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Disease Mapping for Arecanut Tree using CNN

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Abstract

Arecanut is a significant crop in India, with Karnataka accounting for over 80% of its cultivation. The crop is prone to various diseases, including kole roga, Pentatomid bug (Tigane Roga), yellow leaf disease, root grub, and anabe roga. This study presents a system designed to map arecanut diseases in specific locations onto a geographical web map and accurately recognize the disease. The recognition module employs a CNN-based deep learning approach, while the web interface and mapping functionalities are developed using Python and the Django framework. As a case study, the system was tested in villages around Sirsi, including Vrgasara, Agasala, and Puttanamane. The proposed system achieved a validation accuracy of 90% for detecting kole roga in the provided images.

Keywords: Koleroga, Arecanut, Convolution Neural Network

INTRODUCTION

The proposed project focuses on developing a web application to assist farmers and agricultural enthusiasts by providing Detection and Mapping services for arecanut diseases.

Detection Service : The detection functionality enables users to upload an image of arecanut, which is analyzed to determine its health status. The system identifies whether the arecanut is healthy or affected by a disease such as koleroga using supervised learning and deep learning techniques, including Convolutional Neural Networks (CNNs).

Mapping Service: The mapping service allows users to input a survey number, displaying detection results as color-coded pop-ups on a geographical map, with distinct colors representing different diseases. The mapping process integrates latitude-longitude information and GeoJSON data for accurate geographical visualization. The primary goal of mapping is to notify neighboring farms if a contagious disease is detected, enabling timely interventions.

Role of Disease Maps: A key feature of the project is the use of disease maps, which effectively communicate risk levels and spread awareness among farmers and agricultural advisors. These maps encourage the adoption of best practices to mitigate disease spread, ensuring more sustainable farming.

System Overview: This project examines the design and implementation of a system for disease detection and mapping, leveraging machine learning techniques. A user-friendly interface is built to capture, store, and analyze current and historical disease datasets. These datasets are distributed geographically, providing a clear visualization of disease patterns over time.

The system is trained on historical and newly acquired data to predict diseases based on location-specific and climatic factors. Early detection through the system empowers farmers to take timely precautionary measures, minimizing crop losses.

Addressing Arecanut and Rubber Tree Diseases: The yield of plantation crops such as arecanut and rubber trees is influenced by factors like humidity, temperature, wind speed, soil conditions, and diseases. These crops are vulnerable to various diseases that affect key areas, including the leaf, stem, panel, fruit, and roots, throughout their growth. Pathogen infections have been identified as a major cause of yield losses in these crops. Early detection and preventive measures supported by technology are essential to curbing these losses.

Implementation: The recognition module of the proposed system is implemented using a CNN-based deep learning approach. The web interface and geographical mapping functionalities are developed using Python and the Django framework. This project aims to support farmers in Karnataka, particularly those cultivating arecanut, by providing a robust, technology-driven solution for disease management.

LITERATURE SURVEY

P. Chowdappa, Vinayaka Hegde, R. Thava Prakasa Pandian, and M. Chaithra, in their work published in the Indian Journal of Arecanut, Spices & Medicinal Plants [1], have detailed various diseases affecting arecanut and their associated symptoms. Diseases such as kole roga/mahali roga, foot rot/anabe roga, and yellow leaf disease are discussed along with their causes. The paper also explores control measures like medicinal sprays and the removal of infected plant parts.

The TNAU Agriculture Portal, maintained by Tamil Nadu Agricultural University [2], provides detailed descriptions of arecanut diseases, including their symptoms such as leaf yellowing, fungal development, and brown discoloration, along with preventive measures to combat these diseases.

Sharada P. Mohanty, David P. Hughes, and Marcel Salathe, in their paper titled Using Deep Learning for Image-Based Plant Disease Detection [3], analyzed over 50,000 images of plant leaves. They optimized disease prediction by reducing image resolution to 256x256 pixels. The authors developed three datasets, incorporating color and segmentation details of leaves, and trained all three datasets, selecting the best-performing one based on testing accuracy.

Gokulnath B. V. and Usha Devi G., in their paper A Survey on Plant Disease Prediction Using Machine Learning and Deep Learning Techniques [4], discussed various factors affecting plant diseases, including challenges and environmental conditions. They reviewed prominent machine learning and deep learning techniques, such as Random Forest, Bayesian Networks, Decision Trees, and Support Vector Machines, which utilize visual attributes on plant surfaces to detect diseases using supervised learning techniques.

