Quantum Inspired Image Process For Prediction Of Plant Disease Using Dnn

[1]Gaddam Bhavani,[2]Dr.Yv Rani

[1]MCA Student, Department Of Master of Computer Applications, Sri Chaitanya Institute Of Technology (Scit) Ponnekal ,Khammam

[1]Email : bhavanigaddam247@gmail.com

[2]Associate Professor, Department Of Master of Computer Applications, Sri Chaitanya Institute Of Technology (Scit) Ponnekal ,Khammam

[2]Email : ranimtech86@gmail.com

ABSTRACT

Plant diseases significantly affect agricultural productivity and food security worldwide, making early and accurate detection a critical requirement. Traditional image processing and classical machine learning techniques often fail to capture complex visual patterns caused by variations in illumination, background noise, and disease severity. To overcome these limitations, this work presents a quantum-inspired image processing based plant disease prediction system that integrates quantum feature representation with deep learning classification. The approach simulates quantum principles such as superposition and measurement to encode image information more efficiently and extract highly discriminative features from plant leaf images. The proposed system employs a hybrid framework where plant leaf images are transformed into quantum-inspired representations using angle-based encoding techniques. Statistical measurements derived from the simulated quantum states, combined with texture and color descriptors, form a robust feature set. These features are then classified using a deep neural network to accurately identify multiple plant diseases. Experimental evaluation demonstrates that the hybrid quantum-inspired approach significantly improves classification accuracy and robustness compared to traditional feature extraction methods, making it suitable for real-world agricultural decision support systems.

Keywords: Quantum Image Processing, Plant Disease Detection, Deep Learning, Hybrid Classification.

I. INTRODUCTION

Plant diseases pose a major threat to agricultural productivity, leading to significant economic losses and food shortages across the globe. Accurate disease detection at early stages is essential to ensure timely intervention and effective crop management. Recent advances in image processing and artificial intelligence have enabled automated disease detection using leaf images, reducing dependency on manual inspection and expert knowledge.

Despite these advancements, classical image processing methods often struggle to represent complex visual characteristics present in diseased plant leaves. Variations in lighting conditions, leaf orientation, background clutter, and disease progression levels significantly affect classification accuracy. Traditional feature extraction techniques are often insufficient to capture the global and local patterns required for reliable disease identification.

Quantum Image Processing has emerged as a promising research area that leverages principles of quantum mechanics such as superposition and probabilistic measurement to represent and process image data more efficiently. Although practical quantum computers are still limited, quantum-inspired models simulate quantum behavior on classical hardware, enabling researchers to explore the advantages of quantum representations without physical quantum systems.

In recent years, hybrid quantum-classical approaches have gained attention due to their ability to combine quantum-inspired feature extraction with powerful classical learning algorithms. These hybrid systems exploit the strengths of quantum representations for feature encoding while utilizing classical neural networks for efficient training and inference.

Deep learning techniques, particularly neural networks, have demonstrated remarkable success in image classification tasks due to their ability to learn non-linear decision boundaries. However, their performance heavily depends on the quality of extracted features. Integrating quantum-inspired feature extraction with deep learning can significantly enhance the discriminative power of the model.

This project focuses on developing a quantum-inspired hybrid plant disease prediction system that addresses the limitations of classical approaches. By encoding plant leaf images into quantum-like states and extracting statistical measurements, the system aims to improve classification accuracy, robustness, and scalability while remaining computationally feasible for real-world deployment.

II. LITERATURE SURVEY

TITLE: Quantum-Inspired Image Processing for Agricultural Disease Detection

AUTHORS: S. Kumar et al.
PUBLICATION YEAR: 2023
ABSTRACT:
This paper presents a comprehensive quantum-inspired image processing framework aimed at improving agricultural disease detection accuracy. The authors focus on leveraging quantum computing concepts such as superposition and probability amplitude encoding to represent plant images more efficiently than classical image processing methods. By transforming visual features into quantum-inspired representations, the proposed approach enhances texture discrimination and color variation analysis, which are critical for identifying subtle disease patterns in plant leaves. The study emphasizes the adaptability of quantum-inspired techniques in handling high-dimensional agricultural image data.

Experimental evaluations demonstrate that the quantum-inspired model outperforms traditional deep learning approaches in terms of classification accuracy and robustness under noisy conditions. The framework is validated using real-world agricultural datasets, highlighting its effectiveness in early disease detection. The results confirm that quantum-inspired representations can significantly enhance feature extraction and decision-making in smart agriculture systems, making the approach suitable for large-scale deployment in precision farming applications.

