An Analytical Review on Detection of Liver Diseases using Biomedical Image Analysis and Machine Learning Techniques

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Abstract

Liver diseases have become a significant global health concern, with early detection and accurate classification being critical for effective treatment and improved patient outcomes. Traditional diagnostic methods for liver diseases often rely on invasive procedures and subjective interpretations, leading to delays in diagnosis and potential misdiagnosis. This review paper aims to develop an automated approach utilizing biomedical image analysis and machine learning algorithms to detect and classify liver diseases from medical images. By analyzing various imaging modalities, such as CT scans or MRI scans, this research seeks to identify reliable biomarkers and patterns that differentiate between healthy liver tissue and diseased conditions.This paper concludes with some interesting future potential research directions.

Keywords: *Machine Learning, Imaging Modalities, Biomedical Image Analysis, Liver disease detection.*

Introduction

Liver diseases represent a significant health burden worldwide, affecting millions of individuals and contributing to a substantial number of deaths annually. Timely and accurate diagnosis of liver diseases is critical for effective treatment and patient management. Medical imaging techniques, such as ultrasound, CT

scans, and MRI, play a crucial role in visualizing the liver's structure and identifying abnormalities. However, interpreting these complex images can be challenging, often requiring the expertise of specialized medical professionals. In recent years, the intersection of biomedical image analysis and machine learning has shown great promise in enhancing the detection and classification of liver diseases. These technologies extend the potential to automate the diagnostic process, providing more objective and consistent results while reducing the workload on healthcare professionals.

This research aims to explore and develop an advanced system for liver disease detection and classification, using state-of-the-art techniques from both the fields of biomedical image analysis and machine learning. The primary goal is to create an automated solution that can accurately distinguish between normal liver tissues and various liver disease conditions, including hepatocellular carcinoma, cirrhosis, hepatitis, and fatty liver disease, among others.

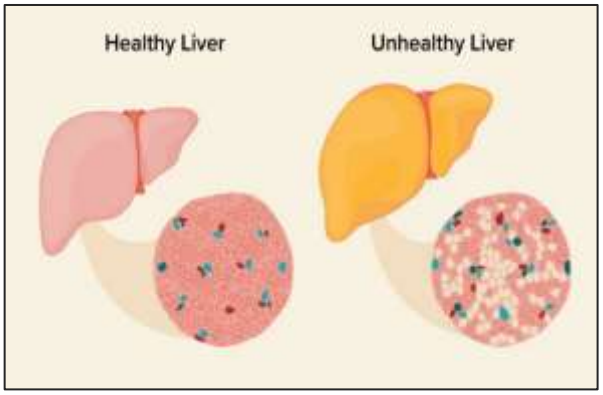

Fig 1:Healthy Liver and Unhealthy Liver

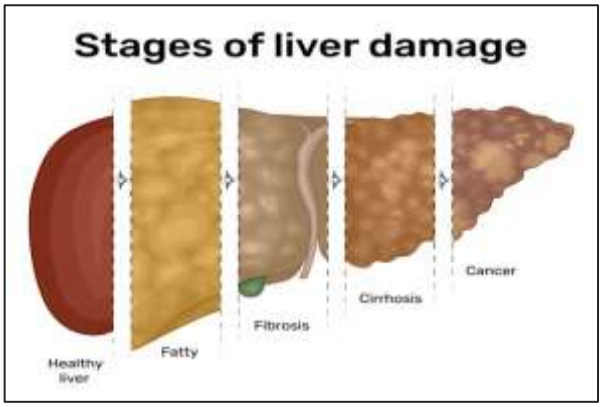

Fig 2: Stages of Liver Damage

In this modern technological world,Machine Learning(ML)based systems can be very useful to medical professionals to dignose liver diseases in their initial stages and help them recover rapidly. Over the years, many Classification Methods were developed to detect and classify the liver diseases Using K-Nearest Neighbours (KNN), Artificial Neutral Networks (ANN), Support Vector Machine (SVM), Decision Tree (DT) ,Random Forest (RF) and Logistic Regression (LR) algorithms.

The main contribution of this review are summarized below:

- Summarize experimental results of the methods cited in research literature publications.
- Describe present research issues of various detection and classification methods and present some interesting potential future research directions.

The rest of this paper is organized as follows:

At first,presented the various detection and classification methods from the available literature and then described those methods with recent methods.Finally,some of the research issues are presented with future directions at the conclusion.

Objectives

According to in depth study, the objectives of this research have been drawn as follows:

1) To Develop an early detection algorithm for liver diseases.
2) To Design a precise diagnostic tool for liver diseases.
3) To Develop a personalized treatment planning system for liver diseases.

By achieving these three objectives, the system will enhance the capabilities of healthcare professionals in managing liver diseases, leading to improve the patient care and better overall outcomes.

Literature Survey

[1] **RT Umbare et al.**, developed a hybrid classifier as a machine learning model to predict and identify liver disorders. The proposed method for detecting liver disease that will improve forecasting, assist users in recognizing the illness, and recommend additional therapy and conscious examination.