Crop losses due to plant diseases can be mitigated through early detection and timely precautions. The proposed project seeks to provide technical assistance via a web application. This application allows users to upload images for disease detection and maps the results geographically using survey numbers. Image classification using Convolutional Neural Networks (CNNs) has been identified as an optimal solution for this purpose.

Problem:

Arecanut is a major crop in Karnataka's Western Ghats, one of the largest producers in India. This crop has a rich history in Indian medicine, as documented in ancient texts such as Vagbhata's (4th century A.D.), which highlight its use in treating cough, anemia, and obesity. Modern applications include eco-friendly plate production, battery cell development, and health-beneficial areca tea.

Despite its significance, arecanut faces severe threats from diseases like kole roga, anabe roga, yellow leaf disease, root grub, and pentatomid bug, which result in substantial crop losses. The proposed system aims

to tackle these challenges by recognizing diseases from user-provided images and mapping affected areas using survey numbers.

MAIN OBJECTIVES

The proposed system seeks to:

- Detect and classify arecanut diseases using input images.
- Map detection results to the respective locations via survey numbers.
- Raise awareness of pathogenic diseases affecting arecanut in Karnataka.
- Support farmers, researchers, and learners by predicting and recognizing diseases under current environmental conditions.

METHODOLOGY

The development process includes:

Data Gathering

Data is collected through farm visits, Google Forms, and inputs from farmers, research labs, institutes, and agri-entrepreneurs. Admins can manually input data into the system.

Data Preparation

Data is processed using Jupyter and Python, structured, and validated to create a dataset for modeling disease patterns.

Website Development and Data Mapping

A website is designed to map disease data as scattered points on a geographical map corresponding to the locations where data was collected.

Modeling

The dataset is divided into training, testing, and validation sets. Training data is used to train classification models, including CNNs. Model performance is validated and optimized, and live data is tested to identify the best-fit model.

CNN ARCHITECTURE

A Convolutional Neural Network (CNN) is used for image-based pattern detection. Key components include:

Input Layer: Processes the input image.

Hidden Layers: Composed of:

Convolution Layer: Extracts features by performing computations.

Pooling Layer: Reduces computational complexity by down-sampling feature maps.

Fully Connected Layer: Links convolution and pooling layers, enabling classification.

Output Layer: Provides the final classification results.

The CNN mimics the human brain, with each layer learning specific features to enhance accuracy.

This methodology ensures an efficient, accurate, and user-friendly solution for arecanut disease detection and mapping.

1. SYSTEM DESIGN

The system's overall design for disease mapping of arecanut and rubber is depicted in **Figure 1** below.

