Analytical Study of Hybrid Modes of Techniques Used to Detect Hydrocephalus from MRI

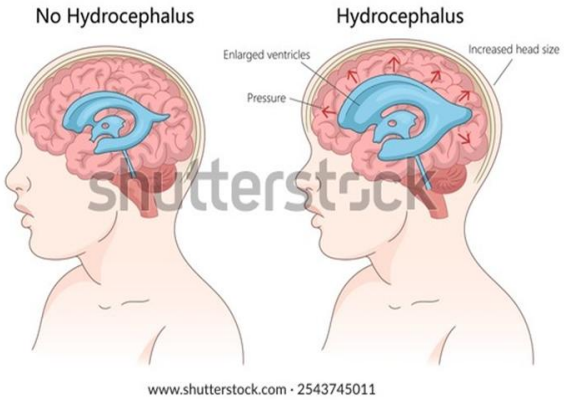
S.V. Rajiga[1], M. Gunasekaran[2]
[1]*Research Scholar, PG and Research Department of Computer Science, Government Arts College (Autonomous), Salem -7*
[2]*Head & Assistant Professor, Department of Computer Science, Government Arts and Science College, Edappadi*

***Abstract*—Hydrocephalus is a condition in which fluid accumulates in the brain, typically in young children, enlarging the head and sometimes causing brain damage. The most common cause of hydrocephalus is obstruction of cerebrospinal fluid (CSF) flow, often due to congenital defects like aqueductal stenosis. In new borns, it is frequently caused by intraventricular haemorrhage (bleeding) related to prematurity. Other major causes include meningitis, tumors, and head injuries. If it is found earlier there is a possibility to cure the disease as well as reduce the risk of disease. In this paper, discussed about three hybrid modes of techniques from Data Mining, Image Processing and Deep Learning. Data Mining concepts used to mine the exact data from the taken MRI image. Image processing techniques used to process the mined data as per the requirement. Deep Learning algorithms finds the exact lesion of the disease and its cause. By applying all these techniques in hybrid mode, it is easy to find the cause of disease and cure the disease in child hood stage itself. From Data Mining Preprocessing and Segmentation techniques used to mine the data. Using Image Processing concept images are scaled upto the necessity. From Deep Learning Conventional Neural Network algorithms are used to categorise the images and predict the risk of the disease.**

***Index Terms*—Hydrocephalus, CSF, Data Mining, Image Processing, Deep Learning, CNN.**

I. INTRODUCTION

Early prediction of hydrocephalus is much important in medical practice. It affects infants commonly. It is easy to diagnose but the most important thing is finding the exact lesion. Hydrocephalus is not a disease but a condition and has several causes. The condition occurs when cerebrospinal fluid builds up in the brain and spinal cord. The pressure from the extra fluid can stop the baby's brain from working properly and lead to brain damage and even death.



II.METHODOLOGY

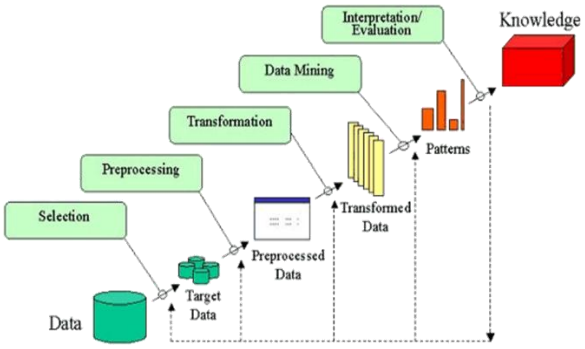
According to the need of diagnose, techniques of Data Mining, Image Processing and Deep Learning are used to find the exact lesion with accuracy. A magnetic resonance image is a non-invasive, radiation-free medical imaging technique that uses a strong magnetic field and radio wave to produce detailed, 3D images of soft tissue, organs and bones. It is primarily used to detect tumors, stroke, joint injuries and brain abnormalities. Here we are using MRI images of infants to predict the exact lesion of hydrocephalus.

