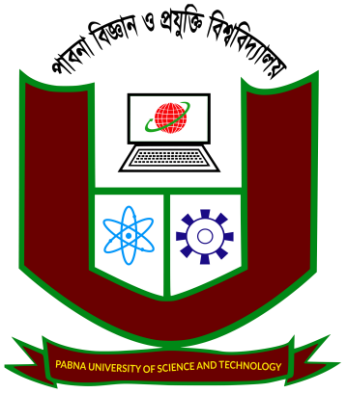
A Capstone Project on

Brain Strokes Detection using Machine Learning and VGG-nets



The project paper is submitted to the department of Information and Communication Engineering for the partial fulfillment of the requirement for the degree of
B.Sc. (Engineering) 3rd year 2nd semester examination

B.Sc. (Engineering) 3rd Year 2nd Semester, Examination-2022

Course Code: ICE-3211

Course Title: Capstone Project/Industrial Tour

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ACKNOWLEDGEMENT

First and foremost, it is imperative for me to express my sincere gratitude to the Almighty Allah for His assistance in enabling me to successfully conduct this research endeavor. Furthermore, I wish to extend my appreciation to my parents and family members whose unwavering support has been a constant source of motivation for me. Additionally, I am thankful to all of my friends for their encouragement and backing throughout this journey.

Moreover, I feel compelled to convey my profound sense of thanks to my esteemed supervisor, Md. Anwar Hossain, Professor in the Department of Information and Communication Engineering (ICE) at Pabna University of Science and Technology (PUST). His scholarly guidance, invaluable supervision, constructive feedback, and insightful discussions have been instrumental in the development and progression of this work. I am deeply appreciative of his decision to allow me the opportunity to pursue this study under his expert supervision.

ABSTRACT

A stroke is triggered by a disruption or decrease in the flow of blood to the brain, resulting in insufficient oxygen and nutrients, leading to the death of brain cells. There exist three primary categories of brain strokes: Ischemic strokes, Hemorrhagic strokes, and Transient Ischemic Attack (TIA). Prior research efforts have utilized MRI image analysis to detect and forecast brain strokes, but these methods have shown limitations in accuracy. In response, we propose a novel approach to enhance the prediction of strokes in the brain through the application of advanced methodologies. This study employs sophisticated methodologies to facilitate the automated prediction of brain strokes, leveraging Magnetic Resonance Imaging (MRI) and Computer-Aided System (CAS). Initially, MRI images of the brain are utilized for stroke prediction. These images undergo preprocessing using Digital Image Processing Methodology, followed by the segmentation of affected brain lesions using Convolutional Neural Network (CNN). Subsequently, various layers such as maxpooling, flatten, dense, dropout layer are utilized, and the data is stored in a database. The Convolutional Neural Network (CNN) is then applied to the database to create a model, make predictions, and assess accuracy. Results are obtained from both training and testing phases, demonstrating an accuracy of 98.02% and a sensitivity of 96.5%. This entire process is executed using machine learning algorithms in Python.

Keywords: MRI images, Convolution Neural Network (CNN), Brain Stroke, Digital Image Processing.

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Chapter 1

Introduction

In this chapter we introduced our research overview, related work, motivation, objective and organization. In section 1.1 we discussed about research introduction; in section 1.2 we discussed about related work; in section 1.3 we discussed about our research motivation; in section 1.4 we discussed about our research objective; in section 1.5 we discussed about the whole research paper organization; in section 1.6 we should give a shot discussion about this chapter.

1.1 Introduction

Brain strokes are a prominent cause of fatality worldwide and the third leading cause in Bangladesh. A stroke transpires when there is an interruption or reduction in the blood supply to the brain, leading to insufficient oxygen and nutrients, resulting in the death of brain cells. The three main types of brain strokes are Ischemic strokes, Hemorrhagic strokes, and Transient Ischemic Attack (TIA). Ischemic strokes are brought about by blockages or narrowing of arteries, with treatment aiming to restore adequate blood flow to the brain. Hemorrhagic strokes occur due to blood leakage into the brain, necessitating the control of bleeding and reduction of pressure on the brain. Transient Ischemic Attacks are described as mini-strokes where blood flow is obstructed from reaching a part of the brain. Global researchers are diligently working on advancing methods to easily and automatically predict brain strokes. This ongoing research utilizes sophisticated mechanisms, features, functions, algorithms, and tools. Physicians rely on Computed Tomography (CT) scans or Magnetic Resonance Imaging (MRI) to detect the affected areas of the brain. In this study, MRI techniques are preferred for their ability to provide clearer brain images compared to CT scans. Following the acquisition of MRI images, preprocessing is conducted using Digital Image Processing techniques to extract features, identify the affected areas, and calculate their sizes. Subsequently, the calculated data and brain image features are stored in a database. The classification of stroke and non-stroke images within the database is carried out using Convolution Neural Network (CNN), yielding more precise results compared to existing methods.

1.2 Related Work

Various researchers have conducted studies on brain strokes in the past; however, the number of studies directly relevant to our research is limited. In this section, we present a discussion of some research works that are related to our own study.

R. Purnita Lakshmi, Melingi Sunil Babu, and Vijayalakshmi [1] proposed a method for voxel-based lesion segmentation using an SVM classifier to enhance the detection of brain strokes. The accuracy, sensitivity, and specificity achieved were 88%, 95%, and 66%, respectively. Their study also categorizes strokes into normal, acute, and subacute levels, overcoming the limitations of the Random Forest Algorithm. S. Keerthana and K. Sathiyakumari [3] introduced a technique for brain stroke segmentation utilizing Fuzzy C-means clustering. This method is designed to detect and extract brain strokes from MRI images of different patients. AbdulRahman Alhawaimil [2] focused on the segmentation of brain stroke images, specifically addressing how to isolate the part of the MRI image corresponding to brain strokes. T. Biswas, M. F. Ahmad Fauzi, F.S. Abas, and H. K. R. Nair [4] presented a study on "Super pixel Classification with Color and Texture Features for Automated Wound Area Segmentation" at the 2018 IEEE Student Conference on Research and Development (SCOReD) in Selangor, Malaysia. This research demonstrates the automatic segmentation of wounded areas in brain strokes using super pixel classification. Darya Chyzhyk and Dacosta Aguayo [5] explored an active learning approach for stroke lesion segmentation in multidimensional MRI data, as discussed in their article in Neurocomputing (ELSEVIER).

