Crop Disorder Detection using Hybrid Model based on Image Processing and Ontology Engineering

Acknowledgment

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Abstract

Farmers' current approach for detecting plant disorders is that they can be spotted with the naked eye and their understanding of plant disorders. It is time-consuming, difficult, and inaccurate to do so on a large number of plants. Using specialists comes at a high price. In such circumstances, suggested procedures are used where technologies are employed for the automatic detection of diseases, making the process cheaper and easier. A high level of complexity is added by visually examining symptoms on plant leaves and pods, where plant disorders can be easily detected. Image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. In some cases, different plant damage shows similar symptoms. In such a case an ontology engineering knowledge base is used to clearly identify whether it is a pest, disease, or nutrition deficiency. It is possible to identify the damage accurately. It also provides solutions to the damage caused by the use of the knowledge base.

Keywords: Disease detection, Pest damage detection, Nutrition deficiency, image processing, Knowledge base

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Chapter 1: Introduction

Project Background

In the agricultural domain, crop diseases are a huge problem for yield production. If the farmers or any other stakeholders who are engaging in crop cultivation, can recognize the diseases of their cultivating crops without the expert knowledge themselves, that will provide huge benefits and can take quick actions on that matter to prevent future damages and losses. Therefore, having a quicker and easy way to detect crop diseases is a necessity.

Sri Lanka is one of the counties based on agriculture. When cultivating a crop, the problems can arise when the crop is harmed by a variety of reasons and it causes to the yield at the end. In order to get a good harvest from the cultivation, it is important to identify diseases, damages done by pests or nutritional deficiency early. When the crop is showing symptoms, if the farmer has no idea about the symptoms, the normal procedure is the farmer has to consult an expert and get his advice to rescue the damages. Meeting an expert every time to take advices is kind of time consuming and trouble making for both farmers and experts. If there is a system that can gather the knowledge of the expert with the identification of the problem that the crop is having then it will be very useful for farmers. There are researches done suggesting different methodologies and developing different kinds of systems in order to identify the crop diseases and other several problems that occur in crop cultivation. In this project we are suggesting an approach with the combination of image processing technology and ontology to identify crop disease, pest and nutritional deficiencies of the crops. When developing the system, we are going to use the Okra (*Abelmoschus esculentus L. Moench*) as the crop.

Okra Cultivation in Sri Lanka

Okra (*Abelmoschus esculentus L. Moench*), commonly known as Lady's Finger is one of the most popular fruit vegetables grown in Wet, Intermediate and Dry zone of Sri Lanka with a total cultivated extent of 8,090.1 Hectares (Yala and Maha 2020), while producing 81,444.0 MT annually ("Highland Crops", 2021). Presently okra is successfully cultivated in the districts of Anuradhapura, Kurunegala, Hambantota, Ratnapura and Matale. Also, it is expanding in potential districts like Puttalam, Matara, Badulla and Monaragala. Okra has been identified as one of the potentially important food plants of Sri Lanka. And Okra is one of the food plants

that are cultivated in any part of the country on a large scale and as a home garden crop. And it is a common food consumed by many Sri Lankans.

Importance of using an Ontology

Today modern technology based agricultural industries are emerging. This is because modern technology can be used to solve real world problems that arise in agriculture. It develops a system that can be easily used by farmers using new technologies to diagnose and address crop disease symptoms. But for now, many are mainly focusing on image-based patterns of cognition and less attention to the observed inequalities in plant diseases. Ontology is a conceptual model that can be used to create a knowledge base. It represents their mutual relations. Knowledge base is like a database but it is more advanced than the database. By using that users can retrieve explicit and implicit. Using such an ontology-based knowledge base is prominent in many domains to solve real-world problems. In the agriculture domain, having such a disease knowledge base is important to retrieve both explicit and implicit disease knowledge for farmers.

Project Description

The proposed project which is focusing on detecting crop cultivation problems like diseases, pest damage, and nutrition deficiency. Also giving the solutions for those problems. This system uses a blend of ontology engineering and image processing. In information technology, an ontology is the working model of entities and interactions in some particular domain of knowledge or practices. In this research, a precise ontology on the problem of crop cultivation will be built in order to provide a more accurate relationship between the damage of crop cultivation. This study will consider the type of diseases, pest damage, and nutrition deficiency.

It is expected to use the leaves and crops to observe these obstacles.
Here we have selected Okra as the crop for testing the proposed methodology. We gathered all the information about the domain of okra through feasibility analysis.

An okra crop belonging to family Malvaceae. Easy to grow and can be grown in throughout the year, making it popular among farmers. Okra has few growing stages. Those are; seed, germinating, young seedling, older plant, flowering, okra pod bearing, harvesting.

