A PROJECT REPORT ON

Medical Image Analysis: Brain tumor Detection and Segmentation

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
IN THE FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING
IN
COMPUTER ENGINEERING

SUBMITTED BY

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CERTIFICATE

This is to certify that the project report entitles

Medical Image Analysis: Brain tumor Detection and Segmentation.

SUBMITTED BY

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ABSTRACT

Medical diagnosis/detection of diseases with the help of image processing, computer vision and machine learning are considered one of the most prominent issues in artificial intelligence. Similarly, Deep learning, which is considered as part of machine learning has gained importance in almost every field where "decision making" is comprised especially in the field of health care. The concept of artificial intelligence has shown encouraging results in disease/virus diagnosis with image processing. In recent year, the brain imaging techniques has regularly vie a necessary role in inspecting and concentrating on new visions of anatomy and brain functions. The image process mechanism is extensively employed in drugs to reinforce early detection and treatment. Segmentation and classification is significant role for imaging brain image processing.

The aim of this work is to develop a system that helps in tumor detection and brain MRI image recognition through the method of the planned image classifier. during this work, we have a tendency to advocate a Deep Neural Network for classification and segmentation. This work proposes a picture compression technique mistreatment a Deep rippling machine encoder (DWA) that mixes the flexibility to attenuate the first perform of automatic encoders with the image degradation property of the wavelet transform. the mixture of the 2 has a necessary impact on reducing the scale of the function set to face up to additionally classification tasks with DNN. A brain system has been eliminated and therefore the planned DNN-DWAE image classification is considered. The performance analysis for the DNN-DWAE classifier has been improved compared with totally different existing method.

Keywords: Deep neural network, Denoising autoencoder, segmentation, tumour detection.

Contents

List of Abbreviations

Abbreviation	Full form
UI	User Interface
ML	Machine Learning
DL	Deep Learning
NN	Neural Networks
CNN	Convolutional Neural Networks
ResNet	Residual Neural Networks
RPN	Region Propsal Network
COCO	Common Objects in Context dataset
API	Application Programming Interface
SDLC	Software Development Life Cycle
UML	Unified Modeling Language
TFA	Two-stage Fine-tuning Approach
FRCNN	Faster R-CNN
FSFSOD	Frustratingly Simple Few Shot Object Detection
PANet	Prototype Alignment Network

Table 1: Abbrevations

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Whenever a person is diagnosed with a disease or any kind of unknown health-related problems. A patient always seeks a third party advice from his/her friends or relatives because he/she is unaware of which hospital or doctor to refer for the best treatment. Often this kind of suggestions are not reliable and may lead to time delay which is very crucial in times of emergency. If we have a recommendation system in place, this type of situations can be avoided thus providing appropriate medication at right time.
Now even though the user knows which hospital/doctor to visit, he/she may have to carry all the previous medical history documents with them which is not absolutely feasible at all times. This data can be recorded on a platform and can be used for future purpose whenever required.

1.2 Motivation

The motivation behind the detection of brain tumor also extends to the classification of the same. This early detection of the tumor can result a better recovery for the patient and a better analysis system for the doctor. The percentage of confidence of the model in a particular result will also state if further inspection is needed on the case. Apart from the detection, these details will make a patients case easier for the doctor to take a look at. This saves time and money both for both the sides. Having brain tumours is a critical condition and can be fatal if not detected early and treated. Increase in fatality rates because of CNS tumor is an alarm for an efficient segmentation. This has become a crucial task in medical image analysis and is often the first and most crucial step in a good deal of clinical diagnosis.

1.3 Problem Definition & Objectives

1.3.1 Problem Definition

In existing non deep learning methodology ,the main downside of growth detection of images are,Poor discriminatory power, High process load, Loss of edge details because of shift variant property and fewer accuracy in classification Medical Resonance images contain a noise caused by operator performance which might result in serious inaccuracies classification.

1.3.2 Objectives

Our objective is to analyse the current Tumor Detection system in the health sector and develop a web-based system with improved facilities to overcome the limitations.

- Collection and classification of MRI images.
- Database for maintaining records of patients.
- Instant upload and test facility.
- Security of data and accuracy of results is improved.
- Optimized Sorting of data also Editing, adding and updating records is improved which results in proper management of data.

CHAPTER 2

LITERATURE SURVEY

No	Title	Author	Publishing Year
1	Wavelet autoencoder based brain tumor detection analysis using DNN [1]	T.Balamurugan, E.Gnanamanoharan, L.Martin	2021
2	3-D MRI brain tumor segmentation using Auto Encoder regularization. [2]	Andriy Myronenko	2020
3	An efficient Brain Tumor Detection from MRI Images using Entropy Measures [3]	Devendra Somwanshi , Ashutosh Kumar, Pratima Sharma, Deepika Joshi	2020
4	A Review on Brain Tumor Detection and Segmentation: Inferences, Key Achievements and Future Road Map [4]	Devendra Somwanshi , Ashutosh Kumar, Pratima Sharma, Deepika Joshi.	2020
5	A dual Autoencoder and singular value decomposition based feature optimization for segmentation of brain tumor from MRI images.[5]	K. Aswani And D.Menaka	2019

Table 2.1: Literature survey on various approaches papers

2.1 Wavelet autoencoder based brain tumor detection analysis using DNN

Author : T.Balamurugan, E.Gnanamanoharan, L.Martin
Summary : Ultrasonic and MRI images were used for achieving better image enhancing and preserving the image textures. In this work, Deep Neural Network is used for classification and segmentation. This work proposes an image compression technique using a Deep Wavelet Auto encoder (DWA) that combines the ability to minimize the primary function of automatic encoders with the image degradation property of the wavelet transform.
In this work, an unsupervised exploratory was used where efficient de-noising enhancing edge detection and preserving details. The combination of the two has an essential impact on reducing the size of the function set to withstand in addition classification tasks with DNN. A brain system has been eliminated and the proposed DNN- DWAE image classification is considered.

2.2 3-D MRI brain tumor segmentation using Auto Encoder regularization.

Author : Andriy Myronenko
Summary : In this study,n this paper, we have investigated the different Entropy functions for tumor segmentation and its detection from various MRI images. The different threshold values are obtained depend on the particular definition of the entropy. The threshold values are dependent on the different entropy function which in turn affects the segmented results. Using the NVIDIA 32GB GPU they were able to double the number of features compared to 16GB version. Finally, the additional VAE branch helped to regularize the shared encoder, which not only improved the performance, but helped to consistently achieve good training accuracy.

2.3 An efficient Brain Tumor Detection from MRI Images using Entropy Measures

Author : Devendra Somwanshi , Ashutosh Kumar, Pratima Sharma, Deepika Joshi
Summary : Here they have have investigated the different Entropy functions for tumor segmentation and its detection from various MRI images. The different threshold values are obtained depend on the particular definition of the entropy. The threshold values are dependent on the different entropy function which in turn affects the segmented results.