1.3 Motivation

We have deliberated on various research papers regarding Brain Strokes. The preceding studies [1,2,3] predominantly concentrate on the segmentation and identification of brain stroke areas. The majority of the papers [1][2] present a remarkable approach for detecting brain strokes through the utilization of MRI or CT scans. These papers solely offer the outcomes of detection or the severity of the stroke situation. Upon reviewing these papers, it becomes apparent that there are areas for enhancement and the incorporation of more advanced elements. Consequently, our focus shifted towards the prediction of Brain strokes based on MRI data through the application of Machine Learning techniques.

1.4 Research Objectives

The aim of this study is to develop a system capable of efficiently detecting and predicting brain strokes with higher accuracy and automation using MRI images. Our goal is to employ more sophisticated methods to enhance existing research on brain strokes, while also exploring the applications of innovative technologies.

1.5 Organization of the Research

In these section we discussed about the organization of the research.

CHAPTER 1: Introduction provides an overview of the background of our work including related work, motivation, and objectives.

CHAPTER 2: Literature Review offers a summary of research literature, a detailed explanation of Digital Image Processing, a synopsis of Brain strokes, the scope of Digital Image Processing, various types of brain strokes, and Discussion.

CHAPTER 3: Methodology and Data Analysis discusses the methods utilized in our research work and presents the workflow. It also introduces new methods and image data.

CHAPTER 4: This chapter presents the results and discussions of our research, which is pivotal. It also evaluates the performance of our work and compares it to other existing classifiers.

CHAPTER 5: Conclusion serves as the final chapter of this paper. This chapter provides a thorough discussion of all workflows along with results analysis. It also briefly outlines future research opportunities in these fields. Lastly, a concise conclusion wraps up our work.

1.6 Discussion

This section serves as the introduction to our study, providing an overview of our research objectives, the relevant prior research conducted by various scholars, and the aims we seek to achieve. Additionally, it outlines the framework and structure of our work.

Chapter 2

Literature Review

In this chapter, our research literature was introduced, focusing on Brain strokes and its various types, as well as Digital image processing and its applications in the field. Section 2.1 delved into the introduction of literature; Section 2.2 explored research literature in the context of Digital Image Processing; Section 2.3 provided an overview of Brain strokes and its various types; Lastly, in Section 2.4, a summary of the chapter was presented.

2.1 Introduction

Research in both non-fiction and fiction literature involves the presentation of a writer's substantiated and validated assertion, necessitating a fundamental review of existing literature for comprehension. The current investigation is centered on Digital Image Processing and Machine Learning, with a particular emphasis on the prediction of Brain Strokes through MRI Analysis, encompassing Ischemic Strokes, Hemorrhagic strokes, and Transient Ischemic Strokes (TIA) within this field of study.

2.2

The study entitled "Prediction of Brain Strokes through MRI Analysis" investigates the application of MRI image processing in the field of Digital image processing, exploring various aspects including different categories of Brain strokes, Magnetic Resonance Imaging, Machine learning, and associated terminology, providing a comprehensive analysis of the subject matter.

2.2.1 Digital Image Processing

Digital Image processing involves the manipulation of digital images using a computer system, focusing specifically on images within the signals and systems subfield. It aims to create a computer system capable of processing images efficiently through algorithms, taking a digital image as input and producing an image as output. This field is experiencing rapid growth in computer science engineering due to advancements in digital imaging technology, computer processing, and storage devices, leading traditional analog users to switch to digital systems for their convenience and cost-effectiveness.

Digital Image processing solution usually involves the following steps:

1. Importing the image using image acquisition tools.
2. Analyzing and modifying the image.
3. Producing an output that could be a modified image or a report derived from the analysis

of the image.

2.2.2 Fields of Digital Image Processing

There are many areas of field in Digital Image processing. The category of these fields of digital image processing are as following :

2.2.2.1 Face Detection

In this approach, significant facial characteristics are identified while disregarding others. The identification of faces can be viewed as a particular instance of detecting object classes. The primary goal of face detection is to locate specific attributes as the positions and dimensions of a predetermined number of faces. Many algorithms face detection concentrate on identifying forward-facing human faces. This also aims address the broader and more challenging issues of detecting faces from multiple viewpoints.

2.2.2.2 Biomedical Image Enhancement & Analysis

Biomedical image enhancement plays a crucial role in the field of biomedical Image diagnosis, with the primary objective being the improvement of the quality of biomedical images. Alongside the traditional digital techniques like Computed Tomography (CT) or Magnetic Resonance Imaging (MRI), older analog imagingmodalitie such as endoscopy or radiography have now transitioned to digital sensors. Digital images are constructed through the arrangement of individual pixels, each representing specific brightness levels or color values. Following enhancement and thorough analysis of biomedical images, they can be effectively processed and objectively assessed.

2.2.2.3 Biometric Verification

Biometrics recognition pertains to the automated identification or authentication of individuals based on their behaviors or characteristics. This method of identification and access control is highly effective in ensuring security measures. The primary objective of implementing biometrics recognition is to guarantee that the services provided are exclusively accessed by authorized users and not by any unauthorized individuals. This innovative technique plays a crucial role in safeguarding sensitive information and preventing potential security breaches.

2.2.2.4 Signature Recognition

Signature verification and recognition is a crucial application that involves determining the authenticity of a signature by comparing it with a set of sample images of the original signatures of the signer. Handwritten signatures are inherently

imprecise, as they often feature rounded corners, imperfectly straight lines, and non-smooth curves.

2.2.2.5 Remote Sensing

Remote sensing involves the retrieval of information signals on a small or large scale from an object or phenomenon without direct physical contact, utilizing wireless real-time sensing devices such as aircraft, spacecraft, satellites, or ships. Essentially, remote sensing encompasses the utilization of various devices to gather diverse data signals for the purpose of obtaining information about a specific object or area. Examples of remote sensing include the supervision of a parolee through ultrasound identification, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), X-radiation (X-ray), and space probes.

