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A Deep Learning Approach to Detect Cancer in Cirrhotic Liver

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Abstract: Hepatocellular Carcinoma (HCC), the primary liver cancer, is a global health concern linked to cirrhosis from hepatitis infections and excessive alcohol consumption. Early detection is vital but often occurs at advanced stages, compromising treatment and survival. Traditional diagnostic methods like biopsy and PET scans are invasive and expensive, making them unsuitable for cirrhotic patients. We propose an AI-powered diagnostic system integrating MRI images and blood biomarkers for a non-invasive, efficient, and potentially more accurate alternative. To develop a solution to detect cancer in cirrhotic liver using Random Forest and Convolutional Neural Network (CNN), our objectives encompass creating a multi-modal data integration framework with greater accuracy, ensuring user-friendliness, and reducing the burden on healthcare professionals. This feasibility study underscores the technical readiness for this project and highlights the pressing need for a reliable diagnostic system. By utilizing diverse datasets, integrating deep learning and traditional algorithms, and employing score ensembles, we aim to provide a unified platform for cirrhotic liver cancer diagnosis, leading to improved accuracy, early detection, efficient clinical workflow, and the potential for valuable research insights.

Keywords: Hepatocellular Carcinoma detection, Cirrhosis detection, Multi-modal data integration, Blood biomarkers data analysis, Image based analysis, Random Forest, Convolutional Neural Network.

I. INTRODUCTION

Hepatocellular carcinoma (HCC) is the most common type of primary liver cancer and a major health problem worldwide. The main risk factor for HCC is cirrhosis, which is a scarring of the liver caused by chronic hepatitis B or C infection, excessive alcohol consumption, or non-alcoholic fatty liver disease (NAFLD). Early detection and treatment of HCC are essential for improving survival. However, HCC is often diagnosed at an advanced stage, when it is more difficult to treat.

This is because HCC typically develops in patients with cirrhosis, which can mask the early signs and symptoms of cancer. Traditional methods of HCC diagnosis include liver biopsy and positron emission tomography (PET) scans. However, these methods are invasive, time-consuming, and expensive. Additionally, liver biopsy can be risky for patients with cirrhosis. Artificial intelligence (AI) has the potential to improve the accuracy and efficiency of HCC diagnosis.

We propose a deep learning-based diagnostic system that has the potential to improve the early detection and diagnosis of HCC in cirrhotic livers by integrating MRI images of cirrhotic liver and relevant blood sample biomarkers such as albumin, bilirubin, phosphate, and aminotransferase, etc. The system is also non-invasive, efficient, and potentially more accurate than traditional methods of HCC diagnosis.

II. LITERATURE SURVEY

[1] The paper introduces deep learning methods, such as the Hybridized Fully Convolutional Neural Network (HFCNN), have been proposed for liver tumor segmentation and lesion identification. These methods have shown high accuracy in extracting features of medical images and segmenting liver tumors. However, in this case, they concentrated on detecting cancer in the normal liver.

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[2] The paper presents a machine learning algorithm based on protein levels in the blood has been developed to aid in the diagnosis of liver cancer. The test showed promising results, especially in patients with smaller tumors and compared to current blood detection tests. Here, only the protein content of the blood was considered.

[3] The paper describes early detection of HCC and its premalignant precursor, dysplastic nodules, is critical for improving patient outcomes. Magnetic resonance imaging (MRI) is a valuable tool for the detection and characterization of liver lesions. However, they have utilized image processing alone to detect cancer.

[4] This paper addresses the effectiveness of various machine learning approaches for the identification of liver disease. This research used five machine learning models to predict the presence of liver disease based on a patient's medical records using an Indian liver patient record dataset. Here they found numerous liver disorders and the accuracy was a bit low.

[5] This research presents a machine learning model that combines multiple clinical data points. Hear the algorithm used is Gradient Bosting. However, this algorithm provides a varying range of accuracy when compared to other machine learning models.