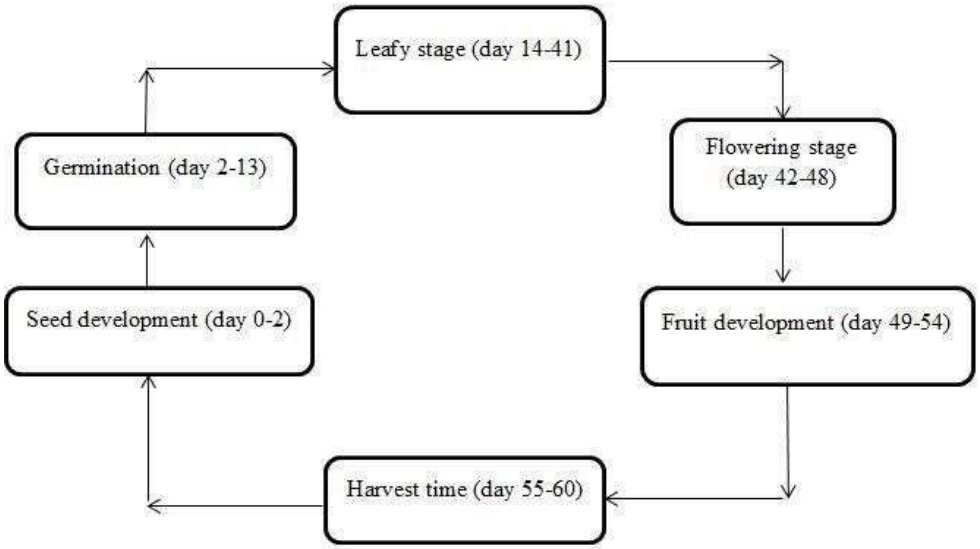


Figure 1:Okra Growing Life Cycle

Okra can victim diseases, pest damage, and nutrition deficiency at any stage after the germination.

Table 1: Diseases, Pest and Nutritional Defeciencies of Okra

Diseases	Pest damage	Nutrition deficiency
Powder mildew	Red-cotton bug	Nitrogen (N)
Yellow vein mosaic	Leaf Webber	Phosphorus (P)
	Shooter and fruit borer	Potassium (K)
		Magnesium (Mg)
		Zinc (Zn)
		Manganese (Mn)
		Calcium (Ca)
		Iron (Fe)
		Sulphur (S)

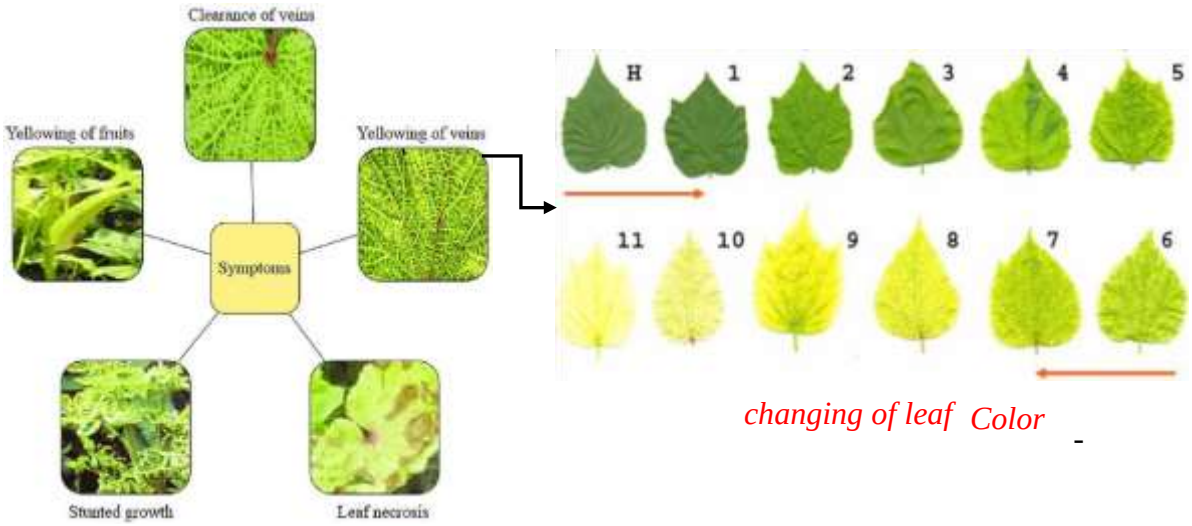
Often the symptoms in the above categories are similar. It is difficult to pinpoint the problem to the crop when it has such similar characteristics. That is why we mainly use ontology engineering for this proposed system. It then hopes to accurately identify damages that are difficult to identify by image processing using ontology engineering.

