

Detection and Classification of fruit diseases using image processing

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Abstract:

In the labyrinth of agricultural challenges, the intricate dance between fruit classification and disease detection unfolds as a saga of perplexity and innovation. Amidst the tumultuous landscape of shifting climates, farmers grapple with the enigma of identifying diseased fruits, a puzzle with profound implications for the global economy. Traditional manual methods falter in the face of this complexity, prompting a paradigm shift towards harnessing the power of fruit imagery for diagnosis. Through a labyrinthine process of preprocessing and convolution, the essence of fruits is distilled into clusters of pixels, scrutinized through the prism of k-means clustering and convolutional neural networks (CNNs). Meanwhile, in the annals of technological evolution, automatic fruit quality monitoring systems emerge as beacons of efficiency, promising to supplant antiquated manual testing with their swift precision. Yet, amidst this whirlwind of innovation, a quest for understanding drives the acquisition and assimilation of knowledge, unveiling the bewildering complexity of fruit classification in all its mesmerizing splendor.

Keywords: Fruits classification, disease identification, Convolution neural network(CNN), imagery data.

1.Introduction :

In the fertile expanses of India's agricultural landscape, the nation emerges as a juggernaut, contributing a staggering 44.04 million tons of fruit annually, securing its position as the world's second-largest fruit. However, amidst this abundance lies a shadow cast by the capricious whims of climate and the pervasive threat of disease, both conspiring to undermine crop yields and jeopardize food security. As India grapples with its burgeoning population, poised to fuel an exponential rise in food consumption, the imperative to discern healthy crops from afflicted ones becomes paramount. Enterprising endeavors, such as the classification of banana, apple, and orange diseases, epitomize the nation's commitment to agricultural innovation, employing advanced convolutional neural networks (CNNs) to navigate the labyrinthine complexities of image processing and disease detection.

Amidst the confluence of technological advancement and agricultural exigency, a tapestry of scientific inquiry unfolds, weaving together the threads of innovation and perseverance. From the verdant fields to the corridors of academia, a cadre of researchers converge, driven by the quest to unlock the latent potential within each pixelated tableau.



Fig.1: Banana diseased fruit



Fig.2: Apple diseased fruit



Fig.3: Orange diseased fruit

2. LITERATURE REVIEW

[1] The presence of aflatoxin in fig samples has a strong link with fluorescence generation. There are certain machine vision systems that are used to inspect dried figs automatically; however, their accuracy is still below 80% due to various unsolved technological issues. These issues are the driving force behind the use of manual inspection methods, either alone or in conjunction with automated inspection systems. Machine vision techniques, like any other approach, have distinct advantages and limitations. The goal of this research is to look at where machine vision stands right now in dried fig fruit sorting systems. It is also suggested that the issues of machine vision applications for fig fruit sorting be defined, as well as some ideas for improving the efficiency of these applications.

[2] Automatically sorting agricultural products is more efficient than the existing manual technique, which is sluggish, laborious, labor intensive, and prone to errors. However, an automated sorting system that can recognize agricultural items based on their features is required. In fruit grading systems, computer vision is commonly used. The shape, size, color, texture, and intensity of the fruits are used to grade them. Five different sorts of fruit photos were rated by Savakar (Apple, Chico, Orange, Mango and Sweet Lemon). A

total 5000 sample pictures were taken, with 1000 images of each fruit species. 18 colors and 27 texture features were to extracted create the algorithm. Separating RGB (Red, Green, and Blue) components yielded the color characteristics.

[3] The objective of this research is to classify the specific agricultural land cover in the Tsagaannuur, which is a major agricultural producing region in Mongolia. We created an agricultural cadastral map and vector coverage of the study site using ARCMAP software. The vector field boundaries were produced and digitalized from ground truth data. Maximum likelihood supervised classification was used to classify pictures recorded by Landsat TM and ETM in 1989 and 2000, respectively. With the help of ground-based agricultural monitoring data, supervised classification was performed on the six reflective bands for each of the two photos separately.