2.3 Brain Strokes

In this particular section, we have delved into the topic of brain strokes, exploring the various classifications including Ischemic strokes, Hemorrhagic strokes, and Transient Ischemic Attack (TIA), providing a comprehensive understanding of each type and their distinct characteristics.

2.3.1 Brain Stroke

A stroke is characterized by the interruption or reduction of the blood supply to a specific part of the brain, leading to a deprivation of oxygen and essential nutrients to the brain tissue. Consequently, brain cells commence to perish within a matter of minutes following the onset of a stroke. The brain stands as a remarkably intricate organ responsible for regulating various bodily functions, showcasing the intricate network of neural connections and signaling pathways. In the unfortunate event of a stroke, where blood flow is impeded from reaching the area controlling a specific bodily function, the affected body part will experience a deviation from its normal operational capacity. The impact of a stroke is contingent on numerous variables, such as the precise location of the blockage and the extent of brain tissue damage incurred. Given that each hemisphere of the brain governs the opposite side of the body, a stroke affecting one hemisphere will manifest as neurological impairments on the corresponding side of the body it impacts.

2.3.2 Types of Brain Strokes

There exist primarily three classifications of brain strokes, specifically Ischemic strokes, Hemorrhagic strokes, and Transient Ischemic Attack (TIA). The following discussion will outline Transient Ischemic Attacks, which are characterized as minor strokes resulting from restricted blood flow to a particular region of the brain.

2.3.2.1 Ischemic Strokes

Ischemic strokes result from the obstruction or constriction of arteries, necessitating treatment aimed at reinstating proper blood flow to the brain. Ischemia refers to

significantly diminished blood flow that leads to harm to brain cells. The blockages typically stem from blood clots that may develop in the cerebral arteries or in other blood vessels elsewhere in the body before traveling through the bloodstream and reaching narrower arteries within the brain.

2.3.2.2 Hemorrhagic strokes:

Hemorrhagic strokes result from blood leakage into the brain, necessitating the management of bleeding and the alleviation of pressure on the brain. The leaked blood exerts pressure on brain cells, causing damage, while also impeding the blood flow to brain tissue post-hemorrhage. Blood vessels may rupture, leading to the release of blood into the brain or in close proximity to its surface, thereby creating a space between the brain and the skull. Intracerebral hemorrhage stands as the most prevalent form of hemorrhagic stroke, manifesting when brain tissue becomes inundated with blood subsequent to the bursting of a brain artery.

2.3.2.3 Transient Ischemic Attacks:

Transient Ischemic Attacks, also known as mini strokes, are characterized by the inability of blood flow to reach a specific area of the brain. Similar to ischemic strokes, TIAs are frequently triggered by blood clots or other blockages. Despite their temporary nature, they should be treated as urgent medical situations. These occurrences act as precursors to potential future strokes, signaling the presence of a partially obstructed artery or a clot originating from the heart.

2.4 Machine Learning

Machine Learning stands as a prominent and potent technology in the contemporary world, serving as a means to convert data into valuable knowledge. The past five decades have witnessed a surge in data accumulation, necessitating the use of machine learning to uncover intricate patterns within this vast information. Through the utilization of machine learning techniques, hidden patterns in complex data can be automatically identified,

enabling prediction of future occurrences and facilitating intricate decision-making processes. This technology, often unnoticed in daily interactions, plays a crucial role in various activities, from internet searches to medical advancements such as cancer detection and the development of self-driving vehicles.

2.4.1 Different Types of Machine Learning

There are mainly four types of Machine Learning these are Supervised Learning, Unsupervised Learning, Semi Supervised Learning and Reinforcement Learning. These are discussed below.

2.4.1.1 Supervised Learning

Supervised learning algorithms develop a mathematical model based on training data containing inputs and desired outputs, represented as feature vectors. These algorithms optimize an objective function iteratively to predict outputs for new inputs, enhancing

accuracy over time and showcasing their learning capacity, with classification and regression being common types used based on the nature of the output values.

2.4.1.2 Unsupervised learning

Unsupervised learning algorithms are utilized to identify patterns like grouping or clustering in unlabeled data, eliminating the necessity for labeled data, and are frequently applied in statistics for density estimation and data summarization.

2.4.1.3 Semi Supervised learning

Semi-supervised learning lies midway between unsupervised learning and supervised learning, with researchers discovering that combining unlabeled data with a small amount of labeled data can significantly enhance learning accuracy.

2.4.1.4 Reinforcement learning

Reinforcement learning, a branch of machine learning, focuses on guiding software agents on how to make decisions in order to optimize cumulative rewards, with applications in various fields like game theory, statistics, and genetic algorithms, including its use in autonomous vehicles and games against human players.

2.4.2 Application of Machine Learning

Machine Learning has a wide range of applications, including disease prediction like heart strokes, brain strokes, ulcer prediction, and cancer prediction, as well as virtual personal assistants, email spam filtering, malware detection, search engine result improvement, product recommendations, online fraud detection, and more.

2.4.3 Some common Supervised learning Algorithms

a) Logistic Regression
b) Support Vector Machine
c) Nearest Neighbor
d) Decision Trees
e) Linear Regression
f) Random Forest
g) Naive Bayes
h) Artificial Neural Networks
i) Convolution Neural Networks (CNN)

2.4.5 Convolutional Neural Networks (CNN)

Convolutional Neural Networks (CNNs) are a class of deep learning algorithms particularly effective for analyzing visual data. Unlike traditional neural networks, CNNs employ a specialized architecture that makes them highly suited for image and video processing tasks. A CNN consists of multiple layers, including convolutional layers, pooling layers, and fully

connected layers, each serving a unique purpose in the feature extraction and classification process.

Convolutional layers apply a set of filters to the input image, producing feature maps that capture various aspects such as edges, textures, and patterns. Pooling layers then reduce the dimensionality of these feature maps, retaining the most significant information while reducing computational complexity. The fully connected layers at the end of the network interpret the extracted features and perform the final classification.