2.1. Data Mining

Medical Data Mining has great potential for exploring the hidden patterns in the data set of medical domains. The key steps involved in knowledge discovery process is

a) Data Selection: Identify and select relevant data from various source for analysis.

b) Data Preprocessing: Clean and transform the data to address errors and inconsistencies making it suitable for analysis.
c) Data Transformation: Convert the cleaned data into a form that is suitable for data mining algorithm.
d) Data Mining: Identify patterns and relations in data by selecting appropriate algorithms and models.
e) Pattern Evolution: Evaluate the identified patterns in making predictions and decisions.
f) Knowledge Refinement: Refine the knowledge obtained to improve accuracy.
g) Knowledge Dissemination: Share the result in easily understandable format.



2.2. IMAGE PROCESSING

Image Processing is a method of performing operations on an image to enhance it or extract useful information using algorithms for task like noise reduction, contrast adjustment and object detection. It converts images into digital forms to analyze, compress or improve them for fields like medical imaging and robotics.

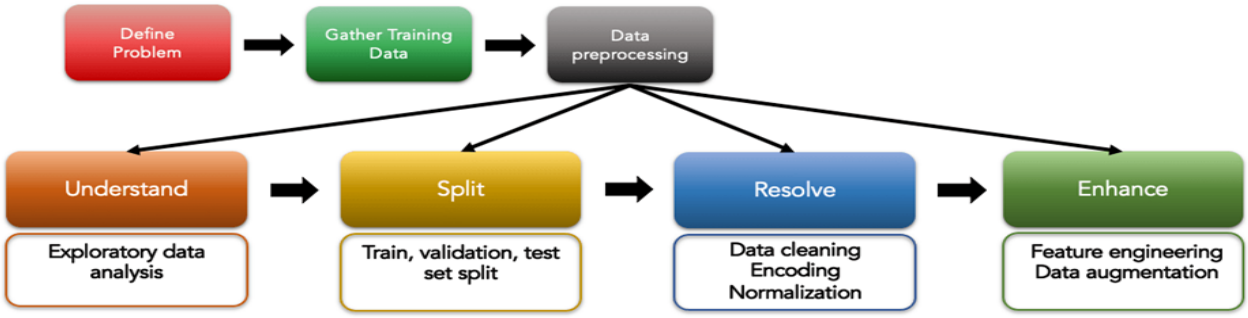
2.2.1.Examples of Image Processing

a) Medical Image (MRI / CT scans): Enhancing contrast to allow doctors to identify tumors or broken bones.
b) Object Detection: Identifying license plates, faces or obstacles in autonomous driving system.

2.2.2.Key Techniques

a) Image Enhancement: Improving image quality for human viewing such as sharpening etc,.
b) Image Segmentation: Partitioning an image into segments to simplify and analysis.
c) Image Restoration: Removing noise or blur to restore the original image
d) Image Compression: Reducing file size by maintaining its quality.

The main common three types of image processing are Image Enhancement, Image Restoration, Encoding and Compression. Image processing is the process of manipulating digital images. It includes list of techniques.



2.3. DEEP LEARNING

Deep learning has revolution the world of computer vision such that the ability for machines to see and interpret the world around them. In particular, Convolutional Neural Network (CNN) were designed to process image data more efficiently than traditional methods.

Deep Learning is a type of Machine Learning that uses artificial neural network to learn from data. CNN are deep learning models designed to process data with grid like topology such as images. The four hidden layers of CNN are The Convolutional Layer, The Pooling Layer, The Fully Connected Layer and The Dropout Layer.

A CNN or ConvNet is a deep learning algorithm designed to automatically and adaptively learn spatial hierarchies of feature from data primarily images using Convolutional Layers.

2.3.1.Key Components

a) Convolutional Layer: The core building block that uses filters(kernals) to perform convolution operations, creating future maps that highlight detect patterns.

b) Pooling Layers: Reduces the dimensionality down sampling of future map, mining computational load and controlling overfitting.
c) Fully Connected Layers: Take high level features extracted by convolutional layers to classify the input into various categories.
d) Activation Function: Typically uses rectified linear unit (ReLU) to introduce non-linearity, allowing the model to learn complex patterns.