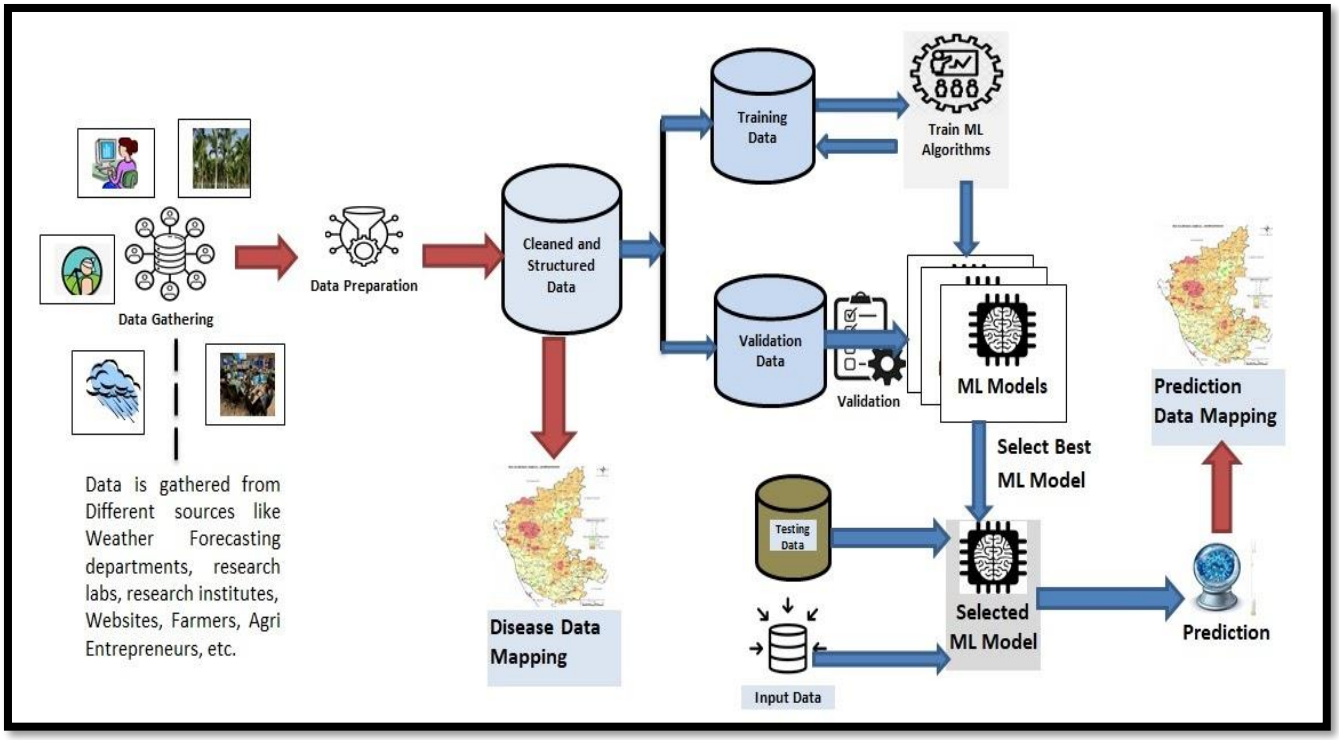

Figure 1: Design of the proposed disease mapping for arecanut

The figure illustrates the **overall design and workflow of the proposed disease mapping system for arecanut and rubber crops**. Below is a step-by-step explanation:

1. Data Gathering :

Data is collected from diverse sources, such as:

- Weather forecasting departments
- Research labs and institutes
- Websites
- Farmers
- Agri-entrepreneurs

The collected data includes disease-related information, environmental conditions, and geographical details.

2. Data Preparation:

The gathered data undergoes preprocessing to ensure it is clean, consistent, and structured.

Key Steps:

1. Combining data from various sources.
2. Organizing and validating the data for analysis.
3. Preparing structured datasets that can be used for machine learning models.

3. Disease Data Mapping

- The structured data is mapped geographically, using location-specific survey numbers.
- Disease occurrences are visualized as scattered points on a geographical map, making it easier to identify affected areas.

4. Dataset Segmentation

The data is divided into three parts for machine learning processes:

- **Training Data:** Used to train machine learning models.
- **Validation Data:** Helps evaluate and optimize different models to choose the best-performing one.
- **Testing Data:** Used to test the trained model with unseen data and ensure its effectiveness.

5. ML Models

Machine learning algorithms are applied to the prepared datasets.

Models are trained, validated, and tested to predict diseases accurately. **CNN (Convolutional Neural Networks)** is the algorithm used in this workt for image classification tasks. After evaluation, the best-performing model is selected.

6. Disease Prediction

Once the selected model is trained, it is deployed to predict whether the given image of an arecanut is diseased or healthy. The prediction results are mapped onto the geographical data using the survey numbers provided by the user.

7. Prediction and Data Mapping

The system outputs predictions for new inputs and integrates them with the mapped data.

This enables farmers, researchers, and other stakeholders to identify affected areas and take preventive measures.

The f**igure1** represents a complete pipeline, starting from data collection and preparation to disease prediction and mapping. The system ensures accurate identification of diseased crops and integrates the findings into a geospatial map for practical applications.

In this research work, the ML model is trained on diseased and healthy images of arecanut. It classifies images into two categories: **Diseased** or **Healthy**, enabling effective disease recognition.

This comprehensive process ensures the system's capability to assist farmers by detecting and mapping arecanut diseases efficiently.

RESULTS AND DISCUSSION

The objective of the research project "Disease Mapping for Arecanut" is to develop a web-based interface capable of detecting diseases in arecanut plants based on user-uploaded images. The mapping of detected diseases is performed using the survey number provided by the user.

