A Blockchain-Based Framework for Distributing and Managing CNN-Derived Brain Tumor Detection Models

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***Abstract*—Convolutional neural networks (CNNs) have greatly enhanced the automatic detection of brain tumors, leading to better treatment effectiveness and diagnostic precision. However, the general use of these models is limited due to obstacles such as constraints on sharing images, the difficulty of exchanging patient data, and the necessity for safe data handling. In order to tackle these problems, our research presents a blockchain-powered system that enables the exchange of customized CNN models among medical institutions that have restricted resources. This solution utilizes smart contracts to oversee authorized upgrades and downloads of the models while guaranteeing adherence to data protection regulations without the necessity of disclosing any patient data. Our own CNN model exhibits exceptional performance in contrast to prevailing techniques and seamlessly incorporates blockchain technology to surmount obstacles in the healthcare system.**

***Index Terms*—Blockchain, Brain tumor detection, CNN, Healthcare system, Hyperledger.**

I. Introduction

The rapid progress in machine learning [1] and deep learning has made significant contributions to addressing various challenges faced by humanity. Brain tumors, classified as either malignant or benign growths found in the brain, pose significant challenges in terms of detection and treatment. The use of imaging techniques, such as MRI, is essential for the identification and classification of brain tumors, playing a critical part in the overall treatment of these illnesses [2]. In recent years, deep learning models have been extensively used to enhance the accuracy and efficiency of brain tumor diagnosis [3]. CNNs have shown remarkable efficacy in the segmentation of brain tumors from MR images. They accomplish this by obtaining expertise in complex patterns and unique characteristics that distinguish tumor tissues from normal brain tissues. Furthermore, the U-Net model and its derivatives have been utilized because of their ability to perform effectively with a low number of data points while still maintaining a high level of accuracy and efficiency in detection with edge devices [4]. However, the healthcare system is reluctant to make patients' images publicly available. Therefore, it is preferable to create a shared model instead of a shared image dataset and the complete model. This approach will guarantee the security and efficiency of patient data, as sharing the full model and image dataset is both unethical and insecure, requiring significant computational power and resources.

This work presents an innovative method for exchanging model metadata and models within healthcare systems. Firstly, a customized CNN model is created to identify brain tumors. In order to achieve decentralization, the model is stored on the (InterPlanetary File System)IPFS, while Hyperledger Besu is utilized to protect access points and assure the security of the model [5]. Only the most recent and the top ten models are kept. Healthcare systems with proper authorization can access and download these models to analyze their own medical photos and accurately identify the presence of tumors in their patients. Only authorized members are allowed to access and download the model, which improves security and control.

II. Proposed Methodology

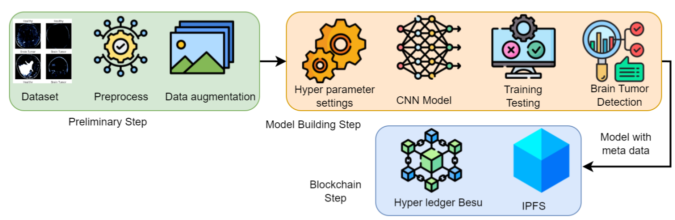

Fig. 1: Proposed workflow diagram

There is already a substantial body of work on the implementation of various deep learning and machine learning models for the identification and classification of brain tumors. However, no one has been successful in spreading it. We have proposed a revolutionary concept3 in which we obtain the image collection from Kaggle and preprocess it according to individual requirements. Next, we enhance it, as the larger the dataset, the greater the capacity for the model to acquire knowledge. Alternatively, when the dataset is less, the model is more prone to overfitting. In this instance, we employed a transformation function in Pytorch to enhance the data.