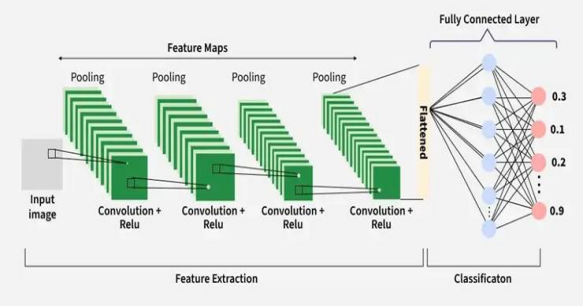
2.3.2.Common Usage

a) Image Classification: Identifying the main object in an image.
b) Object Detection: Identifying and locating multiple objects within an image such as self-driving cars for spotting pedestrians and traffic lights.
c) Medical Image Analysis: Detecting tumors or anomalies in X-Rays and MRIs.
d) Facial Recognition: Identifying faces in security systems or photo tagging.

CNNs can be used for variety of task including image classification object detection and semantic segmentation. Some notable CNN architecture include LeNet-5, AlexNet,VggNet and ResNet, InceptionNet, DenseNet, MobileNet.

2.3.3.Working of CNN

a) Input Image: CNN receives an input image which is pre-processed to ensure uniformity in size and format.
b) Convolutional Layers: Filters are applied to the input image to extract features like edges, textures and shapes.
c) Pooling Layers: The feature maps generated by the convolutional layers are down sampled to reduce dimensionality.
d) Fully Connected Layers: The down sampled feature maps are passed through fully connected layers to produce the final output, such as a classification label.
e) Output: The CNN outputs a prediction, such as the class of the image.



2.3.4.CNN Working Steps

a) Data Preparation: The training images are preprocessed to ensure that they are all in the same format and size.
b) Loss Function: A loss function is used to measure how well the CNN is performing on the training data. The loss function is typically calculated by taking the difference between the predicted labels and the actual labels of the training images.
c) Optimizer: An optimizer is used to update the weights of the CNN in order to minimize the loss function.
d) Back Propagation: Backpropagation is a technique used to calculate the gradients of the loss function with respect to the weights of the CNN. The gradients are then used to update the weights of the CNN using the optimizer.

2.3.5. Evolution of CNN Model

a) Accuracy: Accuracy is the percentage of test images that the CNN correctly classifies.
b) Precision: Precision is the percentage of test images that the CNN predicts as a particular class and that are actually of that class.
c) Recall: Recall is the percentage of test images that are of a particular class and that the CNN predicts as that class.
d) F1 Score: The F1 Score is a harmonic mean of precision and recall. It is a good metric for evaluating the performance of a CNN on classes that are imbalanced.

2.3.6. Application

a) Image Classification: CNNs are the state-of-the-art models for image classification. They can be used to classify images into different categories such as cats and dogs.
b) Object Detection: It can be used to detect objects in images such as people, cars and buildings. They

can also be used to localize objects in images which means that they can identify the location of an object in an image.

c) Image Segmentation: It can be used to segment images which means that they can identify and label different objects in an image. This is useful for applications such as medical imaging and robotics.

d) Video Analysis: It can be used to analyse videos such as tracking objects in a video or detecting events in a video. This is useful for applications such as video surveillance and traffic monitoring.

2.3.7. Advantages

a) High Accuracy: They can achieve high accuracy in various image recognition tasks.

b) Efficiency: They are efficient, especially when implemented on GPUs.

c) Robustness: They are robust to noise and variations in input data.

d) Adaptability: It can be adapted to different tasks by modifying their architecture.

2.3.8. Disadvantages

a) Complexity: It can be complex and difficult to train, especially for large datasets.

b) Resource Intensive: It require significant computational resources for training and deployment.

c) Data Requirements: They need large amounts of labeled data for training.