The dataset for the proposed system comprises images of both diseased arecanut (affected by Kole Roga, 209 images) and healthy arecanut (84 images). The dataset is split in a 7:3 ratio, with 70% used for training and 30% for validation. A machine learning model was trained using these datasets to distinguish between healthy and diseased images. When tested with a random image from the validation dataset, the system successfully classified it. The disease detection model achieved an impressive 100% training accuracy.

The provided image (Fig1) showcases the homepage design of a web application titled "Disease Mapping for Arecanut". Below is a detailed explanation of the components:

Header Section : The navigation menu at the top includes the following options:

Home: Returns to the main homepage.

Recognition: Likely leads to a feature for identifying plant diseases.

Prediction: Redirects to a section for predicting diseases based on input data.

Map: Provides a geographical view or mapping of disease occurrences.

Login: Allows users to log in to the system for additional functionalities.

Main Content

1. **Title:** "Disease Mapping for Arecanut", The title prominently describes the purpose of the web application.
2. **Informational Section:** A brief explanation of the platform is provided:

The system uses plant pathology to study diseases caused by pathogens (e.g., fungi, bacteria, and viruses) and environmental conditions.

The platform applies machine learning and artificial intelligence to determine whether a crop is healthy or diseased based on an uploaded image.

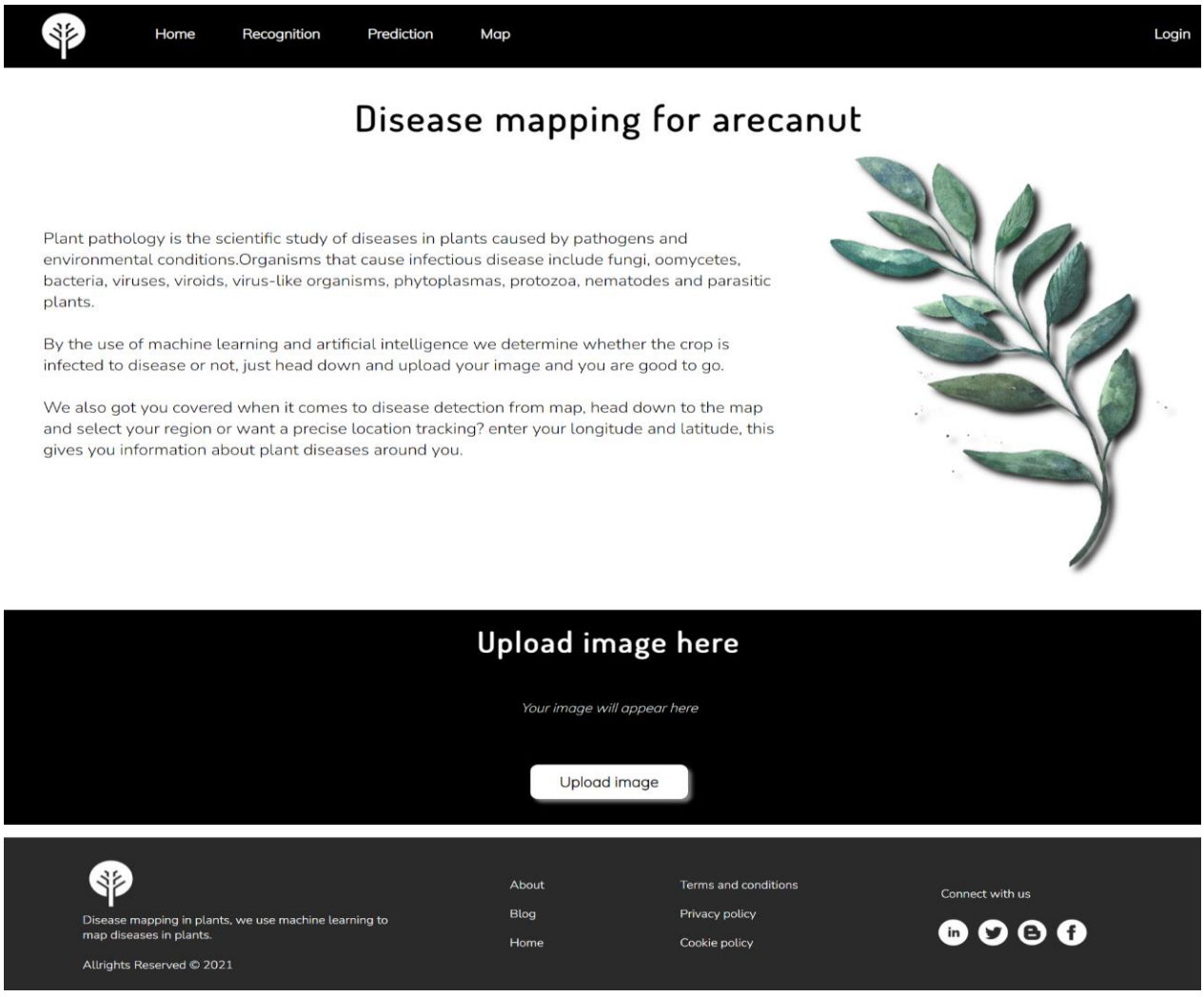

Fig2: Web Interface Design for Arecanut Disease Mapping System

Instructions: Users are guided to upload an image for disease detection.

The system maps the detected disease to a specific geographic location using survey numbers or latitude and longitude.

Image Upload Section: Includes a placeholder for users to upload images of arecanut plants. Button labeled "Upload Image" allows users to select and submit their images for analysis.

Footer Section

About Section: Mentions that the platform focuses on disease mapping for plants with the help of machine learning.

Privacy Policy & Terms: Links to important policy documents.

Social Media Icons: Provides connectivity options for sharing or learning more about the platform.

Visual Design

The design features a minimalist black-and-white theme with a clean layout and an illustration of a plant leaf for visual appeal.

This web interface provides an easy-to-use platform for farmers, researchers, and users interested in identifying and tracking diseases in arecanut crops.

Recognition: In this you can upload the image and get the result as Diseased (with name of the disease) or healthy.

Map: Used to visualize the area which is under the effect/influence of disease.

Login: Used to login to website and to get full access on all the features.

Signup: Used to create new account.