Then, it is necessary to personalize the hyperparameter configurations. In this scenario, the batch size is set to 64, the dropout rate is 0.25, the learning rate is 0.0001, and the Adam optimizer is utilized. We utilized a CNN model with a kernel size of 3, applied four times, along with the flatten

TABLE I: Comparison of the Proposed Study's Result with other Studies

Ref	Method	Accuracy	Precision	Recall	F1
[6]	FastAI	95.78%	96.70%	95.65%	96.17%
[7]	Xception	97.8%	96.6%	98.5%%	97.5%
[7]	ResNet50	97.6%	97.6%	98.2%	97.9%
[7]	FastAI	98.8%	99.4%	99.5%	98.9%
This Model	**CNN**	**99.3%**	**99.5%**	**99.5%**	**99.2%**

function, rectified linear unit (ReLU), and max pooling from the PyTorch library. The input shape was 3,256,256.

After refining the model, the revised version is securely stored using Hyperledger Besu smart contracts and then archived in the IPFS. The hyperledger will store transaction records in the network by utilizing smart contracts for uploaded and downloaded data, employing the hash from IPFS. This not only guarantees the authenticity and availability of the model but also simplifies the process of retrieving and distributing it in a decentralized manner.

III. Performance Evaluation

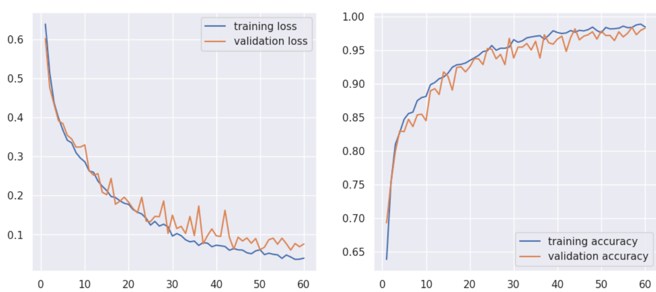

Fig. 2: Results of brain tumor and healthy brain

Figure 2 displays the efficacy of our model. The data clearly shows that the accuracy steadily increases while the loss gradually decreases across the epochs. The comparative results with other academic publications are presented in Table I. According to Dipu et al. (2021), they employ FastAI, a CNN method, achieving accuracy, precision, recall, and f1 scores of 95.78%, 96.70%, 95.65%, and 96.17% correspondingly. Additionally, the existing evidence demonstrates that they achieved favorable outcomes as well. However, our findings surpassed all others, with an accuracy of 99.30%, precision of 99.5%, recall of 99.5%, and F1 score of 99.2%.

block hash	0xb05cdb78c47aec948e73dae0358a8bbb5509d596906de3413057e1438fb0dc74
block number	5
from	0x5B38Da6a701c568545dCfcB03FcB875f56beddC4
to	ModelStorage.storeModel(string,string) 0xD7ACd2a9FD159E69Bb102A1ca21C9a3e3A5F771B
gas	133942 gas
transaction cost	116471 gas
execution cost	93671 gas
input	0x92e...00000
decoded input	{ "string _ipfsHash": "QmQ8SxuN9qLLnuzpEK4NZzXLrSd1cZRMCYdoYmeCitVZto", "string _metaData": "Brain_Tumer_Model_v1" }

Fig. 3: Proposed workflow diagram

The deployed smart contract within the Hyperledger Besu network securely stores both the IPFS hash of the trained model and accompanying metadata. This arrangement facilitates access to the models by participating medical organizations within the network. The schematic depiction of this process is illustrated in Figure 3, representing a pivotal step towards decentralized model access and utilization within the medical community. If the patients want, the administrator can send authorized patients the hash of IPFS or the decentralized model from IPFS so that patients can access the model as well without obtaining anyone's personal information.

IV. Conclusion

This study introduces a novel method for enhancing brain tumor diagnosis through the deployment of a specialized CNN model. This model demonstrates superior performance compared to existing models and employs blockchain technology for secure sharing across healthcare institutions. The model is stored on the IPFS and access is controlled by Hyperledger Besu, ensuring that only authorized healthcare systems can access and use the model for precise tumor identification in MRI scans. This approach not only preserves the confidentiality and protection of patient information but also addresses the ethical concerns and resource demands associated with sharing complete image files. By prioritizing model sharing over data distribution, this study proposes a scalable and secure alternative. Future work will explore the integration of a classification model into this framework to develop a comprehensive system.

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