Powdery Mildew decease

Manganese Deficiency

Figure 2:Different disorders with Similar Symptoms

Sometimes individual stages of a disease can be identified and the symptoms of those stages vary. As well as those symptoms vary from early stage to late stage



Symptoms of Yellow Vein Mosaic Disease

Figure 3: Symptoms of Yellow vein Mosaic Disease- and color changing with the affection

By this proposed approach;

The first process identifying nutrition deficiency and diseases using image processing. In here capture the differences using leaves and crop with healthy Okra and inquiries entered by the prospective user. The second process detecting the pest damage considering crops and leaves. In each of these processes use the ontology knowledge base is activated and a questionnaire is used to identify the problem 100% accurately. And final process proposed the solutions to these identified problems using ontology knowledge-based. Therefore the proposed project may aid to detect and controlling damages that are affected to the Okra cultivation.

Project aims/objectives

Main objective

To identify the okra cultivation problems (diseases, pest damage, nutrition deficiency) and provide the solutions, based on ontology engineering and image processing blend.

Specific objectives

- To identify nutrition deficiency and diseases.
- To identify pest damage.
- Applying ontology knowledge-based to monitor the problem and providing solutions.

Chapter 2: Literature Review

Identifying the disease, pest damages or nutritional deficiency is very important in crop cultivation. Identifying the problem at an early stage and knowing the control methods of those problems is a critical fact for the farmers. The most primary method to address that problem is meeting an expert by a farmer and taking his help to identify the exact problem and taking instructions for controlling the problem to prevent future losses. But this method has few drawbacks. Meeting an expert by a farmer is time consuming and may be costly if the farmer may need to travel a long distance, or if the expert may need to travel to the field. And also, although many farmers have the same problems with their crops the experts may need to visit their fields one by one and instruct the farmers one by one after observing the field. Or the experts may happen to instruct farmers on the same problem one by one. This may be exhaustive for the domain experts. In order to narrow down this process and to identifying the problems that farmers are facing when their crops affected by some disease easily, there are many solutions have been suggested using different methodologies and technologies. The most common method used to detect plant diseases is the image processing technique. There is a proposed leaf disease detection method using image processing for identification of leaf disease in MATLAB. In this approach identification of disease follows the steps like loading the image, contrast enhancement, converting RGB to HSI, extracting of features and SVM. By using this concept, the disease identification is done for all kinds of leaves and also the user can know the affected area of the leaf in percentage by identifying the disease properly. The user can rectify the problem very easily and with less cost. By using this concept, the disease identification is

done for all kinds of leaves and also the user can know the affected area of the leaf in percentage by identifying the disease (Radha, 2017). (Awal et al., 2017) Through this research they have proposed and developed a system using image processing. According to the proposed system, at first the user has to upload a defected crop image on the system then the system will search image related information in the system database, if the uploaded image matches with the database, then it will provide possible disease' name with solution, if it does not match it will show a not match message. They have used the BRISK algorithm in their research to match the uploaded affected crops images with their database images. There is a proposed vision based automatic detection of plant disease detection using Image Processing Technique. Image processing algorithms are developed to detect the plant infection or disease by identifying the colour feature of the leaf area. The K mean algorithm has been used for colour segmentation and GLCM is used for disease classification (Chandramouleeswaran et al, 2018). (Rushikesh et al., 2021)In this study they have implemented techniques of image processing and machine learning that have been used for sorghum leaf disease detection and classification. They have proposed an innovative technique to enhance the deep learning ability of ALEX- NETs. And there is another research done in 2021 to detect plant diseases using image processing. Image processing is used for the detection of plant diseases by capturing the images of the leaves and comparing it with the data sets. The data set consists of different plants in the image format. Apart from detection users are directed to an e-commerce website where different pesticides with its rate and usage directions are displayed. This website can be efficiently used for comparing the MRP of different pesticides and purchasing the required one for the detected disease. The research aimed to support and help the greenhouse farmers in an efficient way. MATLAB has been used for classification. Proposed system has an end-to-end Android application with TFLite (Chhillar et al., 2021). Surveys and reviews like A Survey On Leaf Disease Detection Using Image Processing Techniques (Senthilkumar et al, 2018) and Review On Leaf Disease Detection Using Image Processing Techniques (Raut et al., 2017) have also been done with analyzing the proposed methods, used techniques and advantages and disadvantages of those methods. In literature there are evidence that knowledgebases and ontology technique also have been used to identify the plant infections and related problems. There is a proposed approach that aids the development of a plant protection expert system for date palm. It is based on the ontology concept to diagnose the disease and suggest appropriate treatment by identifying anomalous observations on the parts of the tree. The approach consists of three interrelated components that are knowledge base, reasoning engine and server-side application (El-Askary et al., 2015). (Jearanaiwongkul et al., 2018). This article, they have

