Review on Liver Cancer Detection using Deep Learning

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The largest internal organ in the human body is the liver [1]. Cancer is the irregular growth of the tissue in an organ[3].In cancer, cells divide and proliferate erratically, creating dangerous tumors that spread to neighboring bodily parts[5].One kind of cancer that affects the largest organ in the abdomen is liver cancer. Liver cancer is one of the most prevalent illnesses and a leading cause of mortality in the world each year. Hepatocellular carcinoma (HCC), in particular, is a major cause of cancer-related deaths worldwide and necessitates the use of sophisticated and efficient diagnostic techniques for early identification. This article offers a thorough analysis of current developments in deep learning-based liver cancer detection. Deep learning, a subset of artificial intelligence, has shown promise in a variety of medical imaging applications, including the identification and detection of liver cancer. The review commences by delineating present obstacles in the diagnosis of liver cancer and stressing the significance of timely detection for enhanced patient consequences. An overview of deep learning techniques, including hybrid architectures, recurrent neural networks (RNN), and convolutional neural networks (CNN), is then provided. These deep learning models have demonstrated remarkable proficiency in terms of interpreting complex patterns and features from medical imaging data, particularly from computed tomography (CT) and magnetic resonance imaging (MRI) scans. The overview of the many states of cancer detection technologies is provided in this document, along with a discussion of each method's evaluation.

Keywords: Liver Cancer Detection, Machine Learning, Deep Learning, Image segmentation.

in: *Advancements in Communication and Systems*. Ed. by Ashish Kumar Tripathi and Vivek Shrivastava. Computing and Intelligent Systems, SCRS, India., 2023, pp. 501–508. DOI: https://doi.org/10.56155/978-81-955020-7-3-44

1. Introduction

Liver tumors present significant challenges in clinical diagnosis and treatment planning, requiring accurate and efficient segmentation for accurate assessment. The motivation of liver cancer detection is to develop a model that uses tumor image analysis to help doctors spot cancers when they appear in the liver regionand initiating prompt treatment in accordance with the findings. The enzyme bile is produced by the liver and aids in the body's absorption of nutrients and the proteins required for blood clotting and maintaining the proper balance of bodily fluids. Therefore, a variety of body functions depend on the liver [10]. The objective of this initiative is to reduce mortality rates by promoting early identification of liver cancer.

The liver detoxifies substances and metabolizes drugs in addition to producing bile, cholesterol, and specific proteins [11]. The liver is in charge of producing the proteins involved in the coagulation process [13].

Liver pathology remains a critical problem worldwide, with hepatocellular carcinoma (HCC) and metastatic liver tumors contributing significantly to cancer-related mortality. Recently, machine learning (ML)-based intelligent systems have been used extensively in a variety of domains, particularly in the area of automated medical diagnosis. Machine learning has a significant role in helping healthcare professionals diagnose and cure diseases [9]. Digital images have had a profound impact on contemporary society, and image processing is now a key area of research and development [4]. Any input can be fed into a hybridized fully convolutional network (HFCNN), which will use efficient inference and learning to provide the right result [12].The main risk factors for HCC include persistent viral hepatitis infection, diabetes, obesity, fatty liver disease (alcoholic and non-alcoholic), various types of chronic inflammatory liver disease, and so forth. The human body regularly manufactures antacids and bilirubin. The isolation of hazardous compounds from outside sources, such as alcohol, narcotics, and ordinary poisons, also poses a threat to the liver. Therefore, any increase in these detoxification thresholds results in unanticipated deficits [2].