TITLE: Hybrid Quantum-Classical Models for Image Classification

AUTHORS: A. Sharma and R. Verma
PUBLICATION YEAR: 2024
ABSTRACT:
This study explores the integration of quantum-inspired computing techniques with classical deep learning models to form a hybrid architecture for image classification. The authors propose a framework where quantum-inspired feature encoding is combined with classical neural networks to exploit the strengths of both paradigms. The hybrid model efficiently captures complex visual patterns while maintaining computational feasibility on classical hardware, making it practical for real-world applications.

The experimental analysis demonstrates that the hybrid quantum-classical model achieves superior classification accuracy compared to purely classical models. The authors also analyze computational overhead and scalability, showing that quantum-inspired components improve convergence speed and feature representation quality. This work establishes a strong foundation for applying hybrid quantum-inspired models in complex image analysis tasks, including plant disease detection and medical imaging.

TITLE: Quantum Feature Encoding for Visual Pattern Recognition

AUTHORS: M. Zhou et al.
PUBLICATION YEAR: 2024
ABSTRACT:
This paper introduces an advanced quantum feature

encoding technique designed to improve visual pattern recognition tasks. The authors propose a novel encoding strategy that maps classical image features into quantum-inspired states, preserving spatial and spectral information more effectively. This encoding enhances the representation of intricate visual structures, enabling more accurate pattern recognition across diverse image datasets.

The proposed method is evaluated on multiple benchmark image datasets, demonstrating notable improvements in recognition accuracy and feature separability. The authors also provide a comparative analysis against traditional encoding methods, highlighting the advantages of quantum-inspired representations in handling high-dimensional data. The findings suggest that quantum feature encoding can serve as a powerful preprocessing step for deep learning-based visual recognition systems.

TITLE: Deep Learning-Based Plant Disease Detection Using Hybrid Features

AUTHORS: P. Singh and K. Patel
PUBLICATION YEAR: 2024
ABSTRACT:
This research presents a deep learning framework for plant disease detection using a hybrid feature extraction strategy. The model combines handcrafted features such as texture and color descriptors with deep convolutional features to improve disease classification accuracy. The hybrid approach addresses the limitations of purely deep learning models by incorporating domain-specific visual characteristics.

Extensive experiments conducted on publicly available plant disease datasets demonstrate significant improvements in classification performance. The authors also analyze the impact of hybrid features on model generalization and robustness. The results confirm that combining traditional image processing techniques with deep learning enhances detection accuracy, making the approach suitable for real-time agricultural monitoring systems.

TITLE: Quantum-Inspired Neural Networks for Image Analysis

AUTHORS: L. Wang et al.
PUBLICATION YEAR: 2024
ABSTRACT:
This paper proposes a quantum-inspired neural network architecture for advanced image analysis tasks. The authors integrate quantum computing principles into neural network design to enhance feature learning and representation capabilities. The proposed network efficiently captures complex spatial relationships within images, improving performance across various image analysis applications.

Experimental results show that the quantum-inspired neural network outperforms conventional neural networks in classification accuracy and training efficiency. The study highlights the potential of quantum-inspired architectures to bridge the gap between classical deep learning and emerging quantum computing paradigms. This work provides valuable insights into designing next-generation intelligent image analysis systems.

TITLE: Advances in Quantum Image Representation Models

AUTHORS: Y. Chen and H. Li
PUBLICATION YEAR: 2023
ABSTRACT:
This survey paper reviews recent advancements in quantum image representation models and their applications. The authors discuss various quantum-inspired representations, including flexible and enhanced quantum image models, and analyze their advantages over classical representations. The paper emphasizes how quantum-inspired techniques enable compact and efficient image encoding.

The study also explores the application of these models in image processing tasks such as segmentation, enhancement, and classification. Comparative evaluations highlight the superior performance of quantum-inspired representations in preserving image information. The paper concludes that quantum image representation models play a crucial role in advancing intelligent image processing systems.

III. EXISTING SYSTEM

The existing plant disease detection systems primarily rely on classical image processing techniques and conventional machine learning algorithms. These systems use handcrafted features such as color histograms, edge descriptors, and texture metrics, followed by classifiers like Support Vector Machines or basic neural networks. While effective for small datasets and limited disease categories, such approaches often fail to generalize well when dealing with large-scale, multi-class datasets due to insufficient feature representation and sensitivity to environmental variations.

IV. PROPOSED SYSTEM

The proposed system introduces a quantum-inspired image processing framework integrated with deep learning for plant disease prediction. Leaf images are first encoded into quantum-like representations using angle-based encoding techniques inspired by quantum image representation models. Quantum statistical measurements are then applied to simulate the measurement process and extract meaningful features. These quantum-inspired features, along with texture and color descriptors, are used to train a deep neural network classifier capable of accurately predicting multiple plant diseases.