proposed an ontology-based approach to modeling plant diseases and have demonstrated their approach by developing a rice disease ontology. They also developed a system architecture compatible with the modeled ontology. The proposed conceptual ontology supports identification of plant diseases based on human observation. To identify the plant diseases knowledge based also have been used. Knowledge Based System for Diagnosis and Management of Okra Diseases is an approach done developing a knowledge base using IF and THEN rules. The limitations of this proposed approve are the proposed knowledge based system is specialized in the diagnosis of the six Okra diseases: Charcoal Rot, Fusarium Wilt, Powdery Mildew, Southern Blight, Enation Leaf Curl Disease, and Yellow Vein Mosaic Disease (Saleem et al., 2020). A Semantic Based Answering Technique Using Ontology in MCC is a research done to develop an accurate answer retrieval technique. The answering method for vegetable plant diseases in Mobile Cloud Computing (MCC) quickly answers the farmers' queries about different types of diseases that affect vegetables. The proposed method answers to the preventive and controlling methods of diseases from an ontology. This ontology used in the proposed technique is specifically developed to focus more on vegetable plant diseases, plant types, controlling and prevention of plant diseases. The outcomes of the proposed technique are more accurate and appropriate. From many web pages and Wikipedia, the data of plant diseases are gathered. The proposed technique is evaluated with a web forum that contains questions and answers about the diseases. In order to make this approach more beneficial in the conclusion the researchers have mentioned that this idea can be more beneficial if it allows image-based querying and translation features that help to query in regional language (Samuel et al., 2020).

The problem with many of the researches done using image processing techniques is that, because the process is done to evaluate the percentage of the symptoms on the defected crop or leaf, sometimes they may be wrong if there are many different infections with the same symptoms. This may cause a huge problem when applying the controlling methods to the crop field. It may cause more damage if wrong treatment is done to the crop than the harm done by the disease. The weak point we have identified in the approaches developed using only ontologies are that the farmer or the user of the proposed approach need to investigate the symptoms manually through his or her naked eye and need to query using those visible symptoms. But using image processing this can be done in a more accurate way. Because of those weak points of those separate approaches, we suggest an approach of combining image processing and ontology based knowledge base to identify the crop diseases. To evaluate the

system, we are going to use the Okra plant as the selected crop. Not only leaves but also the okra pods will be considered to identify the defects. We are going to develop an android application with the ability of identifying the infection of the crop in three categories. Those

types of infection categories are diseases, pests and nutritional deficiencies. After identifying the specific problem that the crop is facing the system will suggest the control method needed to prevent or minimize the damage.

Chapter 3: Materials and Methods

The set of Competency Question was analyzed to identify the What should are the question the ontology should answer, And to identify the attributes/ classes and their relationships in broadway. This set of Questions is going to the User for generating formal questions To querying ontology. And This is the initial document that can use when ontology evaluation.

Image Processing Materials

Field Investigation

We visited Agriculture Research station Thelijjawila and Agro Technology Park-Batattha to collect the resources. Met the experts Mr.H.A. Thilakarathne Farm Manager and Met Mr. A.P. Kulararthna One of the Agriculture Instructor at Agro Technology Park -Batatha. While Feild visit we collected following images of Okra plants as bellow

Feasibility Study

As a first step, we collected information on crop problems faced by farmers in agriculture. It was identified that the several plants has various problems as a problem for the farmers in the existing agriculture. For gathering information we selected Batatha Agro-Technology Park and agricultural research station Telijjawila. There we gathered information from two agriculture experts.

- Name : H.A Thilakarathne
  Position : Farmer Manager, Government Bataatha Farm Contact
  : 0717315366

- Name : A.P Kularathne
  Position : Agriculture Instructor, Government Bataatha Farm Contact
  : 0717509848

The people who provided this information recommend us website of department of agriculture, a mobile app and books to study for more information. Accordingly, we refer mobile app called ‘krushi advisor’ and book called ‘Vegetable Cultivation (New Edition)’. Based on the knowledge found, we selected the okra plant to test this system. Accordingly, three methods of damaging the okra plant were identified. Also, the damage caused by each of these methods was identified separately. There we were able to identify damages with similar symptoms.

We have identified that they are diseases that farmers cannot predict with certainty. Our main object here is to make a more efficient decision-making and knowledge-based decision-making process.

