully Connected layer

The yield from the convolution and pooling activities gives noticeable highlights which are removed from the picture. These highlights are then used by Fully Connected layer for consigning the info picture into various classes predicated on the preparation dataset.

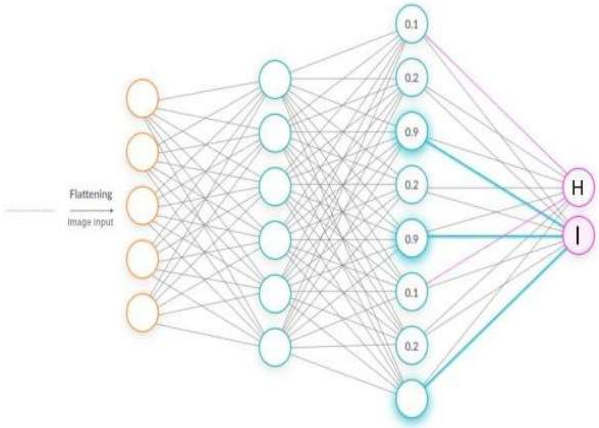


Figure 13: Fully Connected Layer

7. RESULT ANALYSIS

7.1 Accuracy:

To reduce loss, we use Adam Optimizer and define categorical cross entropy which uses a concept of gradient descent which brings down the loss function by providing its weights the direction, so that it moves towards the global minima (Jmin(w)) and thus reducing the loss.

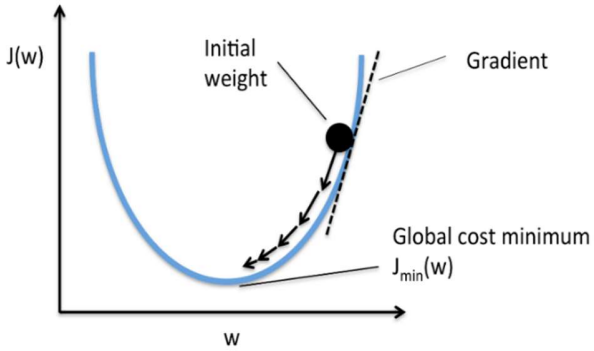


Figure 15: Gradient Descent

7.2 Training and Testing Graphs:

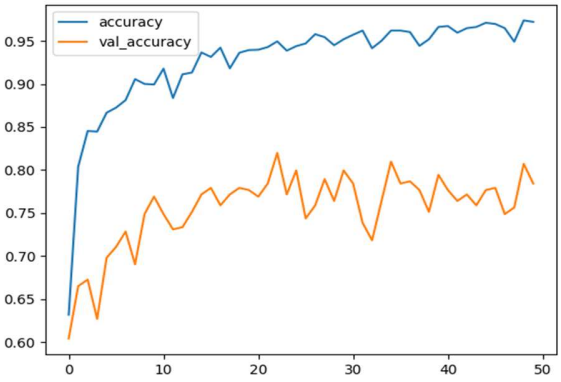


Figure 16: Epoch vs Accuracy Graph

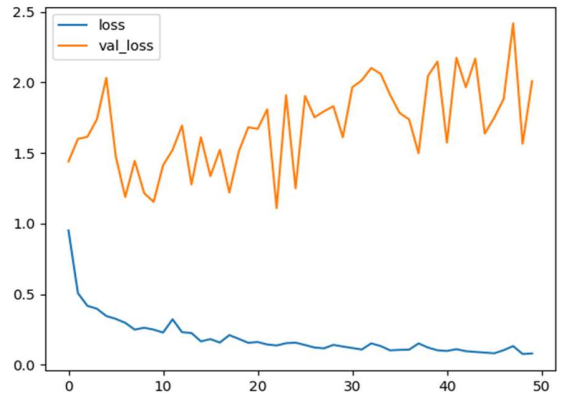


Figure 17: Epoch vs Loss Graph

8. CONCLUSION

We have successfully built our model namely Brain Tumor Detection System using Deep Leaning Algorithms over Machine Learning ones and used Vgg16 Algorithm which solves existing accuracy problem as well as reduce death rates of diseases like brain tumor. After detection of disease the model inform to users how to prevent from a disease. For future work, we can implement this technique on some more diseases and with availability of rich dataset and develop android apps for the same. Increasing the number of diseases and dataset used for the process can improve the accuracy which in turn will help us work on more efficient techniques and Algorithms.

9. LIMITATIONS

The Problems with the model were mainly related to existing dataset which contained multiple duplicate images which we cleared before using but still sometimes it would give wrong predictions for 1 out of 10 images which is problem, but we want 99%+ accuracy, so we are looking for rich dataset. Secondly with limitations of our system and dataset the model sometimes fails on images referred from internet which in turn may or may not be a problem because we need to explore more characteristic images and hence the case of failure. Moreover the model was successful when using the dataset only sometimes it had failed which means increasing epoch can clear it out.

10. APPLICATIONS

- To give unique solution for getting the brain tumor classification and based on that precautions suggestion which is helpful in the medical domain.To automate brain tumor segmentation to make work of radiologist easier and faster and to give accurate results better than existing models.

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