2.4 A Review on Brain Tumor Detection and Segmentation: Inferences, Key Achievements and Future Road Map

Author : Nivedita Swapna Dhanala; Radha D.
Summary : This system will be capable of performing everything right from tumor detection, segmentation, area calculation, and also classification of the tumor thereby reducing the human error to a large extent and will help in on-time detection of the tumor.Though the computation time increases, our proposed model will give accurate results.

2.5 Edge based active contour method

Author : : Deep Gupta
Summary : This paper surveys the various techniques that are part of Medical Image Processing and are prominently used in discovering brain tumors from MRI Images. It has used MRI of skull and brain to detect a disease called as tuberculoma and also to detect some prostatic carcinoma on which segmentation would be performed.
Pros: It Accurately shows the results and also it eliminates the manual requriement and also decreases the processing time needed for execution.
Cons: Algorithm complexity is more, also some relevant images missed as they used the diverse density relevance feedback algorithm. Also manual intervention is required.

CHAPTER 3

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 Introduction

3.1.1 Project Scope

Whenever a person is diagnosed with a disease or any kind of unknown health-related problems. A patient always seeks a third party advice from his/her friends or relatives because he/she is unaware of which hospital or doctor to refer for the best treatment. Often this kind of suggestions are not reliable and may lead to time delay which is very crucial in times of emergency. If we have a recommendation system in place, this type of situations can be avoided thus providing appropriate medication at right time. Now even though the user knows which hospital/doctor to visit, he/she may have to carry all the previous medical history documents with them which is not absolutely feasible at all times. This data can be recorded on a platform and can be used for future purpose whenever required.

Detection of brain tumor with the input of Head MRI images by using Deep Learning. Further extending this use case by attempting to modify/optimize the chosen model, so as to create an optimal model for Head MRIs.
Classification Our final result will consist of a website/webapp that helps to predict the results after uploading the MRIs.

3.1.2 Assumptions and Dependencies

1. We assume that we have optimal data that can be trained, after basic cleaning and preprocessing.
2. Sufficient resources are available for the final training and optimization of the model
3. We have sufficient amount of data that will be enough to train the model optimally.
4. **Dependancies:** We have only considered the case of detecting brain tumors only with Head MRI inputs, other factors in detection are not considered.

3.2 Functional requirements

3.2.1 Input Dataset

The datasets used for the analysis are post contrast T1-weighted MR scans from four publicly available datasets; the Brain Tumor Image Segmentation dataset, Cancer Genome Atlas Glioblastoma Multiform dataset, and The Cancer Genome Atlas Low Grade Glioma dataset and the LGG-1p19q dataset.

3.2.2 Transformed results after training

The final results should be such that they provide a good solution to the problem statement after filtering and segmentation of the data. The solution should help in detecting an early brain tumor. The result when we give an image to the program is a probability that the brain contains a tumor, so we could prioritize the patients who have a higher probability of a positive result

3.2.3 Performance Requiremen

1) **User satisfaction**: The system should be able to determine the confidence of the predicted result so the doctor can analyze it further if needed.

2) **Response time**: the training, the model should be able to update itself and predict the input data faster than it takes to physically analyze the report today.

3) **Application availability**: The appliation should be up and running with minimum downtime

3.3 External interface requirements

3.3.1 Hardware Interfaces

There are no special hardware interface requirements.Since the system is a website; therefore no specific hardware interface is required except for the device being used to open the website should be connected with the Internet.

3.3.2 Software Interfaces

System being a website; the only software required to use the system is a modern web browser. List of supported web browsers is provided in Non-Functional Specification section.

3.4 Non-functional requirements

3.4.1 Performance Requirements

- The system should be more interactive and easy to use.
- It should provide adequate response time and must active all the time.

3.4.2 Software Quality Attributes

1) Accuracy: There should be at least a delta improvement in the performance of the model after addition of more training data, that will get updated as users use the system, and the model will be trained more.

2) Reliability: It is desired that the predictions of the systems are reliable with a high accuracy and precision.

3) Learnability: The learnability of a software system is determined by the user interface design as well as the clarity and simplicity of the user instructions (tutorial or user manual).

4) Speed: System deployment should be such that results are delivered in minimal time

3.5 System requirements

3.5.1 User device requirements

- Any sufficiently recent mobile device or computer will be able to run the application.
- A good internet connection is the only other client side requirement for the system to function properly.

3.5.2 Software Requirements

- NodeJs / Flask / Django: For implementing the backend of the web application. Flask is used for writing web services.
- PyTorch: PyTorch is a deep learning framework written in Python useful for building deep learning architectures.
- Keras: Python API used as an interface for artificial neural networks
- Scikit-learn / Pandas / Numpy: Supporting libraries in Python useful for data analysis and preprocessing.

3.5.3 Hardware Requirements

- Processor (i5 or higher): Fast and efficient systems are needed to handle intensive loads and provide efficient throughput.
- RAM (8GB minimum): Helps in performing fast computations and optimizes execution process.
- Hard disk: 10 GB of available space or more.
- Operating system: Windows

3.6 Analysis Models: SDLC Model to be applied

This project makes use of the waterfall model. It involves the following steps. In a waterfall model, each stage must be finished fully before the next stage can begin. This type of software development model is basically used for small projects and their project not having uncertain requirements.

- SDLC is a process which is followed for any software project, within an organization.
- It consists of a detailed plan describing how to develop the software using the required techniques, how to maintain the software after completion and to replace, alter or enhance specific parts of the project.
- Waterfall model: The Waterfall model was the first process model to be used. It is extremely simple to understand and use, wherein each phase must be completed before starting the next phase. It has no overlapping cycles. There are 6 phases in the waterfall model.

1. **Requirement Analysis**
   During this phase, detailed requirements of the software system to be developed are gathered. We recognize the needs which are essential to developing such an application, namely the different datasets to work upon and the scope and relevant application of our project. The various types of interpretability techniques were studied.
2. **Design**
   This is the phase where the programming language is decided along with other technical details of the project. We designed our project and then decide how the various components of our application can be integrated. We performed the design of our machine learning models in this phase.
3. **Implementation**
   After the design phase, the implementation stage is there, where coding part of the software is performed. Different optimization techniques are used to make the model more accurate and make it more useful as a prediction or segmentation tool.
4. **Testing**
   In this phase, the software which is built is checked that it is built as per the specifications given by the client and that it is working properly.
5. **Deployment**
   In this step, we assure that the environment is up and we can deploy the application in the respective environment. We perform an overall application to ensure the application does not break.
6. **Maintenance**
   Once the system is ready to use, additional changes may be required in the code, later as per customer request. In this phase, if the user finds any problem, we assure to note it and fix the issues that were faced.