Steps of Methodology

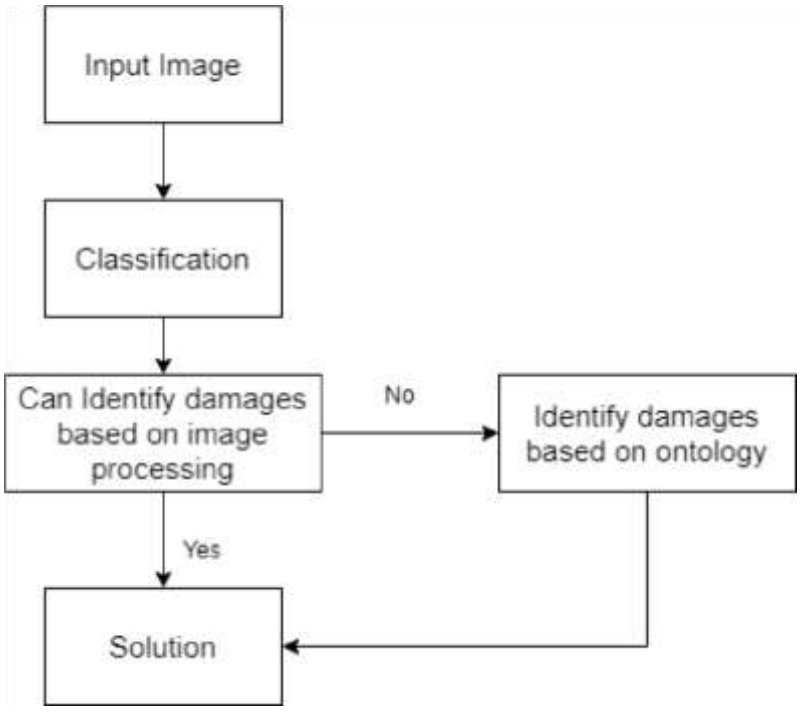


Figure 4:Proposed Methodology

Input image/ Classification

The proposed methodology is mainly focused to provide knowledge-based solutions for cultivation problems based on ontology engineering and image processing. Accordingly, based on the crop and leaf of the plant, this process is about the existing problems regarding diseases, insect damages and nutrient deficiencies. According to this system the leaves and pods of the plant are input. Accordingly, two photographs showing different sides of the diseased part are considered as input. The image processing identifies whether it is a leaf or a pod according to the input image.

Identify damages based on image processing

This step identifies the damages of crop according to the input image. There, compared to a healthy plant, its existing diseases are identified at the first stage. Image acquisition, image preprocessing, image segmentation, feature extraction in image and classification are the steps that we hope to use in image processing part. Here is the process for identify damages based on image processing.

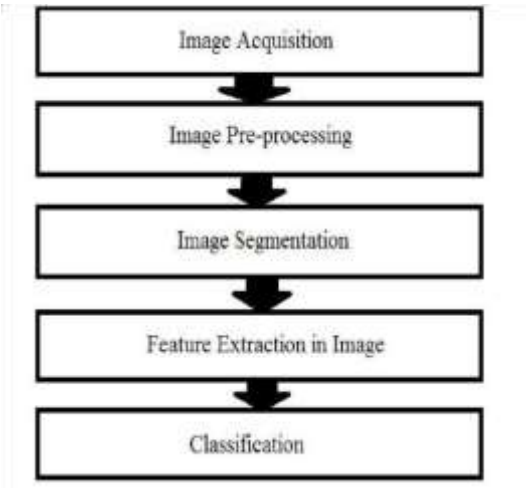


Figure 5: Image Processing Methodology

Identify damages based on ontology

This step identifies damage that could not be detected by image processing. Therefore, we hope to use ontology technology for getting more accurate solution. That is, answers between two or more diseases with similar symptoms on a logical basis. Here the damage is detected using a knowledge base system. For that we use ontology engineering methods. Asks a number of questions from the user and based on that answers the system provide solution on a logical

relationship. Accordingly, we hope to use the methodology called Gruninger and Fox's methodology for this development. Here we hope to use the OWL language to create the ontology, using the tool called Portage.

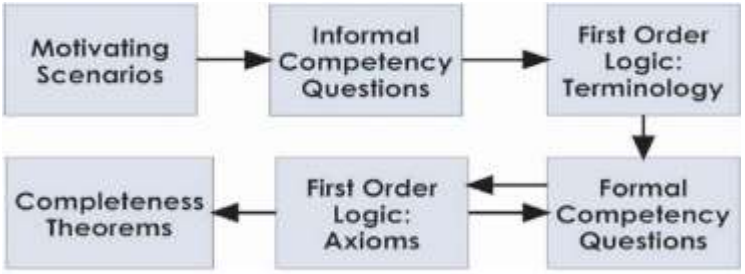


Figure 6:Gruniger and Fox Methodology

Solutions

We hope here is to give a very correct answer as a final step. In the first stage, damage is detected using image processing and then ontology use for get more accurate decisions. That is, it is hoped to correctly diagnose the disease among those with similar symptoms. The final answer is the name of the disease and the treatment to be given.