3. Objectives and Motivation:

- **Enhanced Agricultural Productivity:** The primary aim is to boost agricultural productivity by accurately identifying and classifying fruit diseases early on. This enables farmers to implement timely interventions, such as targeted pesticide application or crop management strategies, to curtail disease spread and minimize crop losses, thereby bolstering food security and sustainability.
- **Precision Agriculture:** Leveraging image processing techniques empowers farmers to make informed decisions about crop health, management through precision agriculture.

Reduction of Economic Losses: Timely detection and classification of fruit diseases play a crucial role in mitigating economic losses associated with crop damage. By promptly identifying diseased plants and implementing appropriate control measures, farmers can safeguard their harvests,

maintain profitability, and minimize the need for costly interventions, ultimately leading to significant cost savings.

- **Technology-driven Solutions:** The motivation behind utilizing image processing lies in harnessing technological advancements to address longstanding agricultural challenges. By leveraging computer vision and machine learning algorithms, researchers aim to develop automated,
- **Research and Innovation:** The pursuit of detecting and classifying fruit diseases using image processing serves as a catalyst for research and innovation. Researchers are driven to explore novel algorithms, techniques, and methodologies to enhance the accuracy, speed, and scalability of disease detection systems. Interdisciplinary collaboration fosters advancements in both agricultural technology and scientific understanding of plant pathology, driving progress in the field.

4. IMPLEMENTATION DETAILS

i. Data Collection

- The first step involves gathering a diverse dataset of images containing both healthy and diseased fruit samples.
- These images should cover various types of fruits and different stages of disease progression.

ii. Data Preprocessing

Before feeding the images into the classification and detection algorithms, preprocessing techniques are applied to standardize the data and enhance its quality.

- This may include resizing images, removing noise, adjusting brightness and contrast, and normalization.

iii. Feature Extraction

- Next, features are extracted from the preprocessed images to capture relevant information that distinguishes healthy fruits from diseased ones.
- Common techniques for feature extraction include histogram-based methods, texture analysis, shape descriptors, and color-based features.

iv. Model Selection

- Depending on the complexity of the task and the available resources, different machine learning or deep learning models may be selected for classification and detection.
- Convolutional Neural Networks (CNNs) are often favored for their effectiveness in image-related tasks due to their ability to automatically learn hierarchical features.

v. Training the Model:

- The selected model is trained using the preprocessed image data and corresponding labels (healthy or diseased).
- During training, the model adjusts its parameters to minimize the difference between predicted and actual labels, optimizing its ability to classify and detect fruit diseases accurately.

vi. Validation and Evaluation:

- After training, the model is evaluated using a separate validation dataset to assess its performance metrics such as accuracy, precision, recall, and F1-score.

