MRI-based Brain Tumour Detection Using Hybrid CNN-ANN Model

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Introduction

A brain tumour is an abnormal growth of cells in or near the brain, categorized into types based on the cell origin, including glioma, meningioma, and pituitary tumours. Magnetic Resonance Imaging (MRI) provides detailed structural images, making it an essential tool for diagnosis. In this work Hybrid Convolutional Neural Network - Artificial Neural Network Model is proposed for the classification of MRI images of brain tumours into four classes: Glioma, Meningioma, Pituitary and Healthy brain.
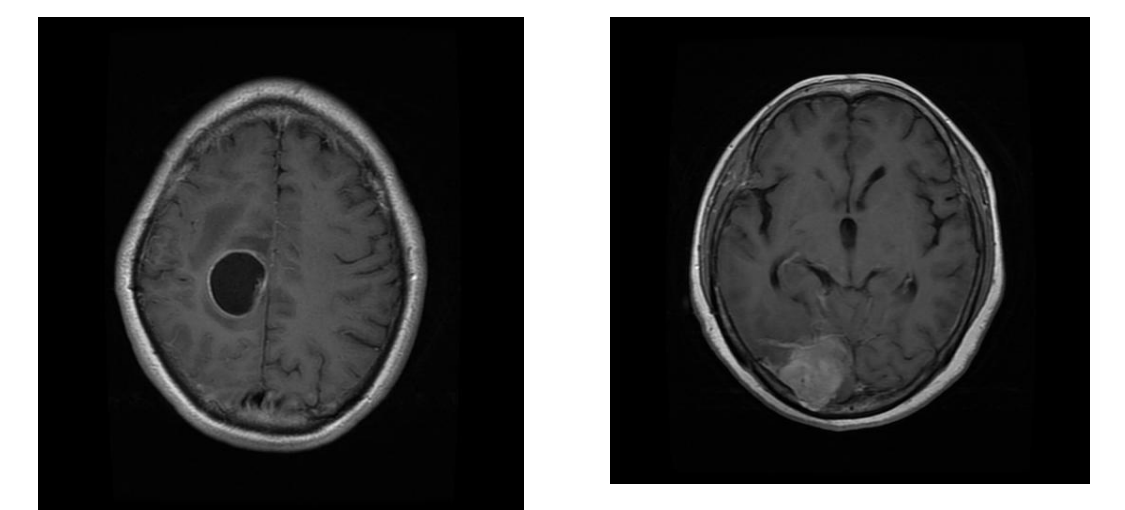
Dataset

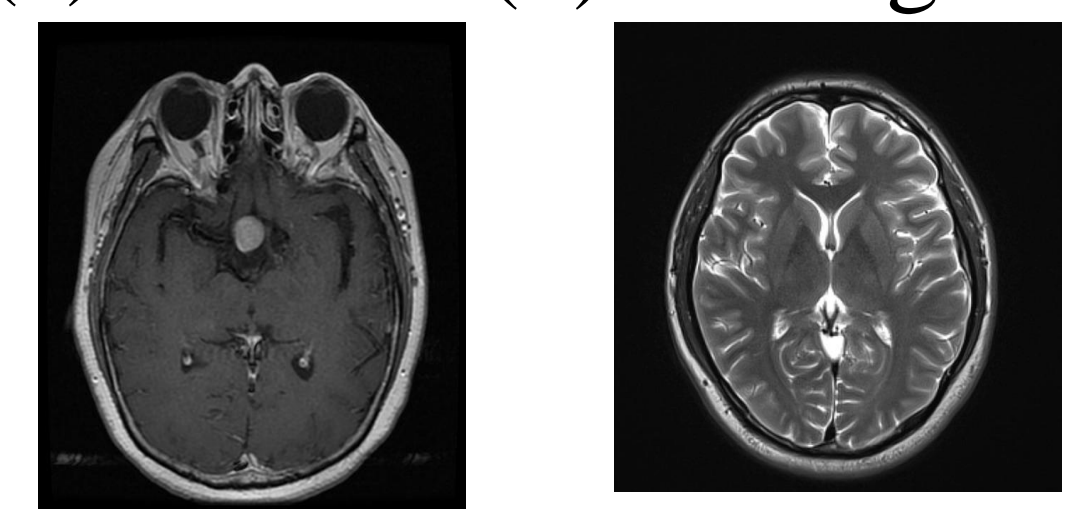Publicly available Brain Tumor MRI Dataset from Kaggle.