III. SCOPE AND METHODOLOGY

Scope

The project's goal is to create new methods for detecting HCC that are faster, cheaper, and safer. This project's scope includes the research, development, and implementation of liver cancer detection utilizing deep learning approaches across numerous datasets which involves simplified blood testing, improved imaging procedures, or the use of artificial intelligence to analyze medical data. These breakthroughs could lead to early detection, saving more lives.

Methodology

A diverse dataset of medical images (including MRI images) and blood test reports, obtained through web scraping, covers both cirrhotic liver cancer and non-afflicted cases. After rigorous preprocessing, the data is split into training, validation, and test sets. The training set is for model training, the validation set monitors real-time performance, and the test set evaluates model generalization. This dataset supports the development of deep learning models for improved cirrhotic liver cancer diagnosis and management.

We would be developing a hybrid approach integrating deep learning (CNNs) and traditional algorithms for accurate cirrhotic liver cancer detection in MRI images. This strategy harnesses deep learning's pattern recognition abilities and traditional algorithms' logic, enhancing accuracy and reliability in diagnosis, ultimately improving patient care. Fuse the scores from the different deep-learning models to produce a single score for each patient. This can be done using a variety of methods, such as averaging the scores or using a weighted average based on the performance of the individual models. Use the ensemble score to classify each patient as having cirrhotic cancer or not. Generate a report that summarizes the reasons for the diagnosis, including the scores from the individual deep learning models and the clinical features of the patient.

IV. SYSTEM ARCHITECTURE

The system architecture is tailored to identify patients with a particular biomarker using image data. It takes in patient data, likely including identifiers and relevant clinical information, alongside bio-marker results, such as blood tests. Image data is also inputted. A Random Forest Method processes the data, possibly for feature selection or classification, while the image data undergoes preprocessing, preparing it for analysis by a Custom CNN Model.

This model is deployed to scrutinize the preprocessed image data. The results from both the Random Forest Method and the Custom CNN Model are then amalgamated using Weighted Averaging. Ultimately, the system generates a result indicating the likely presence or absence of the cancer in the patient. Employing a blend of machine learning techniques (Random Forest) and deep learning (Custom CNN Model), the system offers a comprehensive analysis of both clinical data and medical images, facilitating cancer identification for patient diagnosis.