[2] **Dr. Pravin Ramdas Kshirsagar et al** has used four machine learning techniques i.e SVM, Logistic Regression, KNN, and ANN.The ANN model with 98% accuracy rate was the most precise. When compared this effort to the past research investigations, it was discovered that the effectiveness of ANN was quite high.

[3] **A.Sivasangari et al.,** proposed the diagnosis of liver illness using machine learning models .The step of collecting data, which involved gathering data from the public database and prepping it for -1 value substitution, was followed by the step of liver disease prediction. Eventually, multiple models are measured using

quantitative measurement criteria including precision, accuracy, and recall.

[4] **Dr. Chokka Anuradha et al.** provided a framework for diagnosing and predicting liver illness in patients.In terms of accuracy, precision and recall as evaluation metrics, the integrated model of liver disease prediction performs better than standalone machine learning models.The combined method's highest level of accuracy is 96%.

[5] **Jasleen Kaur et al.,** examined many classifier variants for classification, including J48,RF,HT and DS, in an automated liver disorders detection system employing machine learning and smart contracts.They were evaluated by using a 10-fold cross validation test. J48 was chosen as a reliable classifier. After conversion, the J48 criteria would be encoded in SC to automate the entire process and inform the patient's doctor about their health status so that they could begin treatment right away.

[6] **Chappidi Aswartha Reddy et al,.** presented comparative Analysis implementation with more than 30,000 datasets using various ML Techniques such as LR,RF,SVM,KNN and ANN.Among all these algorithms RF achieved the best results wih 99.5% accuracy.

[7] **B V Ramana et al.,** used a hybridization of random forest and nearest neighbor to address liver disease findings. The authors designed the proposed approach using ensembling classifiers. They worked with two different types of data sets such as UCI and Indian Liver Patients. For the multi-layer classification in combination with the random subset feature in UCI data and for the Indian dataset, the nearest neighbor selection technique was used. The experiment results highlighted significant improvements in terms of accuracy, with 74% for UCI and 73% for the Indian dataset. However, the data set size was small, and they needed to test with a huge number of data sets.

[8] **Tapas Ranjan et al.,** presented a medical support system for doctors by learning patterns using decision trees, 1BK, NB, Multilayer Perceptron, VFI, ANN, and ZeroR and compared the efficiency in terms of accuracy, computing time, and effective interpretation of models. The performance analysis showed that the Multilayer Perception produced better accuracy than the others for the liver disease dataset.

[9] **Xutato Li et al.,**proposed CART-AdaBoost model based on CART.Later,the model was trained and it had gone through the 10-fold cross-validation.In terms of accuracy,precision,recall and F1-Score,the model testing results on the testing set were 83.06%,84.31%,77.48% and 80.75% respectively.This model was used to reduce the detection cost,avoid detection damage for patients,improve the diagnosis efficiency of early disease.

[10] **Yi-ming Lei et al.,**proposed a new computer Aided Diagnosis(CAD) images using Uniform LBP (u-LBP) features. The u-LBP features used to describe the cirrhotic features in the ultrasound images.It extract u-LBP features for each sample on the limited training and test datasets, and make a classification between the normal liver and cirrhotic liver through SVM ,and got accuracy of 87.00%.

[11] **Engy A.Aboulwafa et al.,**proposed CAD system technique based on transfer learning on US images based on DenseNet-201, a pre-trained neural network was used. This method achieved high performance and it was validated against other methods based on TL.The proposed approach achieved high classification performance of accuracy 0.95.The area under receiver operating characteristic curve(AUC) of 0.987 and Cohen score of 0.88659.

[12]**Anju Krishna M et al**., worked on CT images that were used for the detection and classification of liver tumor. A modified SFTA algorithm was used to extract the features from

tumor and these features were used for classification.The results showed that modified SFTA based SVM classifier provided accurate results of 94.531% over SFTA based multi SVM classifier.

[13] **K.Prakash et al.,** proposed a new machine learning approach called Learning Based Disease Prediction Logic (LBDPL).This method considered the problem of Non-Alcoholic Faaty Liver Disease(NAFLD) prediction.This proposed algorithm was cross-validated by using the conventional algorithms such as Logistic Regression(LR) classifier, Support Vector Machine(SVM) and k-Nearest Neighbor (KNN)Algorithm.The new machine learning algorithm LBDPL provided the maximum liver disease prediction accuracy ratio of 98.9% in an outcome.

[14]**Akanksha Soni** have done a comparitive study on four classification algorithms that are LR,RF,DT and KNN have been applied for analyzing their performance which is based on the liver patient data.This comparision study providing, KNN is the best model that generated a great accuracy with 72.04%.

[15] **Prof.Thirunavukkarasu et.al.,** predicted diseases in the liver using three various types of ML classification models algorithms like K Nearest Neighbor (KNN), Support Vector Machine (SVM), and Logistic Regression (LR). KNN and Logistic Regression algorithms had 73% accuracy, while SVM had 71.97%. They used the 70:30 ratio for training and testing their models. They Found that KNN and Logistic Regression had more prediction accuracy compared to others.