Cancer that originates in the liver cells is less prevalent than cancer that spreads to the liver. Malignancy that originates in a different part of the body, like the breast, colon, or lung, and then spreads to the liver is referred to as metastatic cancer as opposed to liver cancer. Cancers that originate in one organ and spread to another are referred to as metastatic cancers, for example, because they originated in the colon and traveled to the liver. Some markers may contain information that is not helpful for diagnosing a condition, which lowers the accuracy of disease diagnosis due to neural networks (NN) and fuzzy neural networks (FNNs) are types of multi-dimensional nonlinear functions [8]. The precise segmentation of liver tumors from medical pictures for improved clinical decision-making is the central challenge of this endeavor. The manual process of tracing the liver boundary on each slice is time-consuming and labor-intensive. Nonetheless, a number of problems with liver segmentation persist in the variety of situations that arise in real-world applications [6].

2. Characteristics

2.1 Technical Competence

- Highly technical users: Comfortable with complex tools and technical details.
- Intermediate technical users: Know the basic use of the software but may require assistance with advanced features.
- Non-technical users: Prefer intuitive and straightforward interfaces.

2.2 Domain Expertise

- Medical experts: They have specialized knowledge in liver pathology, are able to interpret segmented images and size metrics for clinical decisions.

- Non-medical staff: You need clear visualizations and explanations to understand the segmented results.

2.3 Patterns of Use

- Regular users: Frequently connect to the system for diagnostic or research purposes.
- Occasional users: Use the system regularly for specific clinical cases or research projects.

2.4 Handling of Data

- Sensitive Data Handling: Understand the significance of protecting patient privacy and comply with regulations.
- Access to research data: Require access to segmented data for research purposes with appropriate ethical considerations.

3. Relevant Work

Liver cancer detection involves different approaches and advances in medical technology. There are numerous fields of study that are pertinent to the detection of liver cancer, some of which include:

3.1 Imaging Techniques

Ultrasound imaging: Used for initial detection and follow-up of liver tumors. Computed tomography (CT) scan: Provides detailed images of the liver, which helps identify and stage the tumor. Magnetic Resonance Imaging (MRI): Offers high-resolution images for precise detection and characterization of liver lesions. Positron Emission Tomography (PET) scan: Helps identify areas of increased metabolic activity and aids in tumor detection. Some of the datasets are -The Cancer Imaging Archive (TCIA), LiTS17 Dataset, Liver Tumor Segmentation kaggle.

3.2 Biomarkers and Blood Tests

Alpha-fetoprotein (AFP): Traditional liver cancer biomarker; elevated levels may indicate the presence of cancer. Des gamma- carboxy prothrombin (DCP): Another biomarker used in conjunction with AFP for diagnosis and monitoring. Liquid biopsy: A new technique involving the analysis of circulating tumor cells, DNA or RNA in blood samples for early cancer detection.

3.3 Molecular and Genetic Research

Genomic Analysis: Studying Genetic Changes Associated with Liver Cancer to Identify Specific Mutations and Potential Targeted Therapies. Biomolecular markers: Investigating specific molecules or pathways involved in liver cancer development for early detection and personalized treatment strategies.

3.4 Artificial Intelligence and Machine Learning

AI-Based Image Analysis: Using Machine Learning Algorithms to Analyze Medical Images for More Accurate and Faster Liver Tumor Detection. Predictive Modeling: Developing models that integrate patient data and imaging results to predict the risk of developing or recurring liver cancer.

3.5 Intervention Techniques

Biopsy: Helps confirm the presence of liver cancer by analyzing a sample of liver tissue. Image-Guided Ablation: Minimally invasive procedures that use heat or cold to destroy cancer cells in the liver.

3.6 Treatment Monitoring

Radiomics and radio genomics: Analysis of imaging data to predict treatment response and outcomes. Liquid biopsy monitoring: Tracking genetic changes in tumors over time to track treatment effectiveness and detect resistance. Researchers continue to explore these areas and develop innovative methods for early detection, accurate diagnosis and effective monitoring of liver cancer treatment. Collaboration between experts in imaging technology, oncology, genetics and artificial intelligence is leading to significant progress in this field. Figure no.1 shows the accuracy of different algorithms as follows:

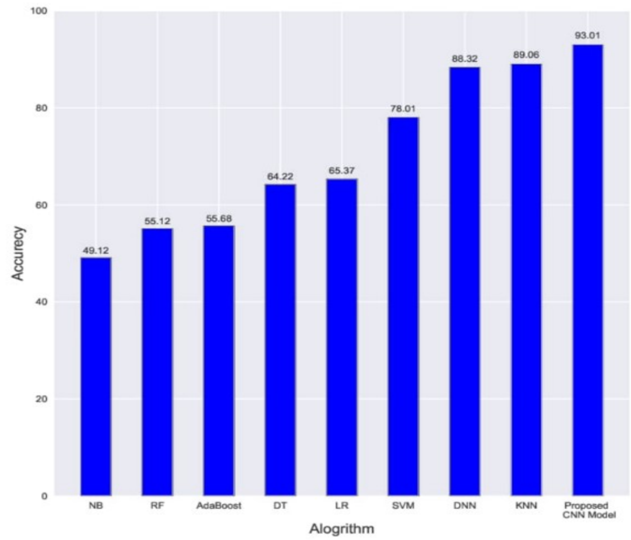

Figure 1. Accuracy of algorithm

4. Methodology

4.1 Data Collection

Gather a representative and varied dataset of liver images, encompassing both healthy and malignant patients. Make use of medical imaging techniques like ultrasonography, MRIs, and CT scans. Ensure that the dataset contains a sufficient number of cases across different stages of liver cancer for robust modelling.

4.2 Data Preprocessing

Standardize and normalize image intensity values to ensure consistency across different display modalities. Use image augmentation methods like scaling, rotation, and flipping to give the training dataset more variety. Resize images to a uniform resolution suitable for feeding a deep learning model. One of the first stages needed to get highest rightness in the identification of liver cancer is image preprocessing [7].

4.3 Labeling

Provide precise ground truth labels for the dataset that indicate whether liver cancer is present or absent. To guarantee precise and dependable annotations, think about enlisting the help of seasoned radiologists.

4.4 Choosing Model

Choose a deep learning architecture (e.g., convolutional neural networks; CNNs) that is most suited for detecting liver cancer, as they have shown effective in tasks involving images. Try employing pre-trained models (transfer learning, for instance) to make use of information from enormous datasets in situations when there is a shortage of medical data.

4.5 Model Architecture

Design your own deep neural network or modify existing architectures to fit the characteristics of liver cancer images. It is advised to utilize several pooling layers for spatial downsampling, multiple convolutional layers for feature extraction, and fully coupled layers for classification.

4.6 Instruction

Make separate sets for testing, validation, and training from the dataset. After the model has been trained using the training set, evaluate its performance using the validation setto make sure overfitting is being monitored. Improve model generalization by putting strategies like batch normalization and dropout into practice.

4.7 Correcting Hyper Parameters

In order to optimize the model's performance, adjust hyper parameters such as the learning rate, batch size, and regularization settings.

4.8 Assessment Metrics

Use pertinent metrics like as sensitivity, specificity, accuracy, recall, F1-score, and area under the ROC curve (AUC-ROC) to assess the model's performance on the test set.

4.9 Interpretability and Explainability

Implement techniques for interpreting deep learning model decisions, such as gradient-based methods or attention mechanisms, to increase clinical acceptance.

4.10 External Datasets Verification

To assess the trained model's generalizability across various patient groups and imaging settings, test it on external datasets.

4.11 Clinical Validation

Work together with medical professionals to confirm the model's effectiveness in a clinical setting.Analyze its effect on real diagnostic procedures and patient results.

4.12 Deployment

If the model performs satisfactorily, deploy it in a healthcare environment with the necessary regulatory compliance and ethical considerations.