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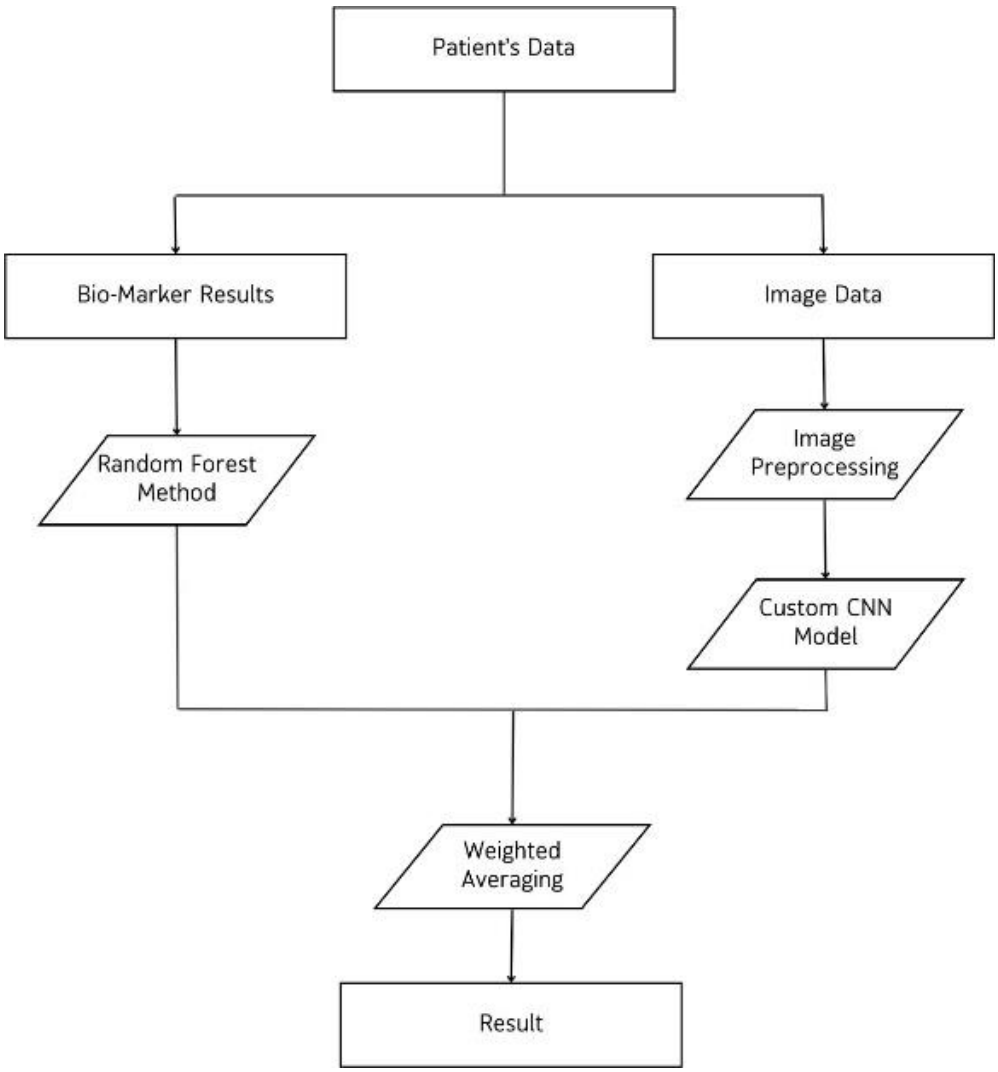

Fig. 1: System architecture

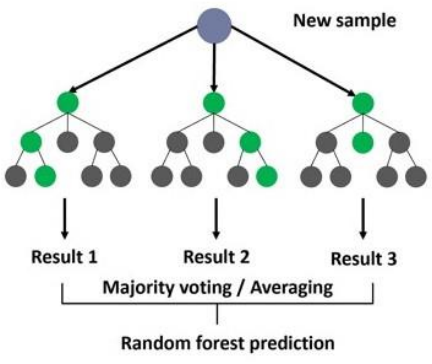

Fig. 2 Random Forest architecture

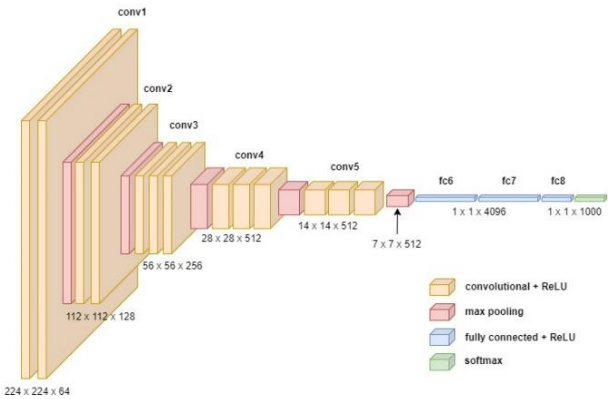

Fig. 3 CNN architecture

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V. CONCLUSION

This project aims to develop a new system for detecting liver cancer in patients with cirrhosis. Current methods are invasive, expensive, and not suitable for all patients. This new system would combine MRI images and blood test data using advanced machine learning techniques to achieve a higher accuracy rate than current methods.

It would be easy to use and improve healthcare professional workflow. The project is feasible with existing resources and could significantly improve early detection of liver cancer, leading to better treatment outcomes and potentially saving lives.

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