CNNs can handle various types of classification problems. In binary classification, CNNs classify inputs into one of two classes (e.g., "cat" vs. "dog"). In multi-class classification, CNNs can categorize inputs into three or more classes (e.g., "cat" vs. "dog" vs. "bird"). Furthermore, CNNs can be used for tasks beyond classification, such as object detection and segmentation, where the goal is to identify and localize multiple objects within an image.

2.5 Discussion

Brain strokes, a cerebrovascular event characterized by an abrupt onset of neurological deficits due to a disruption in the brain's blood supply, stands as a significant contributor to mortality rates globally, emerging as the primary cause of death in various regions, including Bangladesh, where it holds the position as the third leading cause of mortality. Within the realm of cerebrovascular incidents, a myriad of different types of brain strokes exist, each presenting unique characteristics and implications on the affected individuals. Moreover, a crucial aspect that is delved into within this chapter pertains to the delineation of the criteria utilized for classifying these diverse manifestations of brain strokes, shedding light on the diagnostic and prognostic frameworks that guide clinical practice in the realm of neurology. Furthermore, the discourse within this chapter extends to encompass an elucidation of the fundamental principles that underpin the theoretical foundations of the research conducted in this domain, aiming to provide readers with a comprehensive understanding of the conceptual frameworks that inform scholarly inquiry and empirical investigations in the field of cerebrovascular medicine.

Chapter 3

Methodology and Data Analysis

In this chapter we introduced our research Methodology, and Data Analysis description. In section 3.1 we discussed about Introduction of research Methodology; in section 3.2 we discussed about overview of Methodology; in section 3.3 Methodology of proposed Model of work; in section 3.4 we discussed about research Methodology details; in section 3.5 we should give a short discussion of this chapter.

3.1 Introduction

We developed a model which detect and predict Human Brain strokes easily, automatically and more accurately. For detecting and predicting Human Brain Strokes easily we used some new methodology and procedures which provides more accurate result. To develop the model we have to analysis the MRI images of various types of Brain strokes and used some methodology on the MRI images. In this chapter we discussed about the methodology and the procedure that we used for making our model.

3.2 Overview of Methodology

This paper presents an advanced methodology for predicting brain strokes automatically and accurately by utilizing Magnetic Resonance Imaging (MRI) and a Computer-Aided System (CAS). The workflow for stroke prediction is outlined as follows:

1. **MRI Image Acquisition**: Initially, MRI images of the brain are obtained.
2. **Image Preprocessing**: These images are preprocessed using digital image processing techniques to enhance their quality and prepare them for analysis.
3. **Segmentation with Wavelet Transform**: The affected regions of the brain lesions are segmented from the MRI images using Wavelet Transform. This step isolates the stroke-affected areas from the rest of the brain.
4. **HSV Color Space Utilization**: To improve effectiveness, the HSV (Hue, Saturation, Value) color space is used during preprocessing and segmentation.
5. **Feature Calculation**: The area of the affected lesion is calculated and stored in a file for further analysis.
6. **CNN Classifier**: A Convolutional Neural Network (CNN) is employed to create a model, make predictions, and determine the accuracy of classifying the images into "Stroke" and "Non-Stroke" categories. CNNs are particularly effective for image classification due to their ability to automatically learn hierarchical features.
7. **Performance Evaluation**: The results are derived from both training and testing phases using the CNN classifier.

Python's machine learning libraries are used to perform all these activities. The graphical representation of the methodology is shown in Figure 3.1.