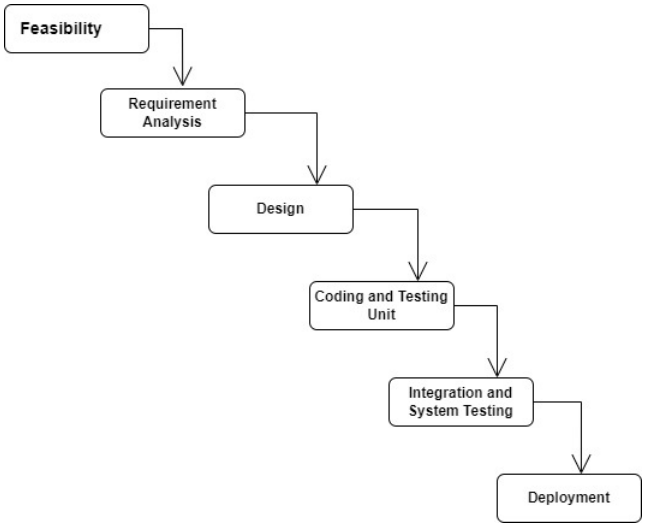


Figure 3.1: SDLC lifecycle

3.7 System Implementation Plan

1) Collection of MRI
The assigned person will be responsible of taking MRI images of the patient who wants to get diagnosed for brain tumor, and the computerised system further makes a database and maps the image with the patient describing his or her details

2) Radiologist
The radiologist maintains the security of the data and provides betterment of security respecting people's identity and to avoid data theft

3) Diagnostic Center
The diagnostic center can get access of this database of patients records and sends it further for processing with the help of the machine learning application.Based over the results classification of severity of tumor is generated and accordingly it is prioritised.