We hope to use the okra plant to test this system. Our feasibility study has shown that there are diseases, pests and nutrient deficiencies related to the okra crop. We also found that the damage had similar features. Accordingly, the damage to the leaves and pods of the okra plant can be identified separately. Accordingly, the use of okra to test this system is expected to be done as follows.

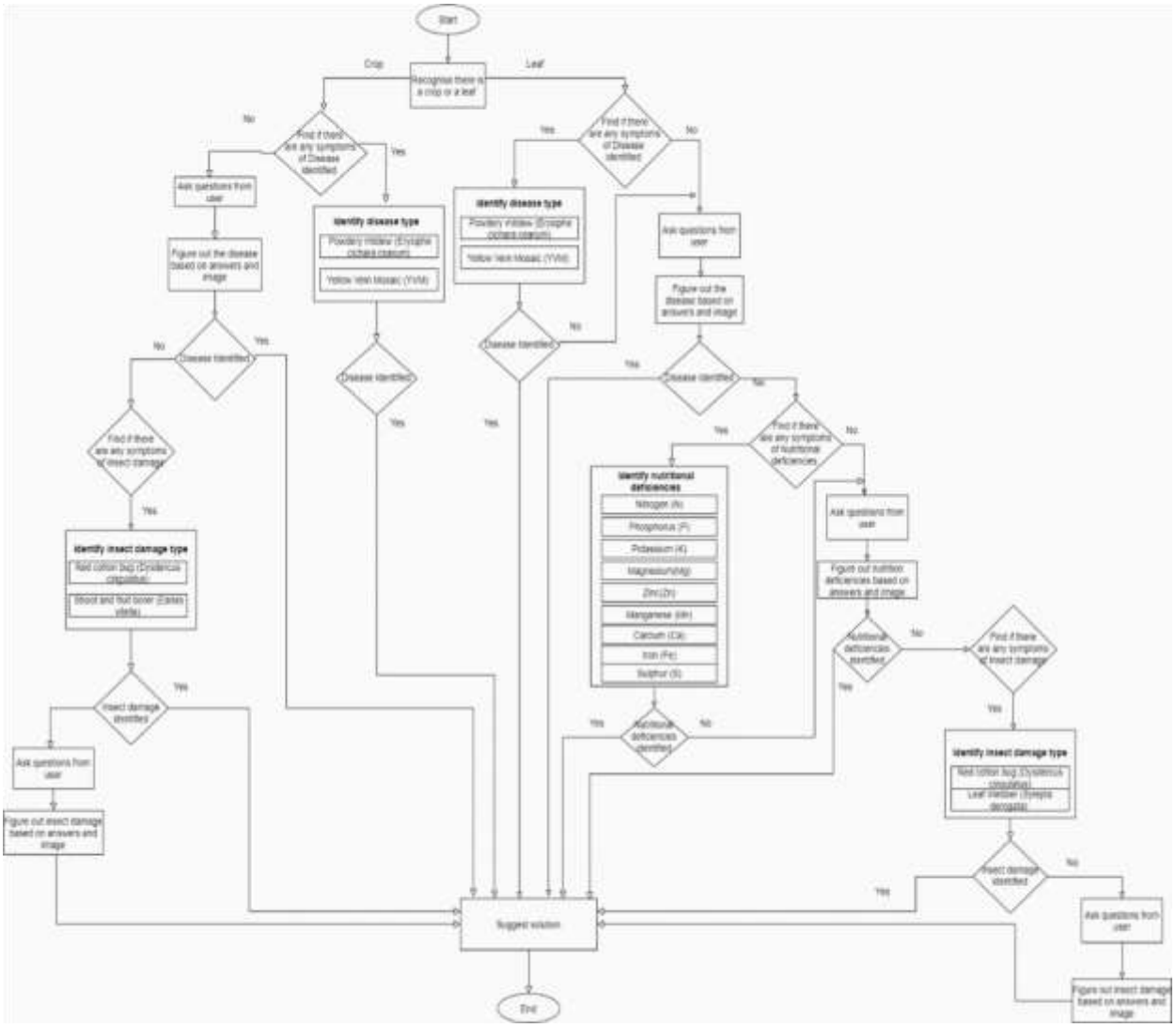


Figure 7: (Overall Process of the proposed system

Disorder analysis and its symptoms

Following are some common symptoms of identified decoders

1. Diseases

   Powdery Mildew

Figure 8:Powder Mildew -Image 02

Figure 9:Powdery Mildew :Image 01

- Scattered white patches appear on the upper surface of leaves
- coalesce to form a powdery coating.
- Heavily attack leaves dry up and drop off.