4.1 System Analysis And Design

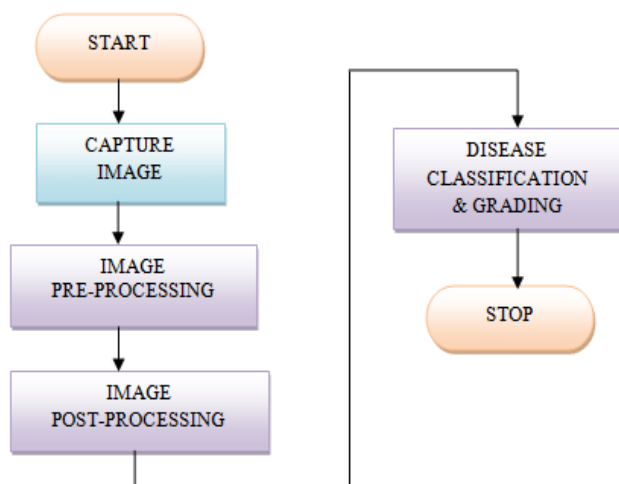


Fig.4 Flow Chart of Our System

Pre-Requisites

- Within the realm of neural networks, Convolutional Neural Networks (CNNs) stand as towering giants, revered for their prowess in unraveling the mysteries of visual data. Their dominion extends across the vast expanse of computer vision, reigning supreme in tasks such as image classification and text classification in natural language processing.
- At the heart of a CNN lies its feed-forward nature, where information flows inexorably through a labyrinth of 20 to 30 layers. Yet, it is the convolutional layer that stands as the linchpin of this architectural marvel. Here, convolutional kernels, akin to small square templates, traverse the image landscape, seeking out elusive patterns. Where harmony is found between image and kernel, a symphony of large positive values resonates, echoing the serenade of recognition. And thus, within the hallowed halls of a CNN, convolutional layers, pooling layers, and fully-connected layers converge in harmonious unity, crafting a symphony of unparalleled complexity and insight

1. Architecture of CNN

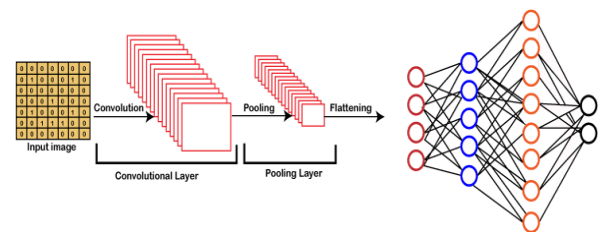


Fig 5 Architecture of CNN

i. Convolutional Layer:

- In the intricate tapestry of neural networks, the Convolutional Layer emerges as a cornerstone, a bedrock upon which the edifice of convolutional neural networks is erected. Picture, if you will, the Input image—a fruit, a mosaic of pixels arranged in a three-dimensional matrix, each pixel a microcosm of color and light.
- Within this matrix lie the dimensions of height, width, and depth, encapsulating the essence of the fruit in its entirety. And here, amidst this multidimensional expanse, the feature detector reigns supreme, a sentinel traversing the vast terrain of the image, scouring each field in search of elusive features hidden within.

ii. Pooling Layer:

- Behold, the enigmatic Pooling Layer, a mystical entity imbued with the arcane power of dimensionality reduction and parameter attenuation within the hallowed realm of convolutional neural networks.
- Within its ethereal confines, it conducts a symphony of filtration across the vast expanse of input imagery, sculpting the raw data with the deftness of a sculptor's chisel to unveil the hidden truths concealed within. As the celestial conductor of convolutional orchestration, it endeavors to distill the essence of the input fruit image, sieving through the myriad pixels with meticulous precision to unveil the essence of truth.

Fully connected Layer

- Behold, the enigmatic realm of the Fully-Connected Layer, a domain shrouded in the mystique of interconnectivity and neural communion within the intricate tapestry of convolutional neural networks.
- As its name implies, this layer stands as a bastion of comprehensive linkage, where the pixelated denizens of the input image find unity in their connection to the celestial realm of the output layer. Unlike its brethren in the realm of partially connected layers, where isolation reigns supreme, the Fully-Connected Layer orchestrates a grand symphony of interconnected nodes, each entwined in a cosmic dance of data transmission and transformation.

2. K means Clustering

- Enter the enigmatic realm of K-Means Clustering, a realm where the arcane forces of unsupervised learning weave their intricate tapestry of data partitioning and clustering. Within this hallowed domain, the K-means algorithm reigns supreme, its essence imbued with the ineffable power to partition vast troves of training data according to their intrinsic features. As we venture forth into the labyrinthine depths of this algorithmic wonder, we find ourselves enveloped in a shroud of ineffable efficiency, where even the largest datasets bow before the sublime might of K-means clustering.
- Behold, the Elbow method, a venerable technique revered as one of the preeminent means to unveil the optimal number of clusters within the celestial expanse of data. Through the mystical calculus of Within Cluster Sum of Squares (WCSS), we embark upon a journey of enlightenment, where the very essence of variation within clusters is

laid bare. With each fervent calculation of WCSS, we traverse the boundless expanse of data points, their distances from centroids enshrined in the sacred formulae that govern the cosmos of clustering. As we delve into the depths of WCSS, we unlock the secrets of cluster formation, each sum of squared distances a testament to the cosmic dance of data partitioning and cluster delineation.