4.13 Constant Refinement

To maintain the model's applicability and efficacy in the ever- evolving field of medical imaging, make constant updates and modifications based on fresh data and cutting-edge technologies. This methodology outlines a systematic approach to the development and implementation of a deep learning framework for liver cancer detection, emphasizing rigorous evaluation, interpretability, and collaboration with medical experts for successful integration into clinical practice. Figure no.2 shows the block diagram of the above methodology as follows:

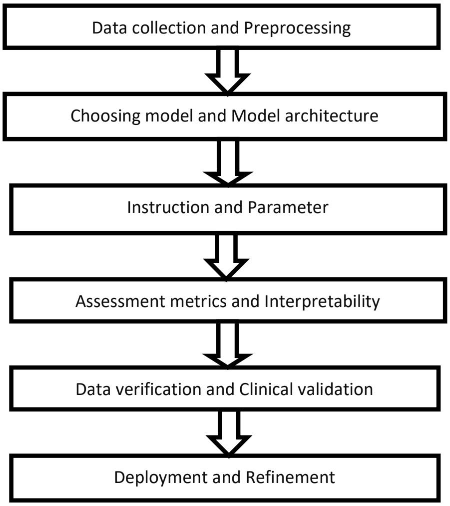

Figure 2. Block diagram on methodology

Table 1. shows the literature survey as follows:

Sr.No	Papername	Authorname	Year
1	A Comparative Study of Data Mining, Digital Image Processing and Genetical Approach for Early Detection of Liver Cancer.	Meenu Sharma, Rafat Parveen.	2020
2	A Review on Liver Cancer Detection Techniques.	Bhawana Maurya, Dr. Saroj Hiranwal, Manoj Kumar.	2020
3	Detection of liver cancer using image processing technique.	Atrayee Dutta, Aditya Dubey.	2019
4	Medical image processing schemes for cancer detection.	Xiaozhou Li, Junxiu Lin, Jianhua Ding, ShuWang.	
5	Apragmatic approach for Detecting liver Cancer using Image processing and data mining.	Anisha P R, Kishorkumar Reddy C, Narasimha Prasad LV.	2015
6	Survey on Automatic Liver Segmentation Techniques from Abdominal CT Images.	Swapnil V, .Vanmore, Sangeeta, R Chougule.	2019
7	Survey on Segmentation of Liver from CT images.	S. priyadarsini, Dr. D. Selvarthi.	2012
8	Effective liver cancer diagonosis method based on machine learning algorithm.	Sangman, Kim, Seungpyo Jung, Youngju Park, jihoon Lee.	2014
9	Prediction of liver disorders using machine learning algorithms.	Md Fazle, Rabbi, S. M, Mahedy Hasan, Arfia Islam Champa	2020
10	Effective Methods to Detect Liver Cancer Using CNN and Deep Learning Algorithms	Archana R, Anand L	2023
11	Ensemble Deep Learning Approaches for Liver Tumor Detection and Prediction	R. Archana, L. Anand	2023
12	Liver Cancer Detection Using Hybridized Fully Convolutional Neural Network Based on Deep Learning Framework.	Xin dong, yizhao zhou, lantian wang ,jingfeng peng .	2022
13	Automatic Liver Cancer Detection Using Deep Convolution Neural Network	Kiran Malhari Napte , Anurag Mahajan ,Shabana Urooj.	2023

5. Conclusion

The many techniques and algorithms used to diagnose liver cancer were examined in this article. The literature on several hybrid intelligence algorithms was thoroughly reviewed. It is widely accepted that research is an ongoing, unavoidable, essential, inventive, and results-driven process. To put it briefly, this work makes a contribution by offering a computer-aided diagnosticsystem that makes use of pictures from some patients' MRIs and CT scans to diagnose liver cancer. On basis of the comparison study, Thus, it can be said that this study will assist medical professionals in diagnosing liver patients with more accuracy. To categorize liver patients, we will use several deep learning and transfer learning algorithms with different feature selection strategies in the future.

6. Acknowledgment

We would like to sincerely thank the staff of CSE
Dept. of Nutan College of Engineering and Research (NCER) for helping us to conduct this work.
Prof UMA PATIL mam for guiding us in this project.

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