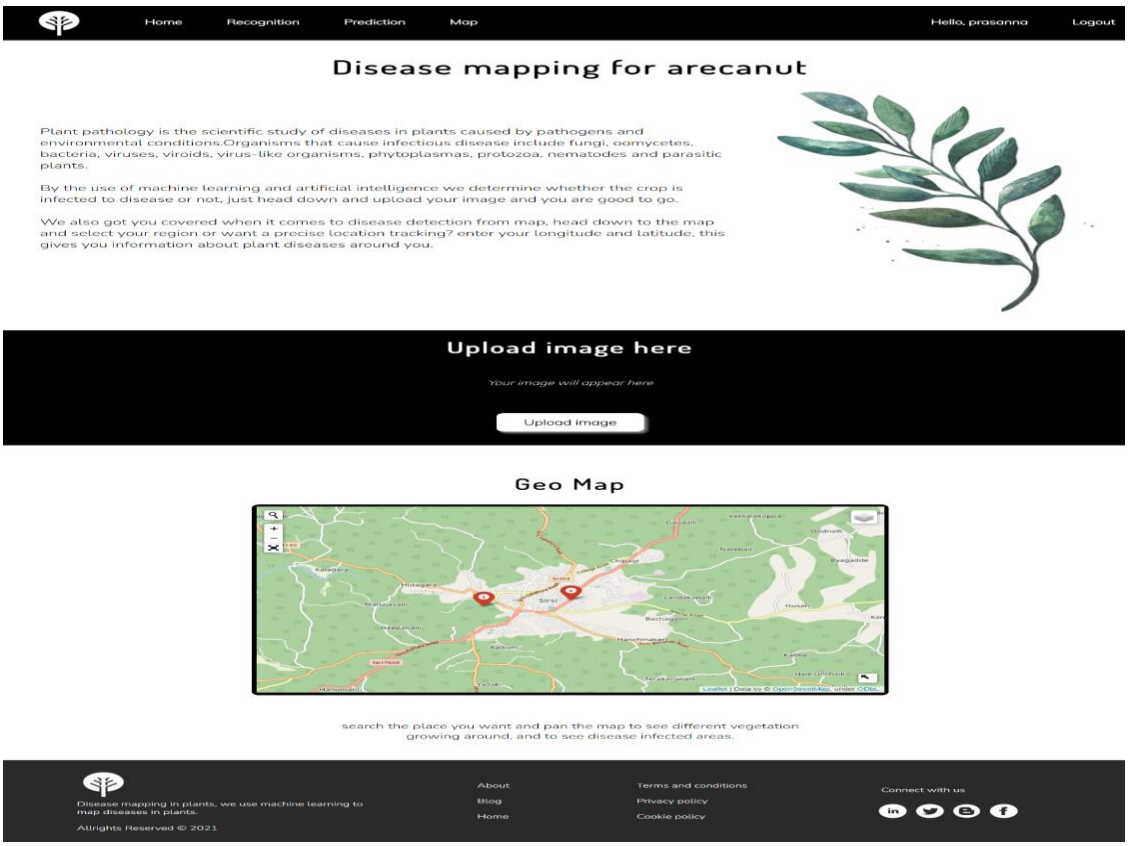

Figure 3: Main Page after login

Geo Map is only visible after login. It ensures Security and privacy for the data. Only authorized user is allowed to view the map. Geo Map consists of markers to show the area which is being effected by the disease.

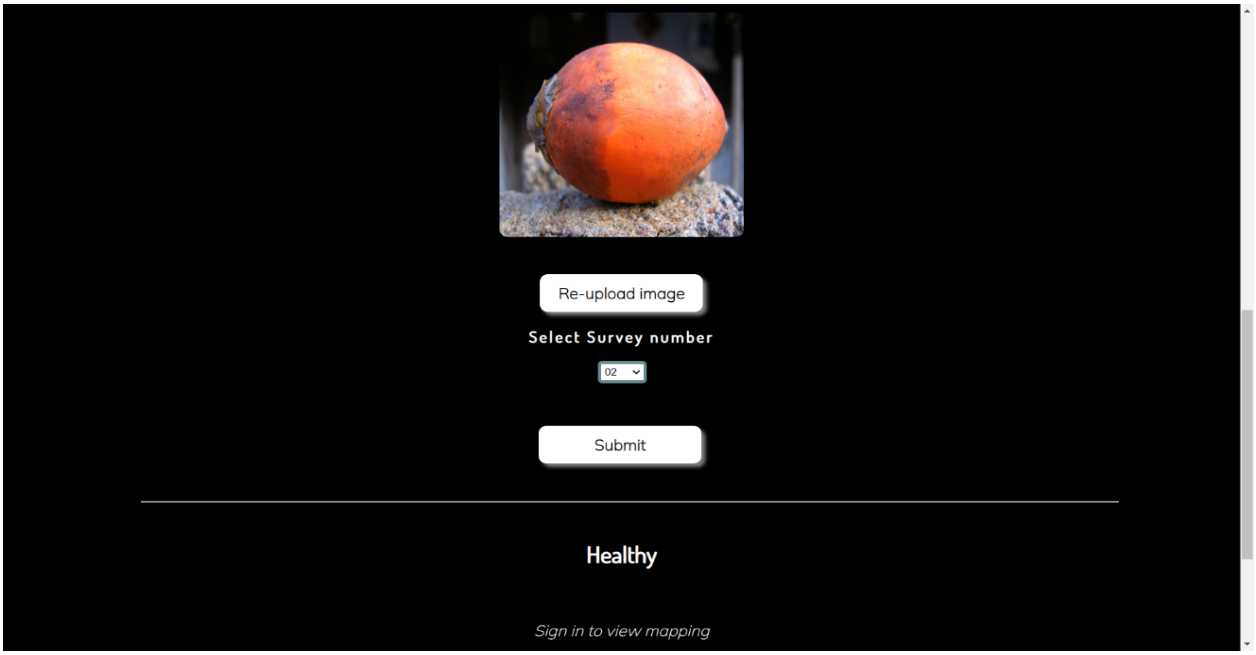

Figure 4: Classifying the image as healthy

Here, image uploaded is healthy arecanut. Proposed system provides drop down menu to select survey number. After clicking the Submit button model will classify whether arecanut is healthy or it is affected by kole roga.

After clicking submit button, model classified the above image as Healthy and it is displayed on the screen. System shows Re-upload image option to upload the different image once again.