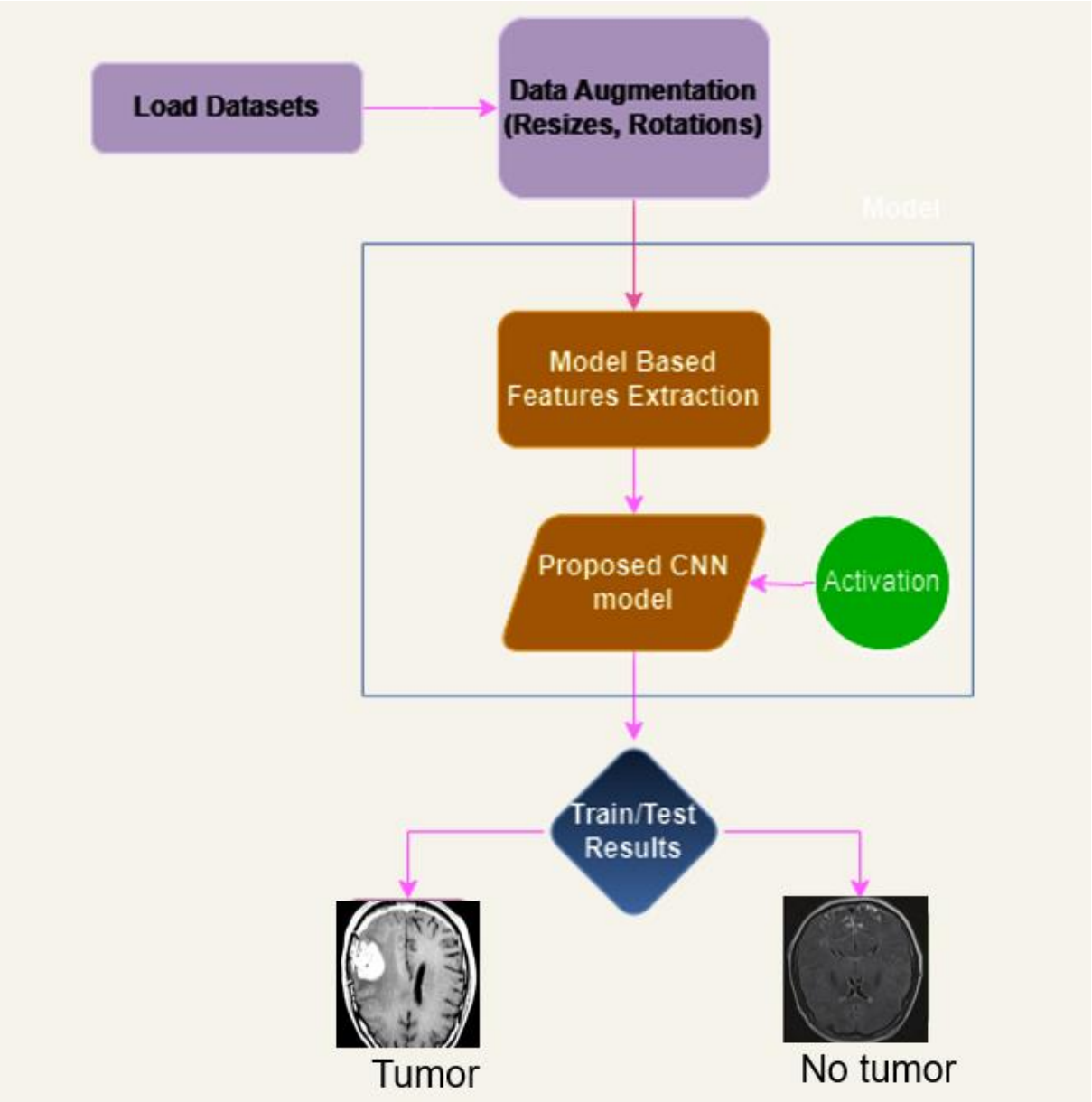


Figure 3.1: Flow Diagram of Proposed Method

Proposed Model Architecture

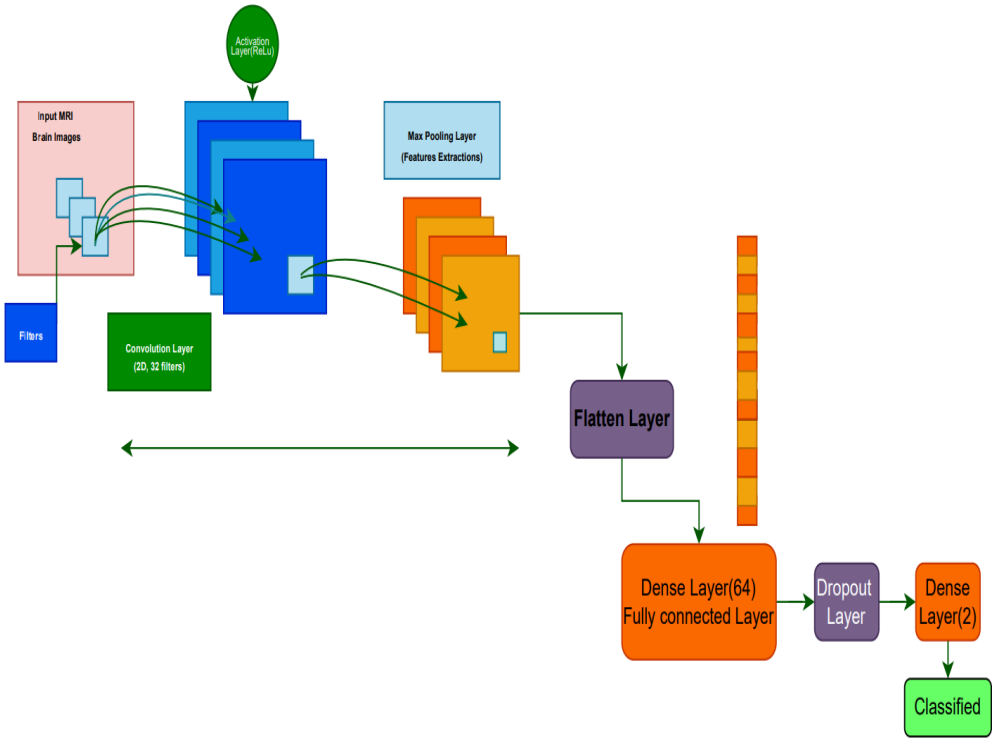


Figure 3.2: Proposed Model Architecture

3.3 Methodology of Proposed Model

To detect and predict Brain strokes, At first we used MRI images of Brain skull. Then we preprocessed these images by using Digital Image Processing Methodology and then we segment the affected part of brain lesion from MRI image by using Convolution 2D, 32 Layer. Then we. Then we used Convolution different layer for creating a model and making prediction and finding accuracy. We discussed below all of the methods that we used.

3.3.1 Magnetic Resonance Imaging – MRI

Magnetic Resonance Imaging is a type of scanning that uses strong magnetic fields and ratio waves to produce detailed images of the inside of the body. Physicians mainly used two types technology for image acquisition from Brain. These are Magnetic Resonance Imaging and Computed Tomography(CT scan). Here in this research work we use MRI technique because its provides more clear image of brain than the CT scan. For this reason, At first we used Magnetic Resonance Imaging for Image Acquisition.

3.3.2 MRI Image Preprocessing

At this stage we preprocess the image by using different Digital Image processing techniques. Firstly we remove noise from the MRI image then we make Gray image from RGB image by using rgb2gray() function.

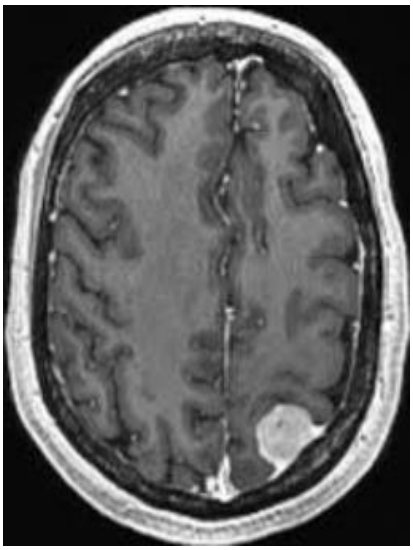


Figure 3.3 : Original Brain Strokes Image

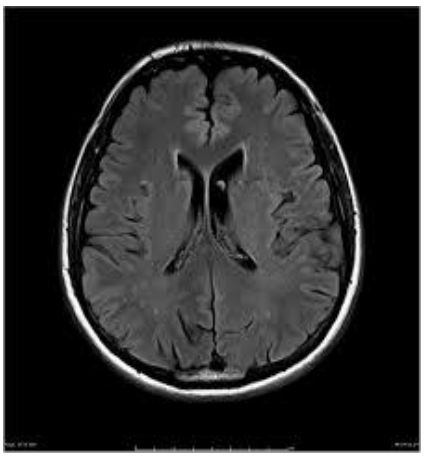


Figure 3.4 : Original No Brain Strokes Image

3.3.3 Features Extraction

Here we applied some convolution layer that's are MaxPooling layer, Flatten Layer , Dense Layer 64 (Fully connected layer) , Dropout layer and finally we used Dense layer (2) that's are identified the brain strokes from the MRI brain images . Its built-in convolutional layer reduces the high dimensionality of images without losing its information. That is why CNNs are especially suited for this use case