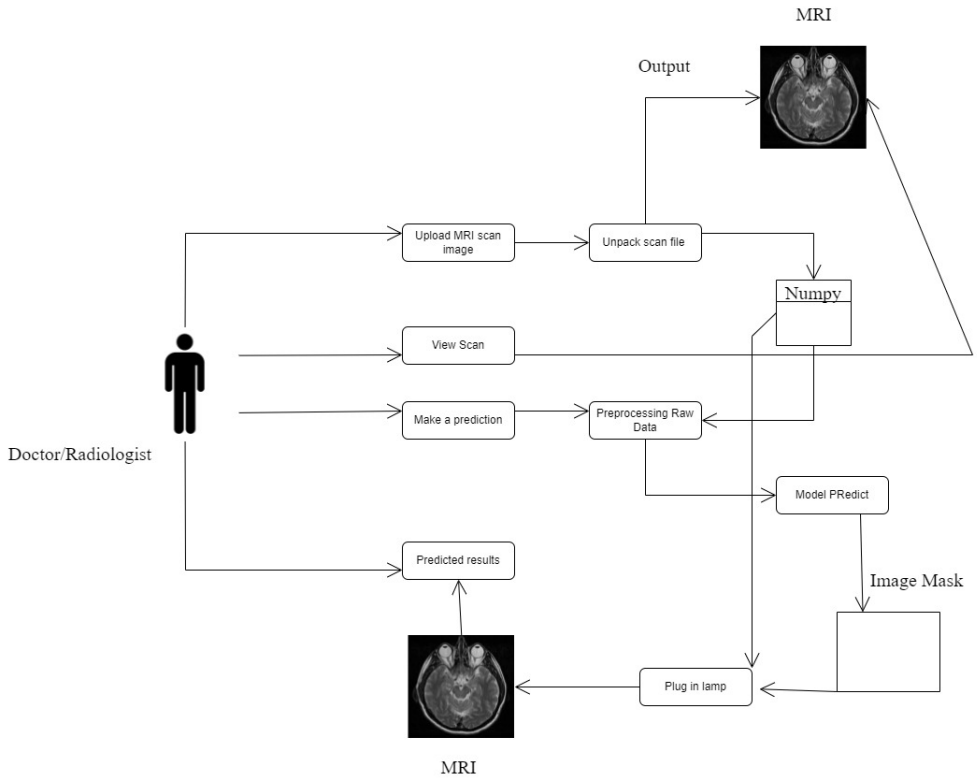


Figure 3.2: Workflow

CHAPTER 4

SYSTEM DESIGN

4.1 System Architecture

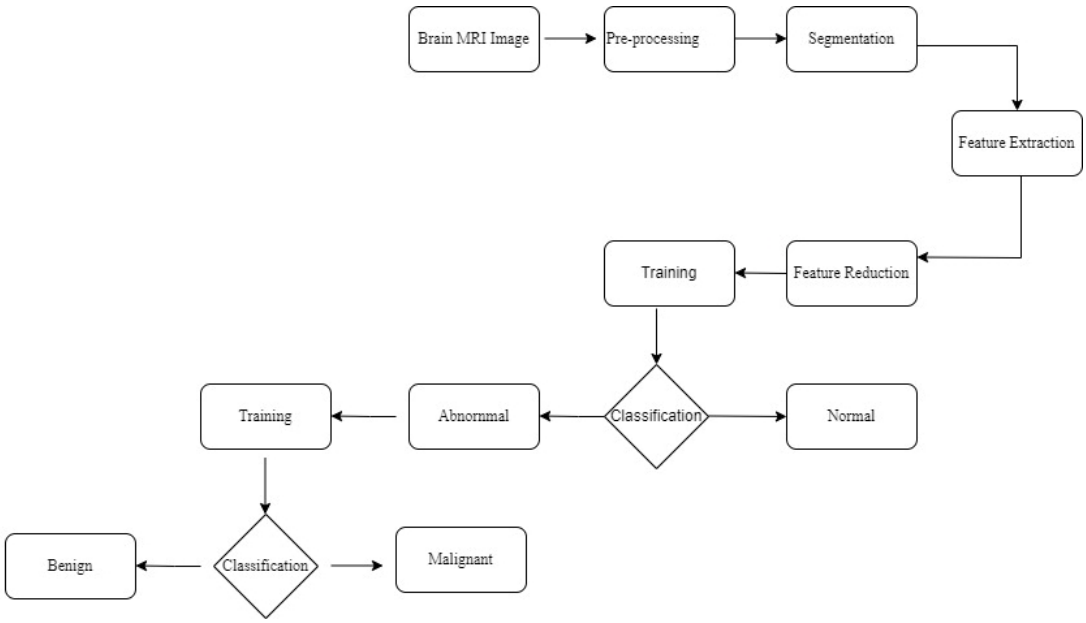


Figure 4.1: System Architecture Diagram

4.2 Data Flow Diagram

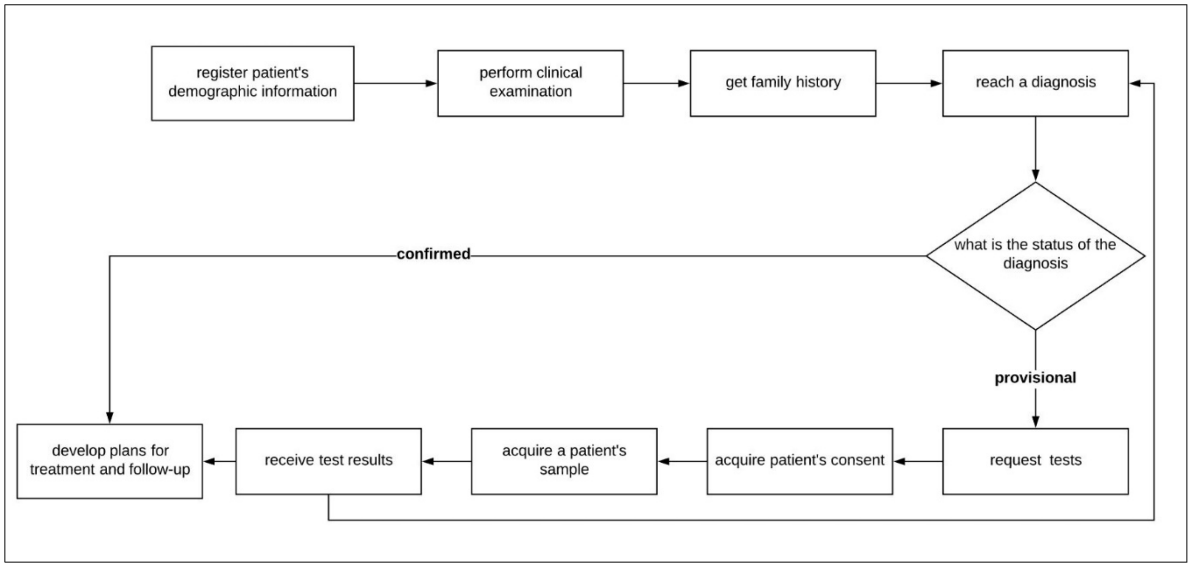


Figure 4.2: Data Flow Diagram Level 0

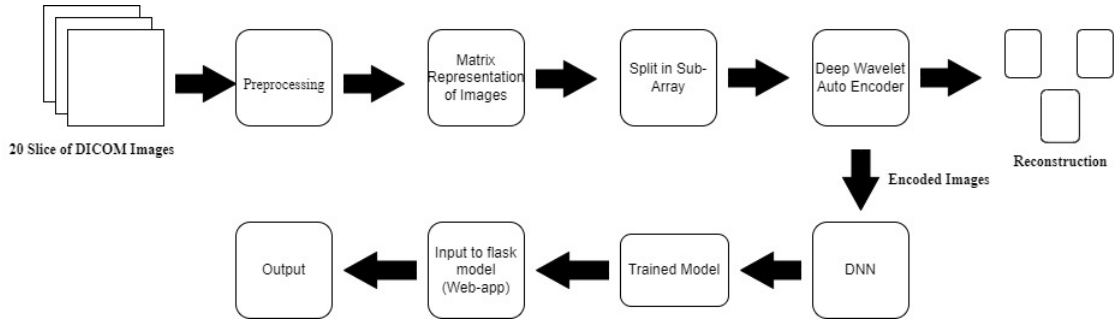


Figure 4.3: Diagram for DWAE

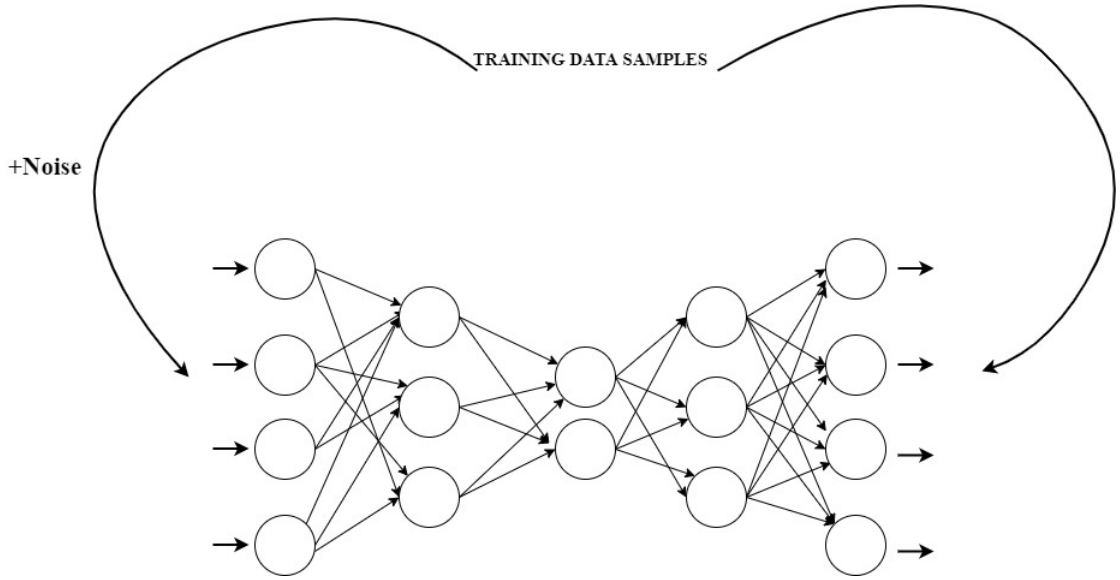


Figure 4.4: Diagram for Denoising technique

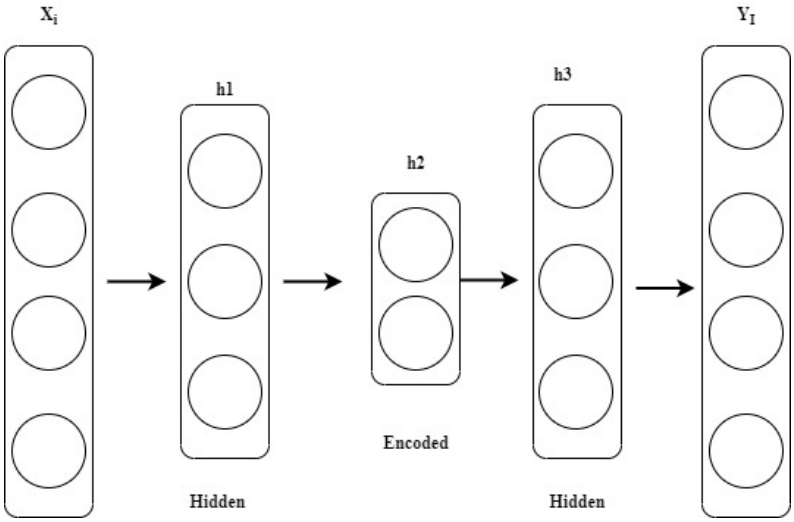


Figure 4.5: Diagram for Schematic Auto-Encoder

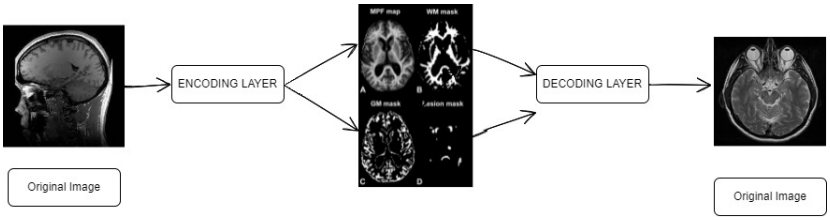


Figure 4.6: DataFlow Diagram for Deep Wavelet Autoencoder

CHAPTER 5

PROJECT PLAN

5.1 Project Estimates

5.1.1 Reconciled Estimates

- Cost Estimate: The software used for the application will incur no cost as it is all released under free open source licenses.
- Time Estimate: 9-10 months