Here, image uploaded is arecanut affected by kole roga. Proposed system provides drop down menu to select survey number. After clicking the Submit button model will classify whether arecanut is healthy or it is affected by kole roga

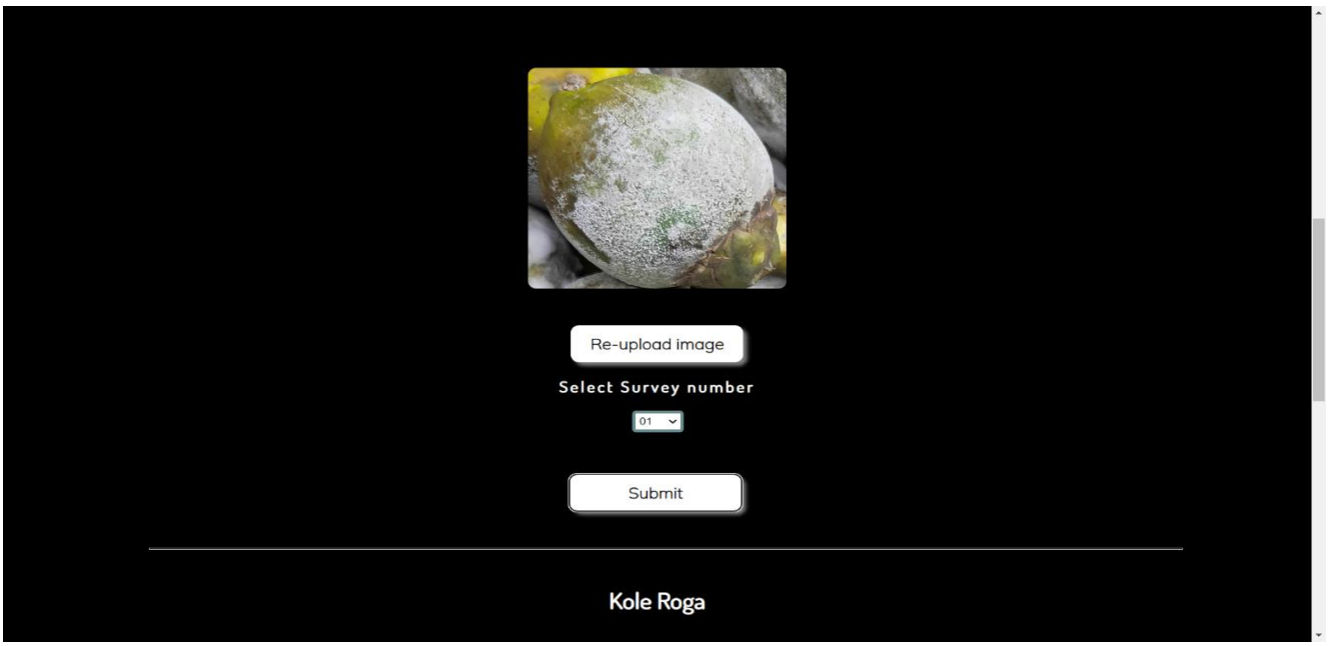

Figure 5: Classifying the image as kole roga

Figure 6: Disease Mapping

Above figure shows the areas effected by kole roga near Sirsi. Markers are used to highlight the areas which are effected by kole roga. Mapping is very much helpful for arecanut growers to take precautionary measures to minimize the loss.

The application id developed using Django framework. Programming language used is python. Above figures shows the various sections of the proposed system. Disease detection model is implemented using CNN. Frontend is implemented using HTML, CSS and Java Script. Mapping uses GeoJson file and folium library.

CONCLUSIONS AND FUTURE WORK

Here, the paper proposes an approach for recognizing and notifying about the various seasonal diseases of Arecanut. This is more useful in preventing the disease and their outbreaks. This project's objective is to develop a Disease mapping and recognition system by implementing a user-friendly web app and enhancing the use of advanced machine learning processes for the efficient solution to help the farmers affected from the diseases causing huge loss.

At present recognition system is implemented only for single disease, multiclass recognition system is required to classify more number of diseases. Prediction system need to be implemented in order to notify the farmers before its outbreak. Implementation of mapping for all over the state is much required.

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