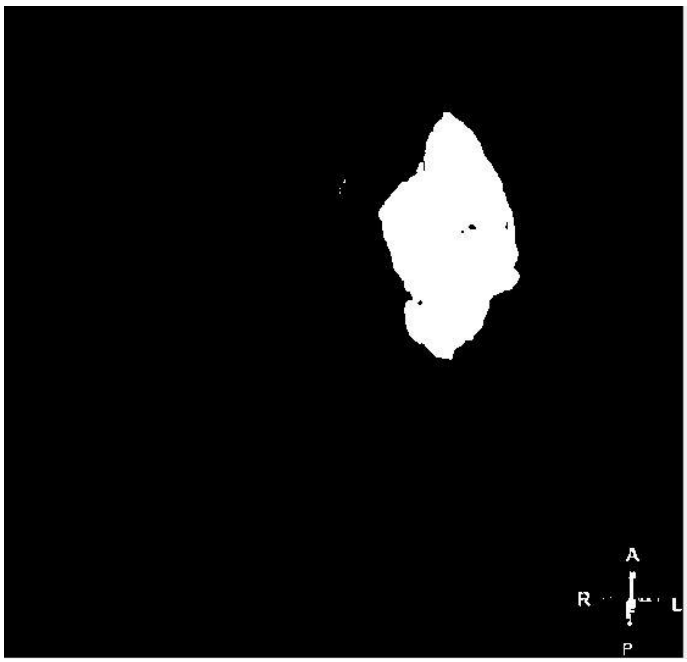


Figure 3.6: Brain Strokes Detected Image

3.3.4 Stroke Feature Extraction Using Convolutional Neural Networks (CNN)

In this method, stroke features of MRI images have been extracted using a Convolutional Neural Network (CNN). The CNN is designed to automatically learn and calculate features such as the mean of hue, standard deviation, mean variance, and the area of the affected stroke portion.

1. **Mean Hue**: In the context of CNNs, the network learns to identify the mean of the dominant wavelength of color pixels in the stroke-affected portion. This feature helps to distinguish the stroke-affected areas from other regions with unwanted colors.
2. **Standard Deviation**: The CNN learns to calculate the standard deviation of pixel intensities, which measures the variation or dispersion of pixel values. A low standard deviation indicates that the pixels are close to the stroke-affected portion, aiding in accurate stroke prediction.
3. **Mean Variance**: Variance is the expectation of the squared deviation of pixel values from their mean. The CNN learns to compute the mean variance, which measures how far the pixel values are spread out. This helps in identifying pixels that are near the stroke-affected area.
4. **Area of Affected Region**: The CNN is trained to detect and measure the area of the brain affected by the stroke. This is crucial for determining the extent of the stroke, whether it is an ischemic stroke or a mini-stroke. Image processing techniques are employed within the CNN to calculate the affected area accurately.

The CNN assigns a specific numerical value to image frames containing stroke portions. In contrast, image frames without any stroke portions have near-zero numerical values. Table 3.1 illustrates some sample results of this analysis.

Type	Mean Hue	Standard Deviation	Mean Variance	Area Of Stroke portion
Strokes	0.0285781144302	0.19379099790	0.0287024094	9005.250
	0.0394353354978	0.29042997100	0.0425652993	8766.250
	0.0184379917233	0.12328608520	0.01567906428	2456.250
	0.0198078609221	0.15678593982	0.02567t10725	8791.125
Non Strokes	0	0	0	0
	0.0038	0.0586	0.0035	0
	0	0	0	0
	0	0	0	0
	0	0	0	0

Table 3.1 : Brain Strokes and Non Strokes feature values

3.3.5 Convolutional Neural Network Classifier

Convolutional Neural Networks (CNNs) are a class of deep learning algorithms particularly effective for classifying images, including differentiating between brain stroke and non-stroke images. Unlike logistic regression, CNNs utilize a specialized architecture designed to automatically extract and learn hierarchical features from raw image data.

For classifying brain stroke and non-stroke images, a CNN classifier has been employed due to its superior performance in handling complex image classification tasks. CNNs are widely used in pattern recognition and have demonstrated exceptional accuracy in various applications, including medical image analysis.

In this method, the CNN is trained using four types of features: mean hue, standard deviation, mean variance, and the area of the affected region. The CNN learns to recognize patterns in these features to accurately classify images into "Stroke" and "Non-Stroke" categories.

To evaluate the performance of the CNN classifier, a 7-fold cross-validation technique has been utilized. This involves partitioning the dataset into seven subsets, training the model on six subsets, and validating it on the seventh, rotating through all subsets to ensure robust performance metrics.

After training, the CNN classifier processes new MRI images, distinguishing between stroke-affected and non-stroke-affected regions with high precision. This automated feature extraction and classification approach enhances the accuracy and efficiency of stroke detection, providing a powerful tool for medical diagnosis.

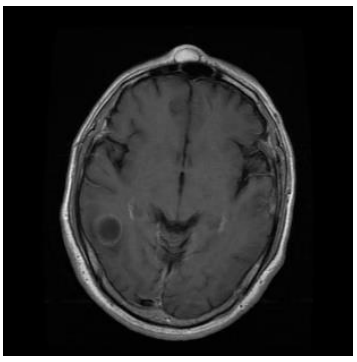


Figure 3.7 : Non Brain Strokes Image

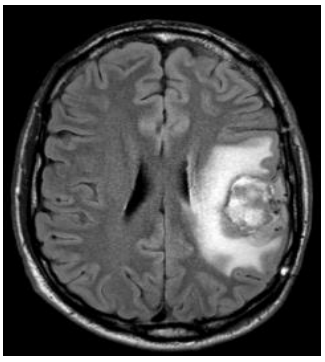


Figure 3.8: Brain Strokes Image

3.4 Discussion

This chapter showed a clear description about the methodology we used for the various analysis of our research. Results and others details will be discussed in next chapter.