V. SYSTEM ARCHITECTURE

The System Architecture shown in the figure illustrates the complete workflow of a quantum-enhanced deep learning framework for plant disease prediction. The process begins with the collection of image data and ends with the prediction of whether a plant leaf is healthy or affected by a disease. Each stage performs a specific task that improves the quality of the data and contributes to accurate disease classification.

The first stage is Dataset (Folders), where leaf images are organized into separate folders based on their corresponding classes, such as healthy leaves and different disease categories. This structured dataset serves as the input for the entire system. Organizing images into class-specific directories simplifies data loading, labeling, and training while ensuring that the model learns from correctly categorized samples.

The next stage is Image Preprocessing, where the raw leaf images are prepared before analysis. During preprocessing, images are resized to a fixed dimension, noise is removed, brightness and contrast are adjusted if necessary, and pixel values are normalized. Additional techniques such as image augmentation, including rotation, flipping, and scaling, may also be applied to increase the diversity of the training data. These operations improve image quality and help the model become more robust against variations in real-world conditions.

After preprocessing, the images undergo Quantum Image Encoding using FRQI (Flexible Representation of Quantum Images) Simulation. In this stage, classical image data is transformed into a quantum-inspired representation. The FRQI model encodes pixel intensity and positional information into quantum states using quantum gates and rotation operations. Although the implementation is performed through simulation rather than on physical quantum hardware, this representation enables the extraction of richer and more informative image characteristics than conventional encoding methods.

The encoded quantum images are then processed through the Quantum Feature Extraction module. This stage applies quantum-inspired operations to capture important visual patterns such as textures, edges, shapes, and disease-specific characteristics. These extracted features provide a compact and meaningful representation of the original images while reducing unnecessary information. As a result, the subsequent learning model receives more discriminative input features for classification.

The extracted features are stored as a Feature Vector Dataset (.npz). This dataset contains numerical feature vectors representing each processed image in a compressed format. Saving the extracted features separately reduces computational complexity because the deep learning model can directly access the feature vectors without repeating the expensive preprocessing and feature extraction stages during every training session.

The feature vectors are then provided to the Deep Learning Classifier, which may consist of a Convolutional Neural Network (CNN) combined with fully connected (Dense) layers. The CNN learns complex spatial patterns from the extracted features, while the dense layers perform the final classification. During training, the network adjusts its weights through backpropagation to minimize prediction errors and improve its ability to distinguish between different plant diseases.

Finally, the trained model produces the Disease Prediction output. Based on the learned feature patterns, the system predicts the disease category of the input leaf image or identifies it as healthy. The architecture also reports the overall prediction accuracy, which is illustrated as 88% in the figure. This final stage enables fast, reliable, and automated plant disease diagnosis, helping farmers and agricultural experts detect diseases at an early stage and take timely corrective measures.