Figure 10:Powdery Mildew-Image 03

Yellow Vein Mosaic(YVM)

- clearing of leaf margins followed by vein chlorosis
- Younger leaves develop yellow veins surrounded by dark and light green patches
- Fruits are small, distorted and chlorotic
- Affected seedlings are stunted resulting in reduced yields

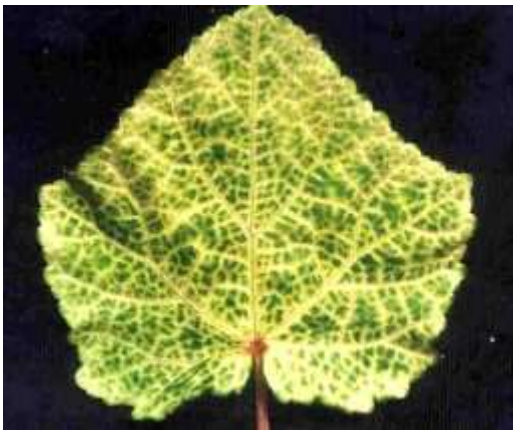


Figure 11:Yellow Vein Mosaic

2. Pest Damages

Red-Cotton bug

- Red-bodied bugs are seen feeding and moving on plants.
- particularly they crowd on mature pods and damage seeds.

Figure 12:Red-Cotton bug

Leaf Webber (Sylepta derogata)

- Appearance of conical leaf rolls hanging from the leaves.
- Green caterpillars is seen inside the rolls

Figure 13:Leaf Webber Infection

Shoot and Fruit Borer

- Drooping shoots and fruits with holes

Figure 14:Shoot and Fruit Borer infection

3. Deficiency of Nutrients

Nitrogen (N) Deficiency

- plants are stanted
- leaves are smaller than normal
- leaves are yellow
- shoots are thin

Figure 15:Nitrogen (N) Deficiency

Posphprus (P) Deficiency

- Leaves are dark green
- Plants are stunted
- Leaves, chlorosis erratic leaf shape
- thin plant stems , fractured

Figure 16:Posphprus (P) Deficiency

- Lower leaves show yellow spots

Figure 17: Magnesium(Mg) Deficiency

Manganese (Mn) Deficiency

- Leaves show chlorosis

Figure 18:Manganese

Chapter 5: Future Directions/Plans

Module 1:

- Train the system to identify crop Deficiency of Nutrients and decease using images of okra leaves and pods.
- Train the system to identify choose the right disease from those with similar symptoms.
- Generate an output of name disease of deficiency and the percentage.
- Develop the android application to insert image and get results.

Module 2:

- Train the system to identify crop pest damages using images of okra leaves and pods.
- Generate an output of name disease of deficiency and the percentage.
- Develop the android application to insert image and get results.
- Train the system to identify choose the right pest damage from those with similar symptoms.

Module 3:

- Construct the ontology
- Generate question bases on the output from image processing.
- Generate an output of name disease of deficiency and the percentage.
- Develop the android application to insert image and get results.

Project Timeline (Gantt chart)

Objectives	Activity	Timeline			
		Year			
		Q1	Q2	Q3	Q4
Objective 01 To identify nutrition deficiency and diseases.	Identify research topic				
	Literature review				
	Feasibility study				
	Proposal presentation and report submission				
	Collecting samples and get extracted images				
	Analyzing images using open CV				
	Progress presentation and report submission				
	Implementation				
	Testing				
Objective 02 To identify pest damage.	Identify research topic				
	Literature review				
	Feasibility study				
	Proposal presentation and report submission				
	Collecting samples and get extracted images				
	Analyzing images using open CV				
	Progress presentation and report submission				
	Implementation				
	Testing				
Objective 03 Applying ontology knowledgebased to monitor the problem and providing solutions.	Identify research topic				
	Literature review				
	Feasibility study				
	Proposal presentation and report submission				
	Gather information for knowledgebase				
	Prepare Otology Requirement Specification D.				
	Progress presentation and report submission				
	Implementation				
	Testing				
	Preparing thesis				
	Final presentation and thesis submission				

Table 2:Project Timeline

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Appendix

Set of Competency questions

1. What are the possible disorders affecting Okra?

2. What are the possible diseases that an okra plant could have?

3. What are the possible pest effects an okra plant could have?

4. What are the possible nutritional deficiencies?

5. What are the possible **symptoms** of disease ….?

- What are the possible symptoms of Powdery Mildew disease?
- What are the possible symptoms of Yellow Vein Mosaic?

6. What are the possible **symptoms** of a pest's effect …?

- What are the possible symptoms of an okra plant affected by the Red-cotton bug?
- What are the possible symptoms of an okra plant affected by Leaf Webber?
- What are the possible symptoms of an okra plant affected by Shooter and fruit borer?