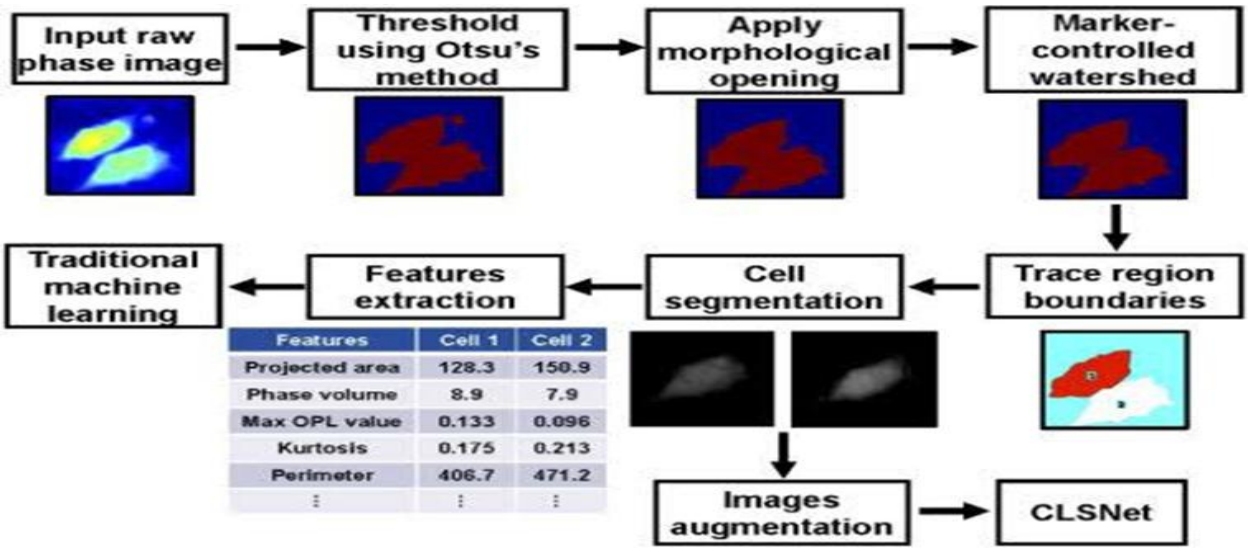
d) Interpretability: They can be difficult to interpret making it challenging to understand their predictions.

III.DISCUSSIONS

As discussed in methodology section data mining, Image Processing and Deep Learning plays vital role in detecting the hydrocephalus in infants using Magnetic Resonance Imaging. All the techniques of the above discussed concept are used to find the exact lesion of disease. So commonly any one of the techniques are implemented to find the lesion of any of the disease. That's why the major role of these techniques is used and implemented medical platforms. All these techniques are considered as more effective to produce the accurate results.

Data Mining focuses on structural data set such as data bases and transaction records, while image mining processing deals with unistructural visual content, requiring advanced feature extraction pattern recognition and machine learning methods. Data mining discovers previously unknown pattern while machine learning is used to reproduce known patterns and apply them to decision making. Deep learning uses neural networks with many layers enabled by increased computing power to learn complicated patterns in large amount of data.

In contrast to traditional image processing techniques deep learning helps to achieve greater accuracy in task such as object detection, image classification, simultaneous localization and mapping and semantic segmentation.



IV.CONCLUSION

In this paper, it is clearly analysed that how various data mining, image processing and deep learning concepts are used to detect hydrocephalus in step-by-step manner. Also, this paper provides a marginal overview of image mining which is simply an expansion of data mining in the field of image processing. It also studied that how deep learning concepts helps to find cerebrospinal fluid in MRI of brain. The purpose of the study was to analyse and investigate features extracted from MRI in predicting the disease. The final process of comparison analyses the place of disease and its occurrence.

REFERENCES

[1] Z. N. K. Swati *et al*., "Content-based brain tumor retrieval for MR images using transfer learning," *IEEE Access*, vol. 7, 2019.

[2] S. Huda *et al*., "A hybrid feature selection with ensemble classification for imbalanced healthcare data: A case study for brain tumor diagnosis," *IEEE Access*, vol. 4, 2017.

[3] E. M. Ali, A. F. Seddik, and M. H. Haggag, "Classification of hydrocephalus using TANNN," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 5, no. 11, 2015.

[4] I. Despotovic and B. Goossens, "MRI segmentation of the human brain: Challenges, methods and applications," *Computational and Mathematical Methods in Medicine*, vol. 2015, 2015.

[5] T. H. Manoj, M. Gunasekaran, and W. Jaisingh, "A BrainNet classification technique based on deep convolutional neural network for detection of brain tumor in FLAIR MRI images," *International Journal of Engineering and Advanced Technology*, vol. 9, no. 1, pp. 3264–3269, 2019.

[6] R. Sathish Kumar *et al*., "Region-based object extraction using adaptive neuro-fuzzy inference system combined with support vector machine," *Asian Journal of Research in Social Sciences and Humanities*, vol. 7, no. 2, pp. 412–427, 2017.