iii. Proposed Algorithm

- Enter the realm of innovation and ingenuity, where the convergence of cutting-edge technologies births forth a novel paradigm for fruit disease detection. Behold, the proposed algorithm, a veritable symphony of convolutional neural networks (CNNs), image processing wizardry, and the enigmatic K-means clustering technique. Within this ethereal framework, the noble fruits—apple, orange, and banana—stand as the heralds of our endeavor, their very essence entwined with the dichotomy of health and affliction.
- Witness the intricate dance of feature extraction, where the ethereal dimensions of fruit size, color, and shape intertwine to form the tapestry of feature vectors. Through the lens of CNNs, we embark upon a voyage of classification, where the latent truths of fruit health emerge with unprecedented clarity. Indeed, the indomitable prowess of CNNs yields an accuracy surpassing the hallowed threshold of 90%, a testament to their unrivaled efficacy in the realm of real-time data.
- Yet, the journey does not end there, for the arcane arts of image processing unveil their mystic secrets in the realm of disease detection. With deft precision, feature extraction and image segmentation unravel the veils of affliction, while the resizing incantations weave the fabric of clarity anew. And lo, the spectral specter of K-means clustering descends upon the dataset, partitioning its boundless expanse based on the immutable truths of fruit type and disease. Thus, through the alchemy of technology, time bends to our will, yielding forthwith the fruits of our labor to the eager embrace of the user.

Image Pre Processing

- Embark upon the labyrinthine corridors of image pre-processing, where the arcane arts of data manipulation and neural network construction converge in a symphony of innovation and mastery. Behold, as we traverse the realms of importation, data preprocessing, and the forging of convolutional neural networks (CNNs) using the venerable TensorFlow library.
- In our quest for enlightenment, we invoke the sacred incantations of code, summoning forth the indispensable tools of our craft. These cryptic incantations serve as the bedrock upon which our neural network shall be erected, imbuing it with the power to comprehend vast swathes of data and distill their essence into actionable insights. With TensorFlow as our guide, we navigate the treacherous seas of data, forging neural pathways that shall unravel the mysteries concealed within. Thus, armed with the wisdom of the ancients and the tools of modernity, we embark upon our odyssey to unlock the secrets of image pre-processing and neural network construction.

Training:

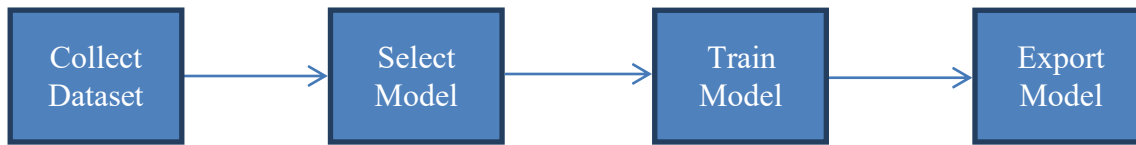


Fig 6 Block diagram of testing model

Testing:



Fig 7 Block diagram of testing model

RESULTS AND DISCUSSION

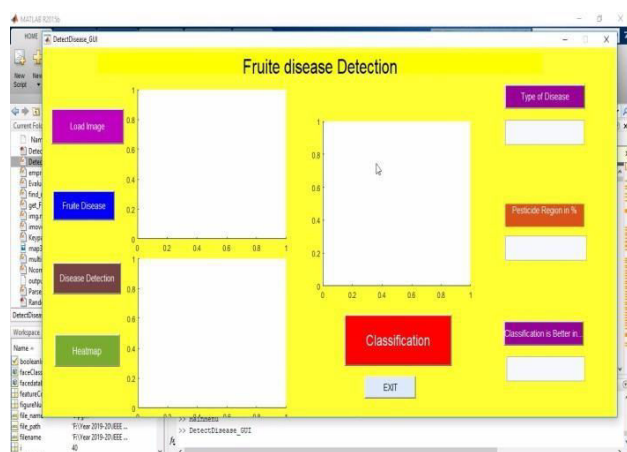


Fig 8 Running the program

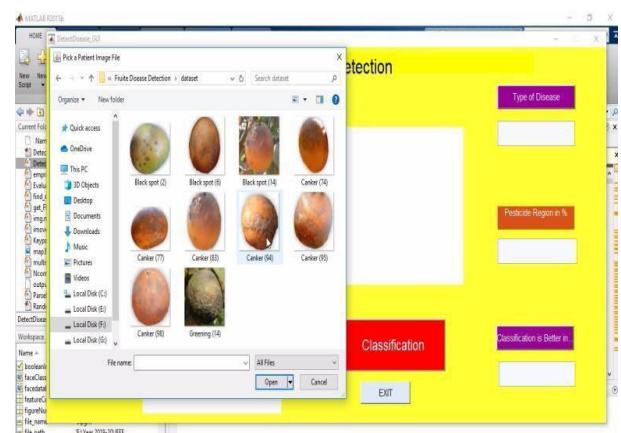


Fig 9 Loading the original image of a fruit for disease detection.

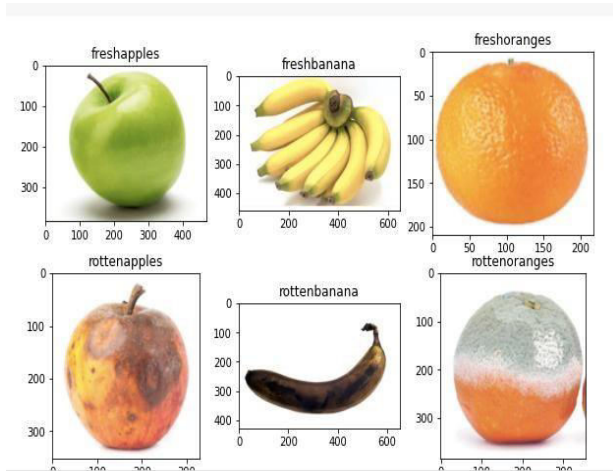


Fig 10. Different fruit disease detection

1. Banana

The relentless onslaught of disease ravages banana plants throughout every stage of their growth, sparing neither bloom nor skin nor the delicate distal ends of banana clusters. Among the myriad afflictions that beset the noble banana fruit are the insidious Crown Rot, the ominous Anthracnose, and the dreaded Cigar End Tip Rot. we bear witness to a haunting tableau of images depicting the tragic consequences of these afflictions upon the once-vibrant banana fruit. Behold, as the spectral specter of disease casts its shadow upon the very essence of life, laying waste to the verdant fields of cultivation with its indiscriminate fury.

