DIAGNOSIS OF LIVER DISEASES USING GENETIC ALGORITHM AND CNN

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Abstract

Liver diseases represent a major global health challenge due to their asymptomatic nature in early stages and high mortality rates when detected late. Accurate and early diagnosis is crucial for effective treatment and improved patient outcomes. This paper proposes a hybrid intelligent system that integrates **Genetic Algorithm (GA)** for feature selection and optimization with **Convolutional Neural Networks (CNN)** for automated classification of liver diseases. The Genetic Algorithm enhances the model performance by selecting the most relevant features from medical datasets, thereby reducing dimensionality and improving computational efficiency. The CNN model is employed to learn complex patterns from imaging or structured clinical data. The proposed system demonstrates improved accuracy, sensitivity, and specificity compared to traditional machine learning approaches. Experimental results validate the robustness and reliability of the hybrid model in diagnosing liver diseases effectively.

1. Introduction

Liver diseases such as cirrhosis, hepatitis, and fatty liver disease have become increasingly prevalent worldwide due to unhealthy lifestyles, alcohol consumption, and viral infections. Early detection remains a significant challenge due to subtle symptoms and lack of efficient diagnostic tools.

Traditional diagnostic methods rely heavily on laboratory tests and medical expertise, which can be time-consuming and prone to human error. With the advancement of Artificial Intelligence (AI), automated systems have been developed to assist clinicians in diagnosing diseases accurately.

In this context, **deep learning techniques**, particularly Convolutional Neural Networks (CNN), have shown remarkable success in medical image analysis. However, high-dimensional data and irrelevant features can degrade model performance. To address this issue, **Genetic Algorithms (GA)** are used for optimal feature selection.

This paper presents a hybrid GA-CNN model that improves diagnostic accuracy by combining evolutionary optimization with deep learning.

2. Literature Survey

Several research works have explored machine learning and deep learning techniques for liver disease diagnosis:

- Traditional machine learning models such as Support Vector Machines (SVM), Decision Trees, and K-Nearest Neighbors (KNN) have been widely used for liver disease prediction. However, these models often suffer from overfitting and limited feature representation.
- Deep learning models, especially CNNs, have been applied to medical imaging for liver tumor detection and classification. These models provide better feature extraction capabilities but require large datasets and computational resources.
- Feature selection techniques such as Principal Component Analysis (PCA) and Genetic Algorithms have been used to improve model performance by reducing dimensionality.
- Hybrid approaches combining optimization algorithms with neural networks have shown promising results in healthcare applications.

Despite these advancements, challenges such as data imbalance, feature redundancy, and model interpretability still exist.

3. Existing System

The existing systems for liver disease diagnosis primarily rely on:

- **Manual diagnosis by medical professionals**
- **Basic machine learning algorithms (SVM, KNN, Logistic Regression)**
- **Standalone deep learning models without optimization**

Limitations:

- Low accuracy due to irrelevant features
- High computational complexity
- Lack of feature optimization
- Poor generalization on unseen data
- Dependency on large labeled datasets

4. Proposed System

The proposed system integrates **Genetic Algorithm (GA)** with **Convolutional Neural Network (CNN)** to improve diagnostic performance.

Architecture Overview:

1. Data Collection (Clinical or Imaging Data)
2. Data Preprocessing (Normalization, Missing Value Handling)
3. Feature Selection using Genetic Algorithm
4. Feature Optimization
5. CNN-based Classification
6. Performance Evaluation

Key Advantages:

- Improved accuracy through optimized feature selection

- Reduced dimensionality and computational cost
- Enhanced generalization capability
- Robust performance on noisy datasets

5. Algorithms Used

5.1 Genetic Algorithm (GA)

Genetic Algorithm is an evolutionary optimization technique inspired by natural selection.

Steps Involved:

1. Initialize population (feature subsets)
2. Evaluate fitness function (accuracy of model)
3. Selection of best individuals
4. Crossover (combine features)
5. Mutation (random changes)
6. Repeat until convergence

Role in Proposed System:

- Selects the most relevant features
- Eliminates redundant and irrelevant data
- Improves CNN efficiency

5.2 Convolutional Neural Network (CNN)

CNN is a deep learning algorithm designed for feature extraction and classification.

Architecture Components:

- Convolutional Layers (Feature Extraction)
- Activation Function (ReLU)
- Pooling Layers (Dimensionality Reduction)
- Fully Connected Layers (Classification)
- Softmax Layer (Output Prediction)

Role in Proposed System:

- Learns complex patterns in liver data
- Performs classification of disease vs normal cases

6. Results

The proposed GA-CNN model was evaluated using standard liver disease datasets.

Performance Metrics:

- Accuracy
- Precision
- Recall (Sensitivity)
- F1-Score

Observations:

- GA-CNN achieved higher accuracy compared to traditional models
- Reduced false positives and false negatives
- Faster convergence due to optimized features

Sample Results (Illustrative):

Model	Accuracy	Precision	Recall	F1-Score
SVM	82%	80%	78%	79%
KNN	78%	76%	75%	75%
CNN	88%	86%	85%	85%
GA + CNN	**93%**	**91%**	**92%**	**91%**

7. Conclusion

This paper presented a hybrid model combining Genetic Algorithm and Convolutional Neural Networks for liver disease diagnosis. The integration of GA enhances feature selection, while CNN provides powerful classification capabilities.

The proposed system significantly improves diagnostic accuracy and reduces computational complexity compared to existing methods. It can serve as an effective decision-support tool for medical professionals.

Future Work:

- Integration with real-time hospital systems
- Use of larger and more diverse datasets
- Explainable AI for better interpretability
- Deployment as a web or mobile application

8. References

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