5.1.2 Human Resources

- Number of people : 4
- Skills: Python, Flask, Machine Learning, Rest APIs, MySQL.
- Geographic restrictions: None
- Client: In our project, the users are people belonging to health sectors.
- Stakeholders: Stakeholders are often members of the project team. Considering the project, stakeholders will be the people who will be using the application, i.e, the clients along with project team.

5.1.3 Development Resources

- Data Collection: Through user registrations
- Software:
    1. Flask
    2. Python
    3. VSCode
    4. Anaconda
    5. Sypder
- Hardware : Any 64 bit operating System with compatible browser Chrome, mozilla firefox

5.2 Risk Management

5.2.1 Risk Identification

1. Scope Risk
2. Schedule Risk
3. Integration Risk
4. Technology Risk

5.2.2 Risk Analysis

1. Scope Risk : The continuous change of requirements in interative manner were considered in design.
2. Schedule Risk : The time for study and implementation were found out and extra 1 months time was kept as backup month.
3. Integration Risk : The modular development design was kept consistent and flexible so that integration of various functionalities is not a problem.
4. Technology Risk : Technology support for a new module and improvements is considered.

5.3 Team Organization

The manner in which a team is organized and the mechanisms for reporting are noted. Updates on development of the software is given to the guide on regular basis. Every month a meet is held with the guide to discuss the next project steps in detail.

5.3.1 Team structure

- Sanket Bhatlawande - Model Selection, Training and development
- Jayesh Bhalchim - Model Selection, development and Data Pre-processing
- Amisha Gokhale - ML model testing and development documentation.
- Varun Patil - Web application designing and development documentation

5.3.2 Management reporting and communication

- Team is always in contact with the project guide.
- Team members also collaborate in-person and work together to improve efficiency. Also, chat groups, mails, and online meetings are used for communication.

CHAPTER 6

PROJECT IMPLEMENTATION

6.1 Overview of Project Modules

6.1.1 ALGORITHM

Step1: Pre-processing of DICOM images to extract the specific image matrix only.

Step2: Flattening of image matrices to construct image dataset.

Step3: Splitting of dataset to sub arrays

Step4: for each sub array continue the steps 5 to 9

Step5: Input the image sub array to Deep Wavelet Autoencoder for encoding

Step6: Pass the encoded image through low pass and high pass filter using discrete wavelet transform for decomposition.

Step7: Apply inverse wavelet transform to combine and decode the images to get original image

Step8: Run the Autoencoder for number of epochs to get optimized weight and bias values

Step9: Extract approximation coefficients from the hidden layer, combine them and provide as input to a deep neural network for classification.

Step10: Train the DNN with the inputs provided by step9 and tests the network for different metrics measurement.

Step11: Apply the Train DNN to the Flask Model

Step12: Upload MRI Image to Scan Model to Predict the Different Results.

6.2 Project Plan

6.2.1 Scheduled Followed

SR NO.	TASK	DUE DATE
1.	Literature survey	2nd week of August
2.	Defining problem statement	3rd week of August
3.	Designing class diagrams, E-R diagrams and related models	3rd week of September
4.	Review of design	4th week of September
5.	Finding appropriate dataset	1st week of November
6.	Preparation and cleaning of final structured data.	3rd week of November
7.	Visualizing trends and communicating reports	1st week of December
8.	Selecting the appropriate algorithms	3rd week of December
9.	Complete model testing	3rd week of February
10.	Application development.	2nd week of March
11.	Testing of the application.	2nd week of March

Figure 6.1: Schedule

CHAPTER 7

SOFTWARE TESTING

7.1 Type of Testing

- Unit Testing :
  There are multiple units components in our model. Unit testing is a type of testing used in which individual unit or group of related units are tested. So we have tested the individual modules of our system such as the quiz module, Search place module,Group Recommender module and the user profile module.In case user have clicked on some place then that place gets added to recently viewed place or not this we have done in unit testing part.

- Integration Testing :
  It is a phase in software testing in which the units or modules are combined and tested as a group. This testing done after completion of unit testing. Here we combine the modules which are providing the same kind of functionality in a single unit and then we performed testing on it like we have combine the user profile with group recommender part so that user can join the different groups.We performed the testing on this module to check whether it is giving the group recommendation to the individual user or not.

- System Testing :
  System testing is performed on the entire system, either in accordance with system requirement requirements, functional requirement specifications, or both. System testing examines the system's design and behaviour, as well as the customer's expectations.we have combined the separated modules into a single unit as a system and performed the system testing on it to check whether the system is providing the accurate recommendation to the user in any case if the user is new or existing.

7.2 Test cases

Table 7.1: Unit Testing Test Cases

Sr No.	Functional Test Cases	Actual Output	Expected Output	Test Status
1	Verify if User is Login in the website	User login successfully.	User login successfully.	Pass
2	Verify if the user is able to see the dialogue and initial page.	User can see the initial page	User can see the initial page	Pass
3	Verify if user can upload and select image	User is able to upload image to the application	User is able to upload image to the application.	Pass
4	Verify if user can select and upload the image correctly.	Shows image uploaded status	Shows image uploaded status	Pass
5	Verify if user is able to see the correctly diagnosed image.	user can check the percentage of severity and the classified tumor	user can check the percentage of severity and the classified tumor	Pass
6	Verify if user can logout or go back to homepage	Reversability of actions	Reversability of actions	Pass

CHAPTER 8

Results

8.1 Outcomes

- User can see that he or she is able to upload the image which has to be tested or diagnosed. company criteria.
- The image selected is further sent for processing.
- The user can view the status whether tumor is present or not
- Displaying messages and remedies regarding the tumor.