[16] **Maria Alex Kuzhippallil et.al.,**used multiple machine-learning techniques and compared them to the Indian Liver Patient dataset from Kaggle. It possessed 416 patient data with 11 features that were used for the project. Feature selection was done by using a Genetic algorithm. Machine learning models like Gradient Boost, Random Forest (RF), Multilayer Perceptron (MLP), K Nearest Neighbor (KNN), AdaBoost, Logistic Regression (LR), Decision Tree (DT), XGBoost. They found that it resulted in a higher prediction rate using the feature selection method.

[17] **Vyshali J Gogi et.al.,**used machine learning algorithms like Support Vector Machine (SVM) Linear Discriminant, and LR, Decision Tree applied for the classification of the liver disease dataset. The parameters were collected through Liver Function Testing from the blood. Logistic Regression(LR) resulted in 95.8% accuracy among all other classification algorithms used.

[18] **Shivangi Gupta et.al.,** identified Liver diseases by using Machine Learning Algorithms They used different Machine Learning models like Random Forest (RF), Naïve Bayes (NB), AdaBoost, and Support Vector Machine (SVM). From the “https://archive.ics.uci.edu/ml” the Indian Liver Patient Dataset was accessed. 583 patients data with 11 features were taken for this project study and training and testing of the ML models. 70:30 ratio i.e 70% of the data from the ILPD dataset was used for the training purpose and 30% of the ILPD datasets were used for the testing purpose of the models. Different ML Models K Nearest Neighbour, ANN, and DT together gained a prediction rate of 93%.

[19]**Jagdeep Singh et.al.,**proposed various classification algorithms such as Logistic Regression, SMO, Random Forest algorithm, Naive Bayes, J48 and k-nearest neighbor (IBk) were implemented on the Liver Patient dataset to find the accuracy. The development of intelligent liver disease prediction software (ILDPS) was done by using feature selection and classification prediction techniques based on software engineering model.

[20] **Golmei Shaheamlung et.al.,**has presented comparative analysis of the entire machine learning techniques for diagnosis and prediction

of liver disease in the medical area, which has already been used for the prediction of liver disease by various authors and the analysis are based on Accuracy, Sensitivity, Precision, and Specificity.

Analytical Review

According to the in depth analysis , the early detection of liver illness was exceedingly challenging.Each model's performance was assessed once it was put into the system. The term "liver disease" referred to a disorder that affects the human liver medically. As a result of liver illnesses, other internal body organs experienced abrupt alterations in the health circumstances that controlled the liver's function.

With the repeated development in machine learning technology, early prediction of liver disease is possible so that people can easily diagnosis the deadly disease in the early stage. This will be more useful in the Healthcare Department and also a medical expert system which can be used in a remote area.

With the help of this survey and study, it has become obvious that some machine learning algorithms, such as SVM,KNN,RF,LR, Decision trees, J48, and ANN, offer more accuracy in the identification and prediction of liver illness.

According to the analysis in the approach[7]a hybrid methodology with a combination of multiple techniques to identify illness from image data enormously improved. The experiment results highlighted significant improvements in terms of accuracy, with 74% for UCI and 73% for the Indian dataset.

In depth study of [2] the dataset and feature selection are crucial for improving prediction outcomes. Different data sets are used which are Kaggle Indian data set,UCI Data set,UCLA data set,ILPD dataset.Different Machine learning techniques applied on datasets to get accuracy result for early detection of liver disease.

According to research results [14],[15],[16],[17] and [18] on some standard data sets have accessed and training and testing of the ML models used. Different ML Models gained a prediction rate of 93%.

Research Challenges

Despite rapid considerable advancements that are emerged in Machine Learning,the mentioned methods from research literature are still failed to detect the liver disease in its early stage.

Based on in depth study, it is oberserved that the prediction of liver disease in its early stages is a difficult task for doctors and scientists due to the apparently sensitive signs. The effects will become apparent only when it is too late. The initiative seeks to use machine learning techniques to address this issue and improve the victims of the disease. Because there are few signs of liver diseases, which are difficult to diagnose and symptoms usually do not appear until it is too late.

Based on the review it is understood that maintaining accuracy in numerous situation, robustness and computational efficiency all at once is an existing research challenge.

Despite the fact that some of the methods offered work effectively in certain difficult situations, they are not strong enough to tackle a variety of situations.

Conclusion and Future Directions

There is a great potential for the Machine learning models and their applications in healthcare systems in view of complexity of health data.

According to the study, the following observations have been made:

- Using a hybrid classifier as a machine learning model, the system to diagnose

liver disease that will increase prediction and help users in identify the disease and prescribe further treatment and examinations with more consciousness

- Quantitative US texture features characterize liver fibrosis changes with high accuracy and can differentiate early from advanced disease.
- In the future, it will explore methods for completely automatic detection of metastases using their actual ROIs instead of rectangular ones, using higher-level features, and advanced classification techniques. We also plan to improve the results with larger training and testing datasets.
- Introducing some deep learning principles such as Convolutional Neural Network and so on to improve the timing efficiency as well as the deep learning principles eliminate the complex nature of conventional algorithms in nature.
- Future research should explore several preprocessing techniques for the images as well as the classification for the severity of the disease.

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