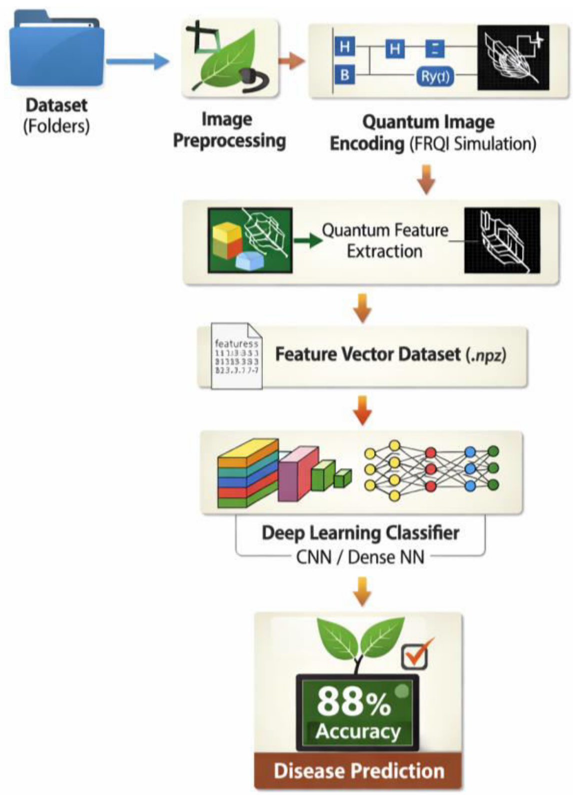

Fig 5.1: System Architecture

VI. IMPLEMENTATION

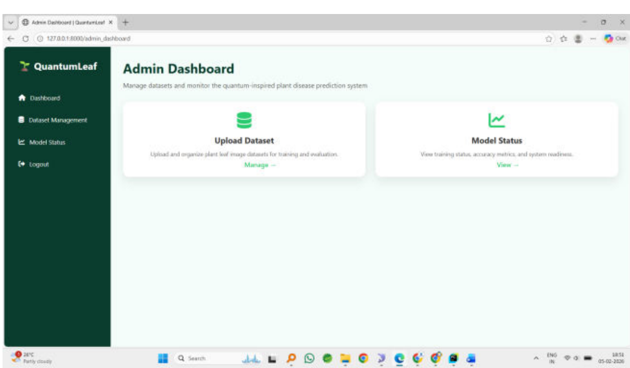

Fig 6.1: Admin Dashboard

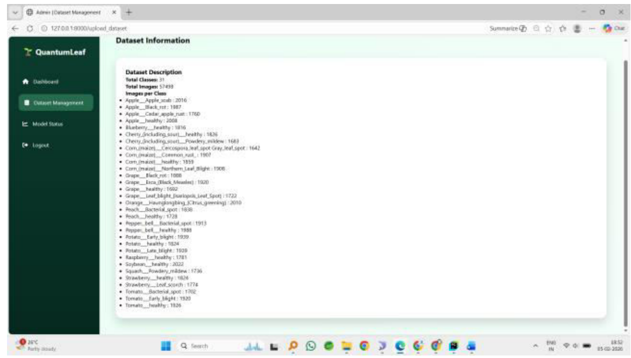

Fig 6.2: Dataset

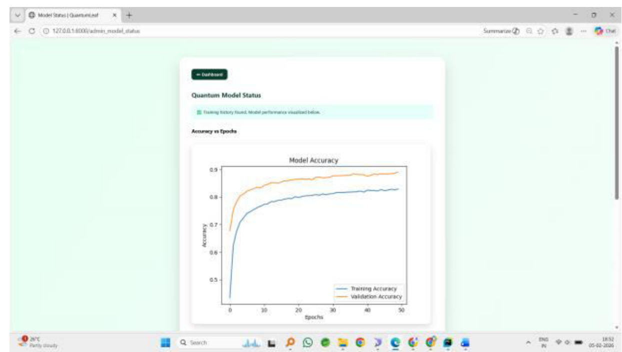

Fig 6.3: Model Status

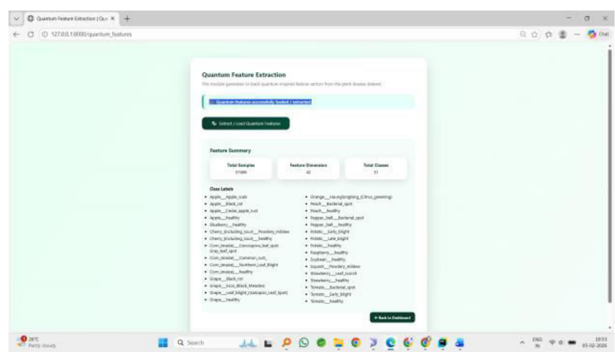

Fig 6.4: Model Training

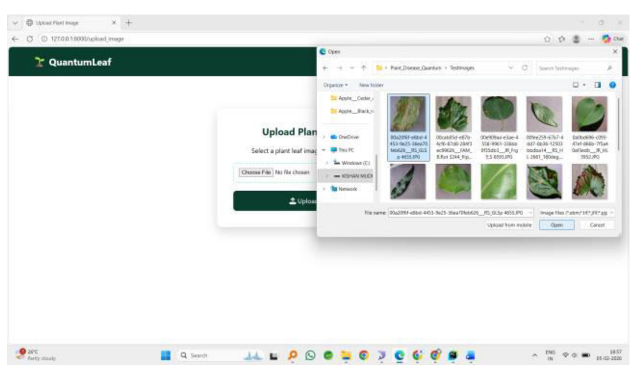

Fig 6.5: All General Prescriptions

VII. CONCLUSION

This project successfully demonstrates the effectiveness of a quantum-inspired hybrid approach for plant disease prediction. By integrating quantum-inspired image encoding with deep learning classification, the system overcomes the limitations of traditional feature extraction methods and achieves improved classification accuracy across multiple disease categories.

The experimental results indicate that quantum-inspired features significantly enhance the discriminative capability of the model while maintaining computational feasibility. The proposed framework provides a robust and scalable solution for automated plant disease detection, making it suitable for real-world agricultural applications.

VIII. FUTURE SCOPE

Future work can focus on integrating convolutional neural networks with quantum-inspired feature extraction to further improve classification accuracy. Hybrid CNN-QIP architectures may capture both spatial and quantum-inspired representations, leading to superior performance.

Additionally, the system can be extended to incorporate real quantum circuits using emerging quantum computing platforms. Integration with mobile and web-based applications can enable real-time disease diagnosis for farmers, contributing to precision agriculture and sustainable farming practices.

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