7. What are the possible **symptoms** of nutritional deficiency ….?

- What are the possible symptoms of an okra plant suffering from Nitrogen (N) deficiency?
- What are the possible symptoms of an okra plant suffering from Phosphorus (P) deficiency?
- What are the possible symptoms of an okra plant suffering from Potassium (K) deficiency?
- What are the possible symptoms of an okra plant suffering from Magnesium (Mg) deficiency?

- What are the possible symptoms of an okra plant suffering from Zinc (Zn) deficiency?
- What are the possible symptoms of an okra plant suffering from Manganese (Mn) deficiency?
- What are the possible symptoms of an okra plant suffering from Calcium (Ca) deficiency?
- What are the possible symptoms of an okra plant suffering from Iron (Fe) deficiency?
- What are the possible symptoms of an okra plant suffering from Sulfur (S) deficiency?

8. What are the possible **reasons** for disease ….?

- What are the possible reasons for Powdery Mildew disease?
- What are the possible reasons for Yellow Vein Mosaic?

9. What are the possible **reasons** for the pest's effect …?

- What are the possible reasons for the Red-cotton bug effect?
- What are the possible reasons for the Leaf Webber effect?
- What are the possible reasons for the Shooter and fruit borer effect?

10.What are the possible **reasons** for nutritional deficiency ….?

- What are the possible reasons for Nitrogen (N) deficiency?
- What are the possible reasons for Phosphorus (P) deficiency?
- What are the possible reasons for Potassium (K) deficiency?
- What are the possible reasons for Magnesium (Mg) deficiency?
- What are the possible reasons for Zinc (Zn) deficiency?
- What are the possible reasons for Manganese (Mn) deficiency?
- What are the possible reasons for Calcium (Ca) deficiency?
- What are the possible reasons for Iron (Fe) deficiency?
- What are the possible reasons for Sulfur (S) deficiency?

11. What are the possible **Control Methods** for disease ….?

- What are the possible Control Methods for Powdery Mildew disease?
- What are the possible Control Methods Yellow Vein Mosaic?

12. What are the possible **Control Methods** for the pest's effect …?

- What are the possible Control Methods for the Red-cotton bug effect?
- What are the possible Control Methods for the Leaf Webber effect?
- What are the possible Control Methods for the Shooter and fruit borer effect?

13.What are the possible **Control Methods** for nutritional deficiency ….?

- What are the possible Control Methods for Nitrogen (N) deficiency?
- What are the possible reason Control Methods for Phosphorus (P) deficiency?
- What are the possible Control Methods for Potassium (K) deficiency?
- What are the possible Control Methods for Magnesium (Mg) deficiency?
- What are the possible Control Methods for Zinc (Zn) deficiency?
- What are the possible Control Methods for Manganese (Mn) deficiency?
- What are the possible Control Methods for Calcium (Ca) deficiency?
- What are the possible Control Methods for Iron (Fe) deficiency?
- What are the possible Control Methods for Sulfur (S) deficiency?

14. What are the possible diseases if an Okra plant has a symptom A?

15. What are the possible diseases if an okra plant has symptoms A, B, . . . ?

16. What are the possible pests effects if an Okra plant has a symptom A?

17. What are the possible pests effects if an okra plant has symptoms A, B, . . . ?

18. What are the possible nutritional deficiencies if an Okra plant has a symptom A?

19. What are the possible nutritional deficiencies if an okra plant has symptoms A, B, . . . ?

	This is a diseased okra pod. **Yellow Vein Mosaic(YVM)** Fruits are distorted and chlorotic.
	This is a diseased okra pod. **Yellow Vein Mosaic(YVM)** Fruits are distorted and chlorotic.
	This is a Deficiency of Nutrients. **Potassium(K)**. Leaf margins are brown yellow , brown or scorched.
	This is a healthy okra leaf. The color and shape of the leaf remain the same.

	This is a healthy okra leaf. The color and shape of the leaf remain the same.
	This is a pest damaged leaf. **Leaf Webber(Sylepta derogata)**
	This is **Powdery Mildew** Disease. It Scattered white patches appear on the upper surface of leaves.
	This is **Powdery Mildew** Disease. It Scattered white patches appear on the upper surface of leaves. Also Lower leaves show yellow spots. So it is Deficiency of Nutrients. **Posphprus (P)**

	This is a healthy okra leaf. The color and shape of the leaf remain the same.
	This is a pest damaged leaf. **Leaf Webber(Sylepta derogata)**
	This is a healthy okra leaf. The color and shape of the leaf remain the same.

	This is **Powdery Mildew** Disease. It Scattered white patches appear on the upper surface of leaves
	This is **Powdery Mildew** Disease. It Scattered white patches appear on the upper surface of leaves
	This is a **Deficiency of Nutrients**. This is caused by lack of **Sulphur (S)**. Because uniform chlorosis developed on maturing leaves.