Chapter 4

Results and Discussion

The most important chapter, mainly focused about all analysis results and discussion. Section 4.1 we discussed about these chapter introduction; in section 4.2 we discussed result of proposed system; in section 4.3 is the discussion part of this chapter.

4.1 Introduction

This chapter showed the results of Strokes and Non Strokes Magnetic Resonance Imaging-MRI image and what is the performance of this system. Besides we discussed what the procedures we used for getting better results from our proposed model. Also we discussed how better the proposed system is worked than the other existing system. Also showed the performance with the Accuracy ,Sensitivity, Specificity.

4.2 Result of the Proposed System

Here in this research work for classify strokes or non strokes we used a well known Machine Learning Classifier namely Convolution Neural Networks (CNN). The performance of Convolution Neural Networks (CNN) in MRI images is measured by Accuracy, Specificity and Sensitivity which are extensively used to evaluate performances of classification. To obtain the result cross validation is applied. The result is obtained from Confusion Matrix and from two phases these are Training phases and Testing phases.

In Training phase we used 80% images for training model and we obtained results of training model Accuracy is 99%. Then we test the model by using new images about 20% of images of testing model. Then we have obtained the testing model results. The testing model results are the Accuracy of testing model is 98.02% ,

For finding better accuracy, sensitivity and specificity we have taken ten times of calculation result of confusion matrix on different images datasets with different numbers of fold and validation. Then the average value have taken form all ten observations. It helped to find better results of the system.

The Confusion Matrix of Training Phase and Testing Phases is Given below:

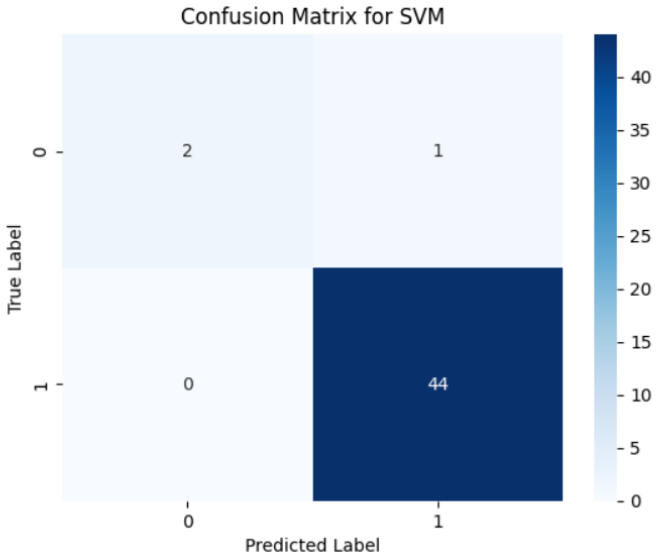


Figure 4.1: The Confusion Matrix

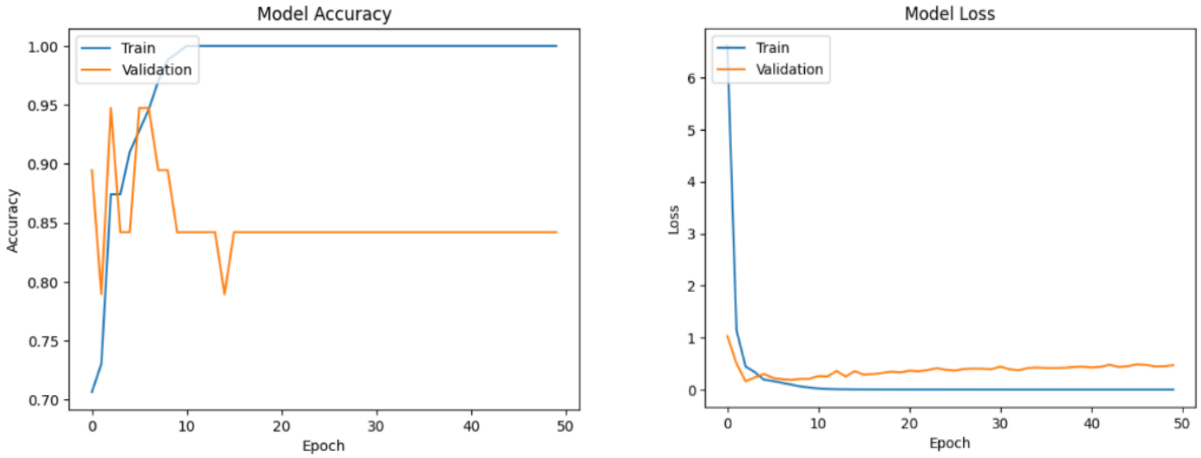


Figure 4.2 : Proposed Model Performance

The formulae of Accuracy, Sensitivity and Specificity is given below.

$$\text{Accuracy} = \frac{\text{True Positive+True Negative}}{\text{True Positive+False Positive+True Negative+False Negative}}$$

$$\text{Sensitivity} = \frac{\text{True Positive}}{\text{True Positive+False Negative}}$$

Number of correct predictions is the sum of strokes and non-strokes images prediction is correct. Number of correct positive predictions is the number of strokes images prediction is correct. Number of correct negative predictions is the number of non-strokes images prediction is correct.

Here, The Accuracy indicate to measure how well the test predicts both strokes and not strokes categories. Its also means the overall accuracy of the proposed model. And The Sensitivity indicates how well the test predicts brain strokes and Specificity indicates how well the test predicts non brain strokes.

Our proposed model has provides 98.02% accuracy that means the model 98.02 of 3500 images accurately predict the brain strokes and non strokes classes. And the Sensitivity of our model is 86.5% that means 86.5 of strokes images of 3500 strokes images are correctly predicted and strokes images are correctly predicted.

And the Specificity of our model is 96.26% that means 96.26 of non strokes images of 100 non strokes images are correctly predicted and 4 non strokes images are not correctly predicted.