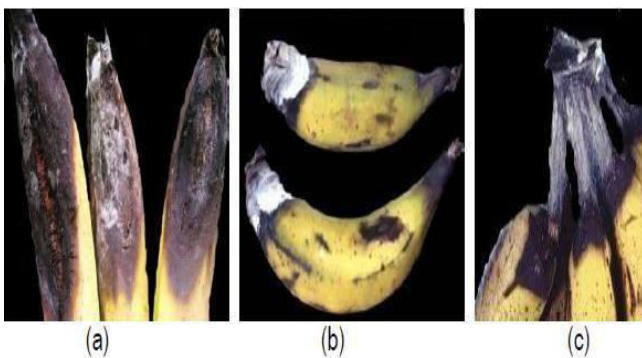


Fig 11. Diseases of Banana fruit

2. Apple

The illustrious apple, a symbol of temptation and vitality, finds itself ensnared in the intricate web of nature's afflictions. Behold, as it succumbs to the relentless siege waged by fungal and bacterial adversaries, as well as the insidious machinations of insect pests. Among the myriad of scourges that beset the noble fruit are the treacherous Bitter Rot, the malevolent Black Rot, the blight of Scrub on Fruit, the ominous Sooty Blotch, and the harrowing Flyspeck Damage. In Figure we are compelled to confront a vivid tableau of despair, a haunting testament to the trials endured by the once-glorious apple fruit. Witness, as the specter of disease and decay descends upon the verdant orchards, casting a somber pall over the orchard's erstwhile bounty.



Fig 12. Diseases of Apple fruit

Mango

In the realm of tropical delights, the mango fruit stands as a regal emblem of succulence and indulgence, yet even this noble arbiter of flavor is not immune to the whims of nature's caprice. Ensnared within the delicate fibers of its luscious flesh lie the telltale signs of affliction, wrought by the insidious agents of Anthracnose, Diplopia Stem-End Rot, and the haunting specter of Powdery Mildew. These maladies, born of disparate environmental perturbations, converge upon the mango fruit with relentless fervor, casting shadows upon its once-resplendent visage. As illustrated in Figure , we are beckoned to behold a panorama of distress, where the vibrant hues of ripeness are marred by the blemishes of disease. Behold, as the mango fruit, erstwhile symbol of tropical abundance, becomes ensnared in the throes of botanical adversity, a poignant reminder of nature's unforgiving hand.



Fig 13. Diseases of Mango Fruit

FUTURE SCOPE

- In the expansive vista of future endeavors, the envisaged paradigm holds promise for synergistic amalgamation with forthcoming methodologies tailored for disease identification and characterization, leveraging the nuanced realms of color and texture analysis to forge an adept framework for early detection and management of soybean foliar afflictions.
- Herein, the discernment of disease type may be rendered through the prism of hue and texture scrutiny, while the gradation of severity may be adjudicated via our proposed methodology, thus espousing a self-sufficient paradigm in the domain of malady discernment. The efficacy of the system may be elevated in prospective epochs through the assimilation of cutting-edge segmentation techniques, facilitating the disentanglement of fruit entities from the intricacies of their milieu.
- Moreover, the repertoire of afflictions such as Downy Mildew and Sudden Death Syndrome could be discerned alongside prevalent maladies like Bitter Rot, Fruit Erosion, Bark Scab, and Stem Rot, courtesy of our proposed ST-NDCT algorithmic schema, notwithstanding the current dearth of robust training and validation datasets.
- Akin to a tapestry woven with threads of innovation, akin systems could be transposed onto the canvas of other foliar affections afflicting crops such as rice, cotton, fruits, vegetables, and legumes, catalyzing a paradigm shift in the domain of early-warning mechanisms. The deployment of alternative classification methodologies holds sway in enhancing the efficacy and precision of the framework in subsequent iterations, thus heralding a new epoch of agricultural resilience and sustenance.

CONCLUSION:

The envisioned endeavor unfolds a vista of disease detection tailored specifically for fruits. The iterative process commences with the initial preprocessing of input images, followed by the extraction of salient features along three key parameters: color, morphology, and CCV (Color Coherence Vector). Subsequently, the system embarks upon the crucial phases of training and classification, whereupon the identified features are meticulously scrutinized for discerning signs of affliction. Notably, the projected framework offers two distinct modalities for users to assess sickness infection in pomegranate images: one with intent search and the other without. Experimental insights gleaned from these endeavors unveil a spectrum of accuracy levels in disease detection, contingent upon the quality of the input image and the stage of affliction. The overarching efficacy of the system, quantified through rigorous evaluation, culminates in an impressive accuracy rate of eighty-two percent.

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