8.2 Performance Analysis

Parameter	Image 1
Contrast	0.9754
Correlation	0.5409
Dissimilarity	0.2921
Energy	0.5905
Entropy	1.0443
Homogeneity	0.9305
Max.-probability	0.7624
Variance	26.18
Autocorrelation	24.27
Accuracy	93.33
Types of tumors	Glioma Tumour

Figure 8.1: Analysis Result

8.3 Model Analysis Result

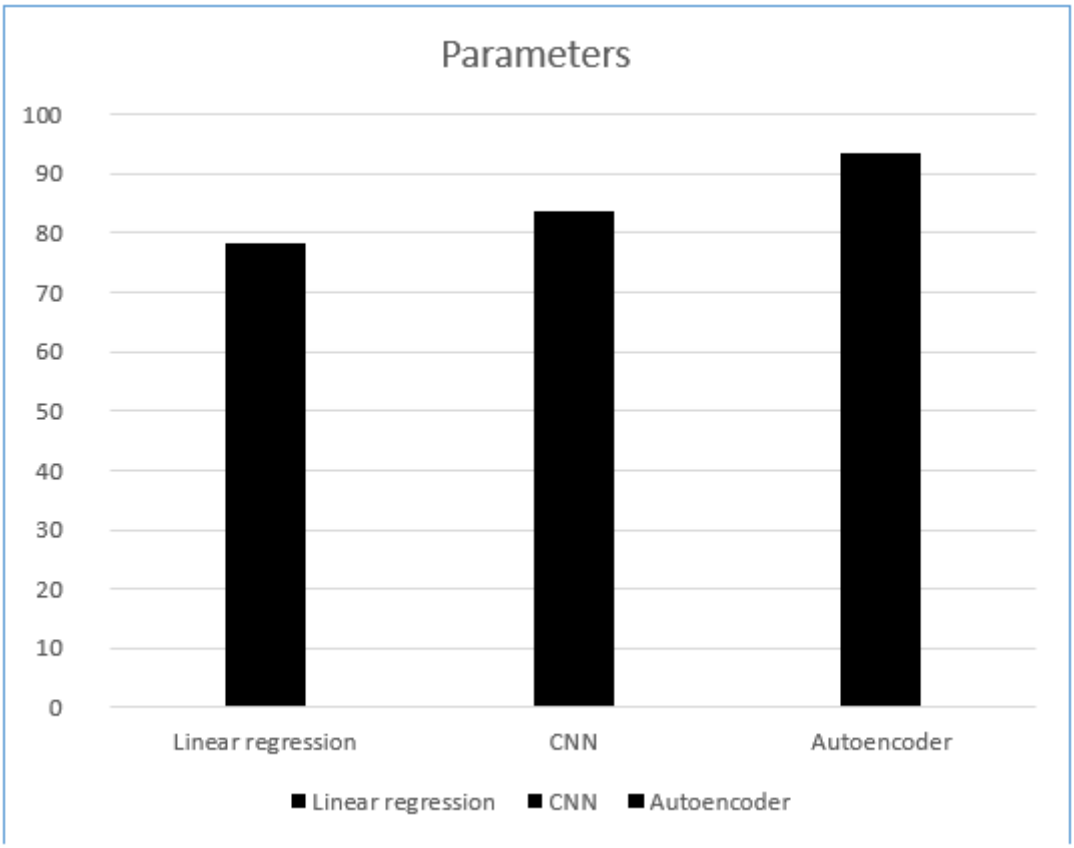


Figure 8.2: Comparison parameters of Model

8.4 Screen Shots

8.4.1 Feature Extraction

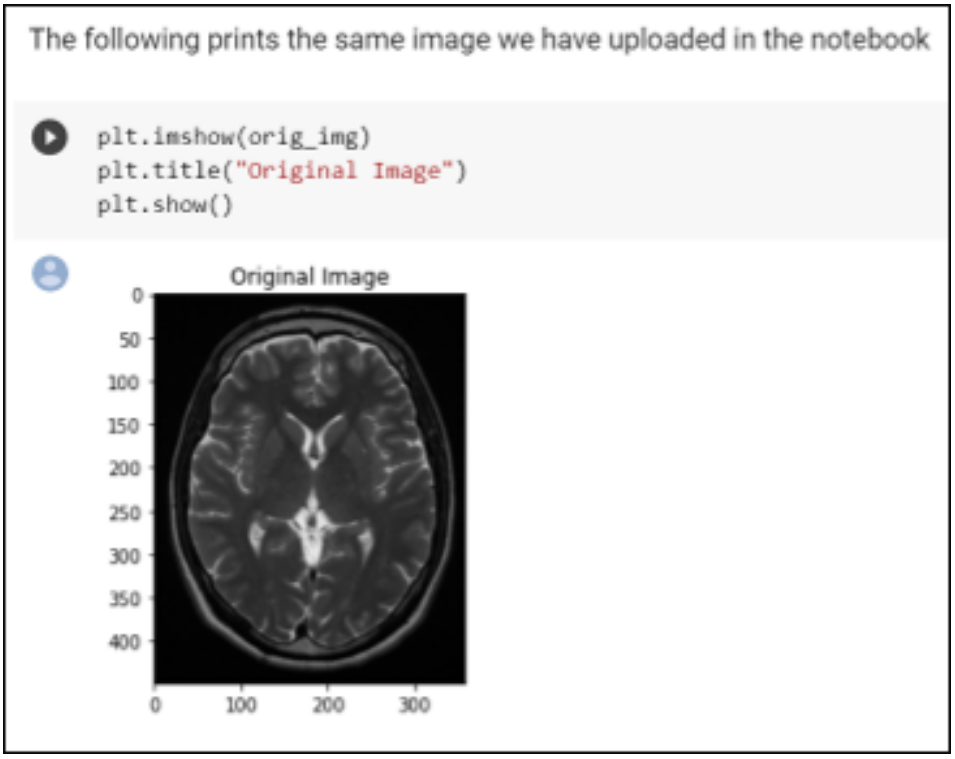


Figure 8.3: Original MRI

8.4.2 Removing Noise

```
# Salt & Pepper Noise
median_filtered = cv2.medianBlur(gray_img, 5)
plt.imshow(median_filtered,cmap='gray')
plt.show()
```