The Convolution Neural Network (CNN) results obtained from the testing phase are summarized the table 4.1 and shows the different parameter and parameter's values

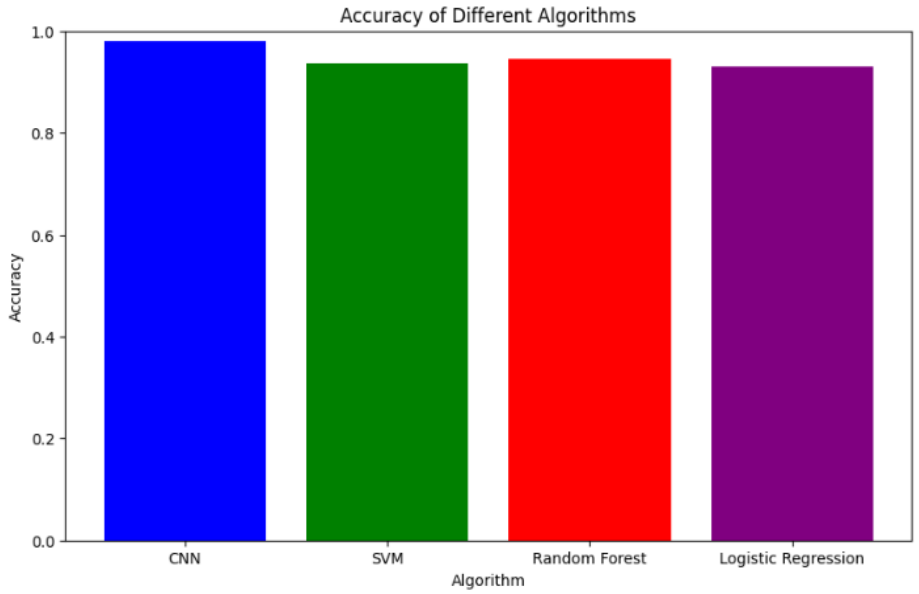
in percentages. In addition, the table 4.2 shows the evidence of higher performance of proposed classifier than the mentioned existing classifier like Random forest[1] and Support Vector Machine (SVM)[1].

Parameters	Values
Accuracy	98.02 ±.05%

Table 4.1 : Results obtained using Convolution Neural Network(CNN) for Strokes prediction

Parameters	Random Forest[1]	SVM[1]	Proposed Classifier (CNN)
Accuracy	94.55%	93.56%	98.02%

Table 4.2: Comparison among different Classifier Algorithm with CNN



Figures 4.3: Comparison among different Classifier Algorithm with CNN

The Convolution Neural Network(CNN) has been showing better performance for this research work model . Here for classification we have taken 5 steps for image classifying these are MaxPooling, Flatten, Dense, Dropout , FullyConnectedDense. For using these features we have been finding more accurate results than the previous research work . We have been finding better performance because we used some statistical method with image processing method which helps to find more accurate outputs of the model.

And finally the area of affected part by strokes is the most important part of predicting brain strokes. It helps to identify how much area are affected which also helps to know the level of strokes that is indicate Ischemic or Mini strokes.For this reason we calculated the affected area by image processing techniques.

4.3 Discussion

In this study we have considered three classification algorithm and also show the performance of classification algorithm. We used an important tool that we used that is Convolution Neural Network(CNN) which help to extract better features. By using Convolution layer we also segmented the strokes part. We use five features(MaxPooling, Flatten, Dense 64, Dropout, Dense 2) that helps to achieve better performance. Convolution Neural Network (CNN) has been showing better performance than SVM[1] and Random Forest[1] Algorithm. The Convolution Neural Network (CNN) has been showing better performance for this research work model.

Chapter 5

Conclusions

We should summarize the problem in this chapter. In section 5.1 we should give a clear discussion about our research and results. In section 5.2 we discussed about the future work opportunities. In section 5.3 we should conclude the whole work in a summary.

5.1 Discussion

Brain strokes is a leading cause of death all over the world and third leading cause in Bangladesh. A stroke occurs when the supply of blood to the brain is either interrupted or reduced. When this happens the brain does not get enough oxygen or nutrients, and brain cell start to die. There are mainly three types of brain strokes namely Ischemic strokes, Hemorrhagic strokes and Transient Ischemic Attack(TIA). Ischemic strokes are caused by arteries being blocked or narrowed ,and so treatment focuses on restoring an adequate flow of blood to brain. Hemorrhagic strokes are caused by blood leaking into the brain so it is necessary to control bleeding and reduced pressure on brain. Transient Ischemic Attacks is referred to mini stokes that means the blood flow cannot reach to the part of the brain. Researchers all over the world are working for making an advance method to predict brain strokes easily and automatically. This research is also a part of these working because we use some advance mechanisms , features, function, algorithm and tools. To detect the affected part of the brain Physicians depends on Computed Tomography(CT) scan or Magnetic Resonance Imaging(MRI). Here in this research work we use MRI technique because its provides more clear image of brain than the CT scan. After taking MRI images we preprocess those images by Digital Image Processing techniques for extracting features. Then we detect the affected part of the image and calculated the area. After that we stored the calculated area and features of the brain image into a Database. Then we use Convolution Neural Network (CNN) for classify strokes and non strokes images of Database. The Method we use has given more accurate output than the existing method. The result of our research work is Accuracy, Sensitivity are about 98.02% ,96.5%respectively.

6.1 Future Work

Our study named ”Prediction of Brain Strokes using MRI Analysis” would be useful for detecting and predicting Brain Strokes more accurately than the existing method. We have showed some strong approach with good features for prediction of brain strokes. There will have an opportunity to used new accessories of image dataset with better quality also can use new technology and new methods which may provide good results.

5.3 Conclusions

This paper proposed a method using convolution layer masking for selecting the strokes portion in MRI images. After selecting the strokes portion in MRI images features are extracted only from the strokes portion. Analysis of strokes features values has been successfully prepared for providing the Convolution Neural Network (CNN) that offers the best separation of strokes and non-strokes images. The method has applied for numerous frames of MRI and found effectiveness. The result has obtained 98.02% accuracy and 96.5% sensitivity which proof that the proposed method is more accurate. The results especially accuracy and specificity encourage that the method can be enhanced in the future by adding more image data base, statistical and texture features descriptor of other color spaces too. This study will help our society people to detect and predict there brain strokes easily and take immediate medical action to prevent abnormal death

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