Glioma: 1631 Images

Meningioma: 1645 Images

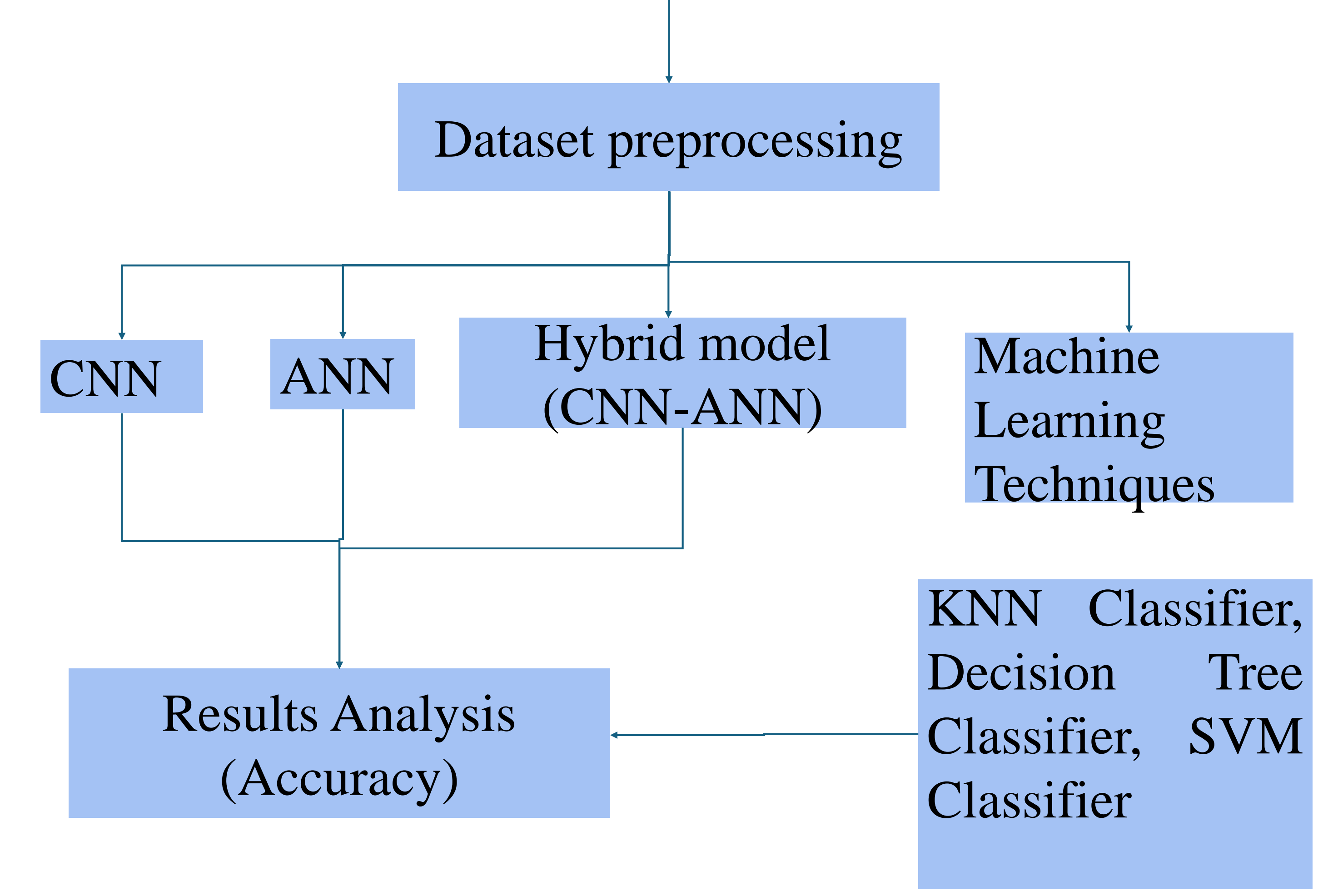Pituitary: 1762 Images

Healthy brain: 2000 Images
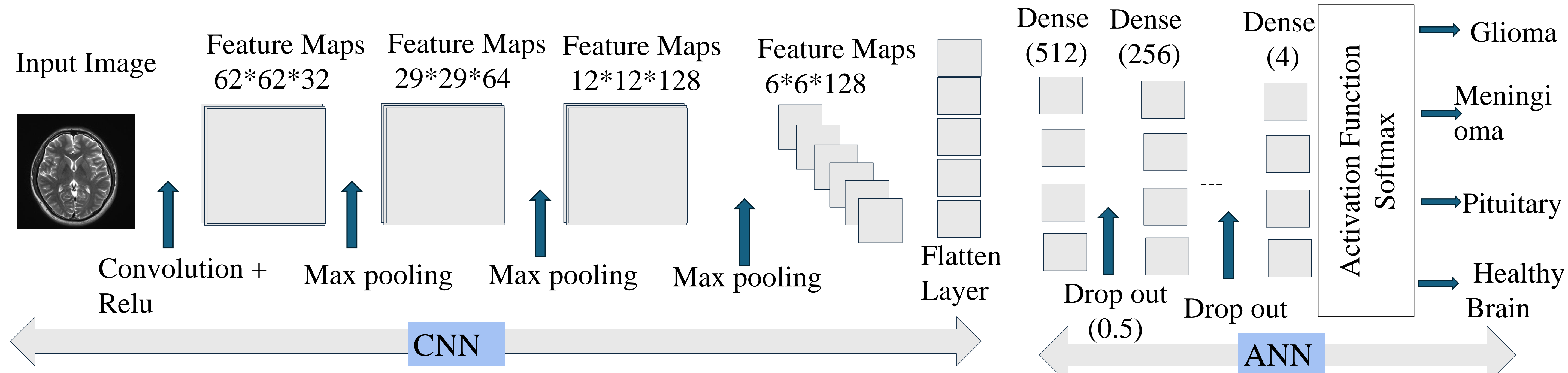

(a) Glioma (b) Meningioma
(c) Pituitary (d) Healthy Brain

Methodology

Brain Tumour Dataset collection
(7,038 MRI labeled Images) (80% of data used for training and 20% data used for testing)

Dataset preprocessing

CNN | ANN | Hybrid model (CNN-ANN) | Machine Learning Techniques

Results Analysis (Accuracy)

KNN Classifier, Decision Tree Classifier, SVM Classifier

The Hybrid model's final layer has 4 units (one for each class) with softmax activation. Softmax ensures that the output is a probability distribution across the 4 classes, where the sum of all probabilities is 1.
The class with the highest probability is selected as the predicted class.

Methodology… (Hybrid CNN-ANN model)

Input Image — Convolution + Relu — Feature Maps 62*62*32 — Max pooling — Feature Maps 29*29*64 — Max pooling — Feature Maps 12*12*128 — Max pooling — Feature Maps 6*6*128 — Flatten Layer (CNN)

Dense (512) — Drop out (0.5) — Dense (256) — Drop out — Dense (4) — Activation Function Softmax → Glioma, Meningioma, Pituitary, Healthy Brain (ANN)

Proposed model implemented by using the CNN to extract relevant features from MRI images through multiple convolutional and pooling layers. Extracted features were passed to ANN, which performed the final classification.

Testing Results

The overall accuracy is the ratio of correct predictions to the total number of predictions across all classes

Model	Accuracy	Machine Learning Techniques	
CNN	98.33% (Epochs 48)	KNN	85.18%
ANN	93.99% (Epochs 64)	Decision Tree	87.81%
Hybrid	97.64% (Epochs 53)	SVM	91.11%

Conclusion

This work proposed a model combines a CNN to extract features from MRI images with an ANN for tumour classification.
The proposed Hybrid CNN-ANN model performs better than ANN model and Machine Learning approaches (KNN classifier, Decision Tree Classifier, SVM Classifier).
Data augmentation will increase the classification accuracy.

References

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