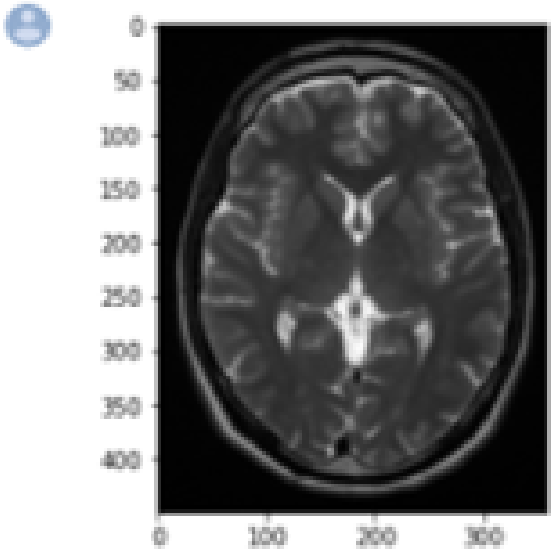


Figure 8.4: Noise Removal

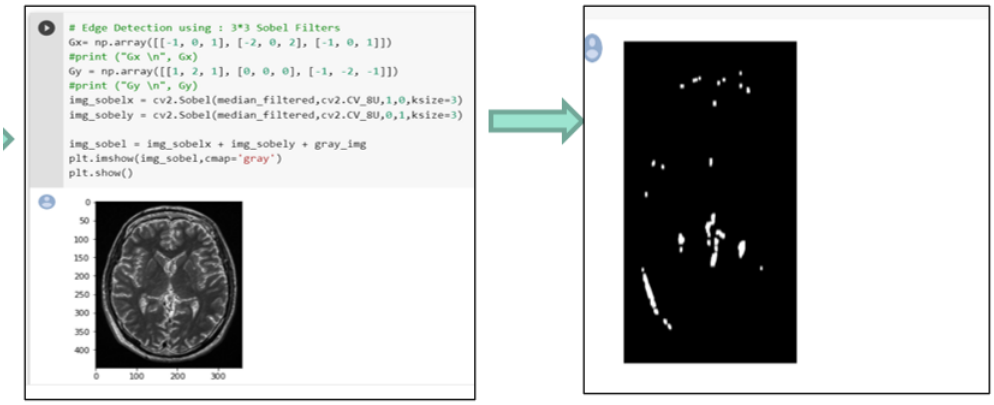


Figure 8.5: Edge detection and Morphological Operation

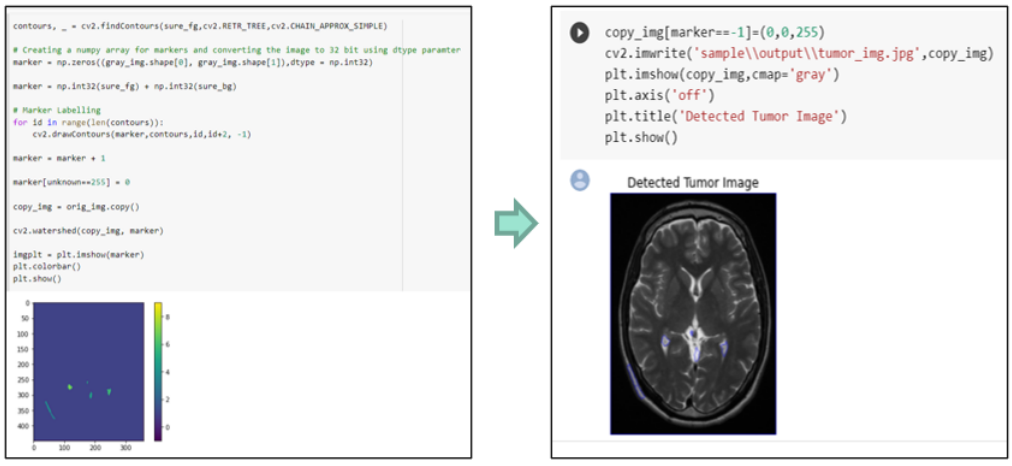


Figure 8.6: Contour Mapping to Detecting Abnormality

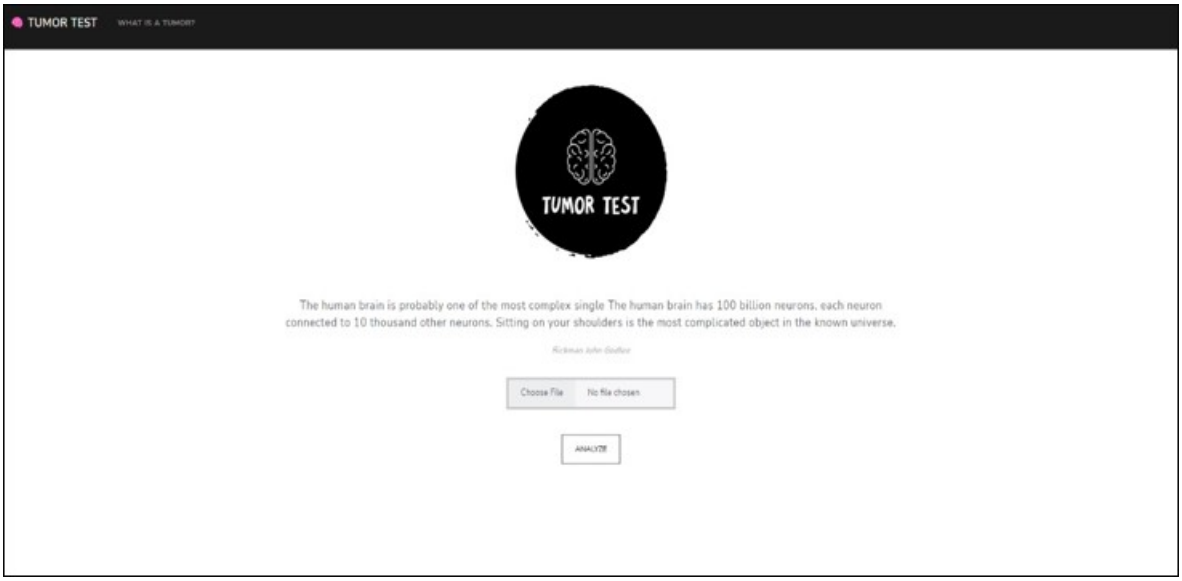


Figure 8.7: Initial Page

Figure 8.8: Meningioma Tumor Detected

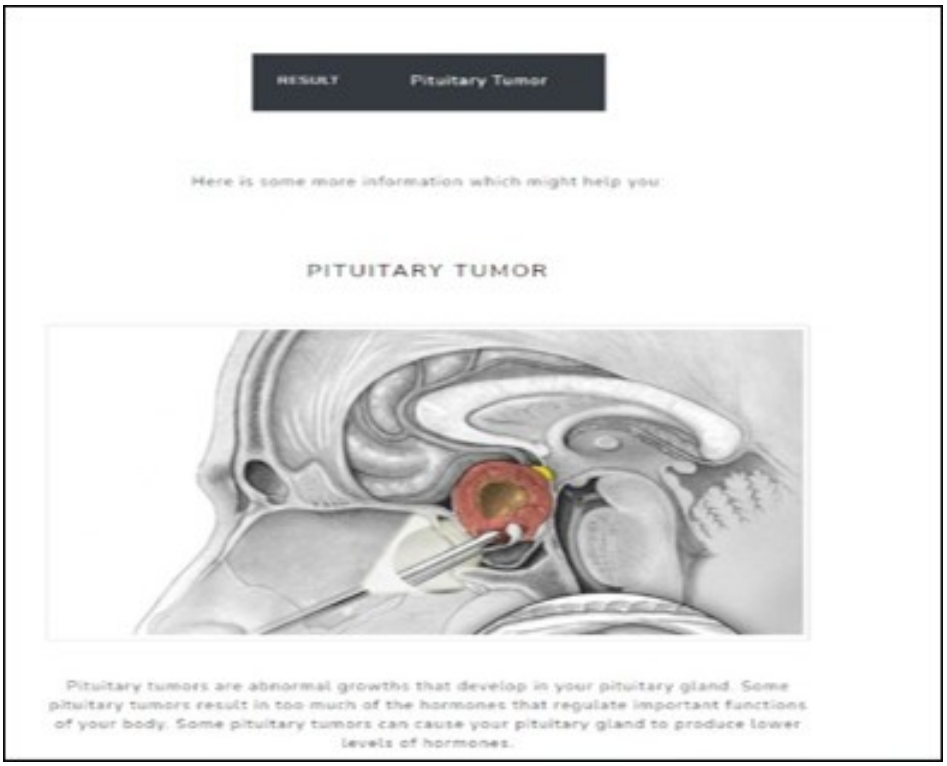


Figure 8.9: Pitituary Tumor Detected

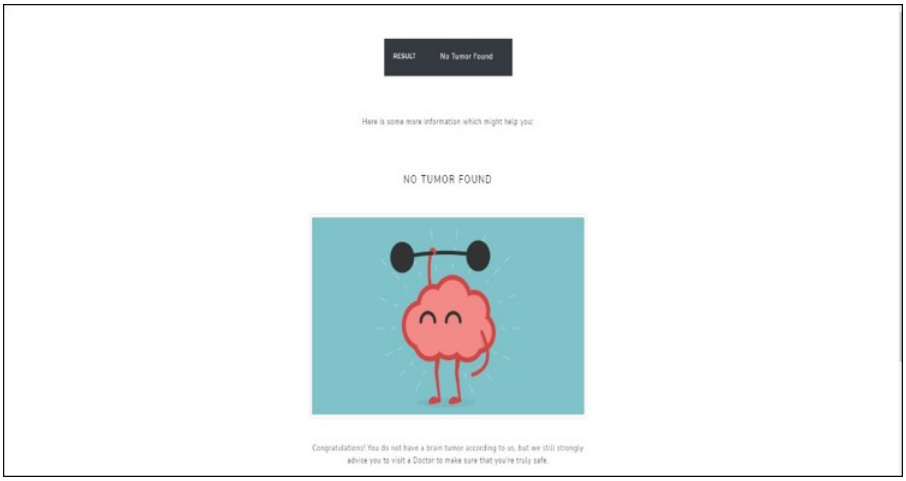


Figure 8.10: No tumor Detected

CHAPTER 9

CONCLUSION & FUTURE WORK

9.1 CONCLUSION

There is no proper tumor detection system as of now in the sector of medical sciences, with the help of technology human errors would be minimised and the whole system will be data driven with zero data manipulation and self feeding data after some period of time. With the help of this, we can do preliminary analysis and this model would be able to give medical analysed results to the patients depending on his or her severity of tumour.

9.2 FUTURE SCOPE

1. With this model, ML + web, we would look forward for tumour diagnosis not just from MRI but also from blood cells and CT scan images as well. With possible inclusion of these two, not just tumour any other anomalies in the brain can be classified as well helping with initial diagnosis.

9.3 APPLICATIONS

a. The system can be used to predict the tumor of a huge dataset.

b. The system can further be used to prioritise patients based on the severity of tumor.

APPENDIX A
MATHEMATICAL MODEL

A.1 Problem Statement Feasibility

Set Theory:
S = $\{s, e, X, Y, \emptyset\}$

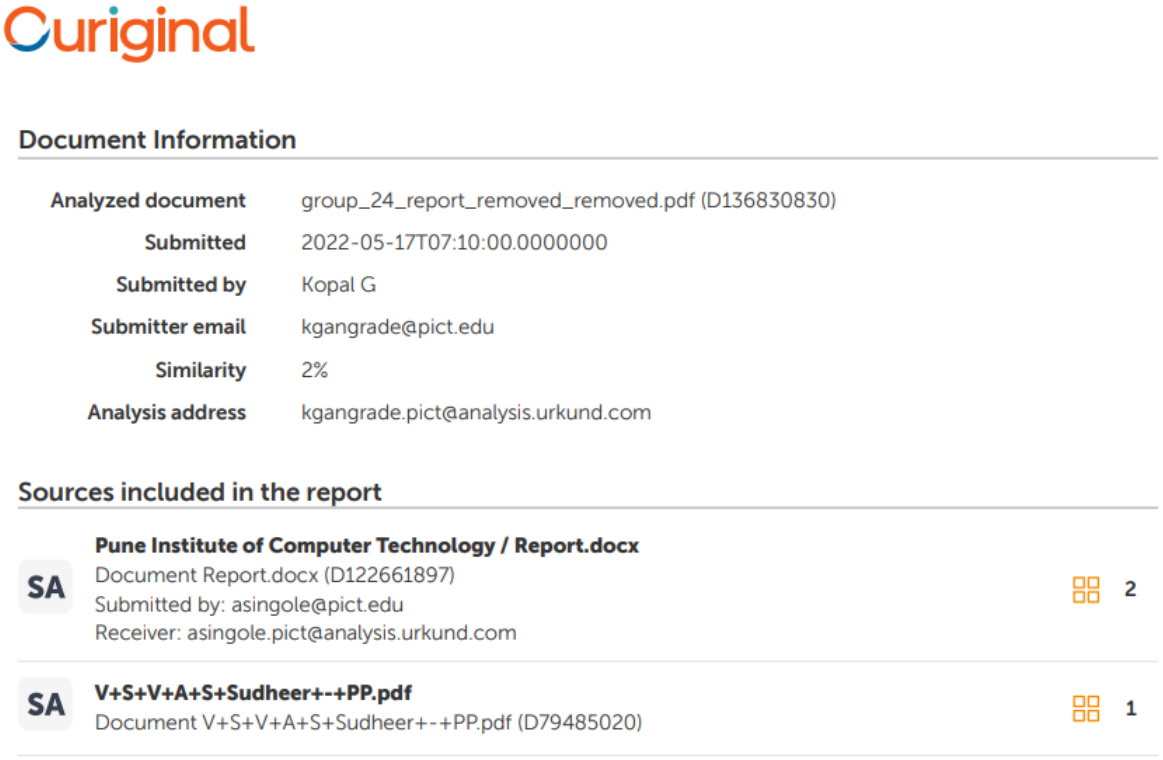
Where,
s = Start of the program.

- Registration
- Login
- Upload Image
- Check for Tumor
- Get the type
- Go back to homepage

e = End of the program.
Resultant output provided by the input data.
X = Input of the program.
Y = Output of the program.

APPENDIX B
PLAGIARISM REPORT

B.1 Plagiarism Report



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1

Figure 9.1: Plagiarism Report

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