SMART STSTEM FOR OPTIMIZED ORGANIC CROP ROTATION USING PRECISION AGRICULTURE DATA

TMP-23-113

Project Proposal Report

Ihalagedara I.H.U.B

B.Sc. (Hons) Degree in Information Technology

Specializing in Software Engineering

Department of Software Engineering

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DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
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The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

03/20/2023

Signature of the supervisor: Date

Abstract

When we take the modern world, agriculture has become one of the key areas that can affects the economy of the country. Due to many reasons like economic issues and health issues, organic cultivations have become more popular time to time. Although the organic cultivation is there, most of the people do not have much knowledge about the process, ways we can optimize the cultivation and managing pests and diseases. Hence, even though organic cultivation has its benefits, without a common reading about the process it can be costly.

The concept of organic cultivation with the crop rotation can be an efficient and effective way cultivation not only for commercial usages but also for the domestic usages. So, having a platform where we can get and manage all the necessary data and information will be so useful for the day to day life activities.

Even though we full fill all the requirements pests and diseases can play a major role when it comes to the productivity of the cultivation. This can be challenging for the larger organizations. If we take a specific disease or a pest, there are so many organic ways of controlling those pests or diseases which most of the people doesn't know.

This research involves in providing a solution to identify pests or diseases through a cloud computing and machine learning based developed model and provide all the information about it including a description and ways of handling them in organic methodologies.

Keywords - cloud computing, machine learning, crop rotation, organic cultivation

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LIST OF ABBREVIATIONS

Abbreviation	Description
SLIIT	Sri Lanka Institute of Information Technology
N	Nitrogen
GMO	Genetically Modified Organism
HTTP	Hypertext Transfer Protocol
SVM	Support Vector Machine

1. INTRODUCTION

1.1. Background and literature

Agriculture is one of the foremost factors that depicts the economic and national incoming factors of a country like Sri Lanka. From the ancient times Sri Lanka is famous for their agricultural factors with the vast area of knowledge and technologies they used for their day to day life style. Since the agriculture or the cultivation was part of the people they had a good reading about the weather changes, the nutrition as well as the pests and diseases. Because of the technology was not developed those days they had their own ways or finding nutrition and treatments for their cultivations in order to prevent any kind of a diseases and pest attacks.

At the same time if we take the modern world one of the major problems faced by the farmers are the pest attacks or diseases in their cultivations. Due to some reasons like busy schedules or lack of knowledge of the people, most of the people try to go for chemical solutions hoping that they will get quick results. Another hope is to increase the productivity of the cultivation in a short period of time [1]. Even though those quick measures can work up to some limit, there are so many long-term problems or disadvantages we have to face. Some of the key problems are soil fertility loss [2] and unhealthy chemicals for the humans. Those problems occur because of the lack of knowledge about the diseases or pests and the organic solutions for those problems. Therefore, as a solution all of those problems can be covered with the concept of crop rotation in an organic way [3]. Below are some common environmental consequences of pesticide use in Sri Lanka [6].

- Destruction of pollinators of plants
- Elimination of natural enemies of pests
- Development of pest resistance
- Poisoning chemicals for human health

Pesticides management is one of the key areas in any kind of a cultivations. This plays a major role when it comes to the productivity and the healthiness of the product. Over the decades, the usage of pesticides has increased. For an example if take the paddy cultivation in Sri Lanka during the two major seasons “Maha” and “Yala” around 0.8million hectares were cultivated by around 1.8 million farmers [5]. So, any kind of a pest attack can be vital for this kind of an area. In pest management, identifying the correct pest and the predictions that we have to made are crucial since it can lead us to huge loss in productivity, time and money. Therefore, this study will go through the process of pests and diseases identification, providing details about them and providing preventing solution with the help of the concept “Crop rotation” in an organic manner.

In this study the main goal is to provide the user to identify the pests or the disease based on a provided image. As the output a description about the pest and the possible organic ways of preventing or controlling the problem will be provided. Another way of identifying those diseases is to examine the color of the leaf. The Leaf Color Chart (LCC) is a methodology which is commonly used in rice production [7]. In this methodology Nitrogen (N) fertilizer is measured to identify and examine the need of nitrogen for the plant.

I have identified some research attempts to accomplish this task. Below I am going to talk about them.

“Insect classification and detection in field crops using modern machine learning techniques” is one of the papers about insect identifications using the machine learning concepts which was written by Thenmozhi Kasinthan, Dakshayani Singaraju and Srinivasulu Redy Uyyala. This paper presents the experiment for classifying insects based on nine different insect classes using the machine learning techniques like artificial neural network (ANN), support vector machine (SVM), k-

nearest neighbors (KNN) [8]. In this paper the highest classification rate was 91.5% and it was achieved for nine and twenty-four different class using the concept of convolutional neural network (CNN) model. Main methodologies of this proposed system can be point out like below.

- Dataset Classification
- Image pre-processing
- Image augmentation

“Insect pest image recognition including maturity stage classification” is another research attempt that I have identified by Jaco C. Gomes and Dibio L. Borges [9]. In this attempt they mainly consider the two stages of the pest as “early stage” and “adult stage”. After the experiment was conducted for those categories the best result was 86.33 for the adults and 87.91% for the early stage using a special measure of Kullback-Leibler divergence. The experiment was conducted using 97 classes of adult insect images and 45 classes of early stages insects. The final dataset for those insects was 6817. For the image recognition implementation, they propose an automated computer vision-based system and machine learning features like convolution neural network.

2. Research Gap

The primary goal of this research is to develop a pest and disease identification mechanism and provide the available organic solutions so that the user can work on their own plantation. When the user has this kind of a system with them even though they are involving in an enterprise level or domestic level of cultivation, they still can use this system to get the advices through a knowledge-based system for their organic cultivation.

A thorough study of the existing similar solutions has been made and it is identified that the neither of the existing systems does not support for the organic cultivation in Sri Lanka. Different kind of object detection mechanisms or methodologies are available, but neither of them is providing further information about the detected pest or the disease. The proposed systems are capable of identifying the pests or the diseases through an image and provide the necessary guidelines for the future references with a knowledge-based system.

The initial discussion came to place with the research report “Possibilities to minimize pesticide usage in Sri Lankan paddy cultivation: An emphasis on risk management” [10]. We can identify some challenges that people faced when it comes to the organic cultivations and lack of knowledge about the agricultural area like pests and diseases. So even though we can find already existing systems to identify pests and diseases we can provide additional measures to develop or help the growth of the cultivation.

When we go through the publications [7,8], we can identify the above facts that a system is proposed using machine learning features like convolution neural network (CNN) and computer vision, neither of them provide a solution for those identified problems for the organic cultivation. Another way to accomplish this task is to use the cloud computing platforms like azure and use their cognitive service and use algorithms like YOLO.

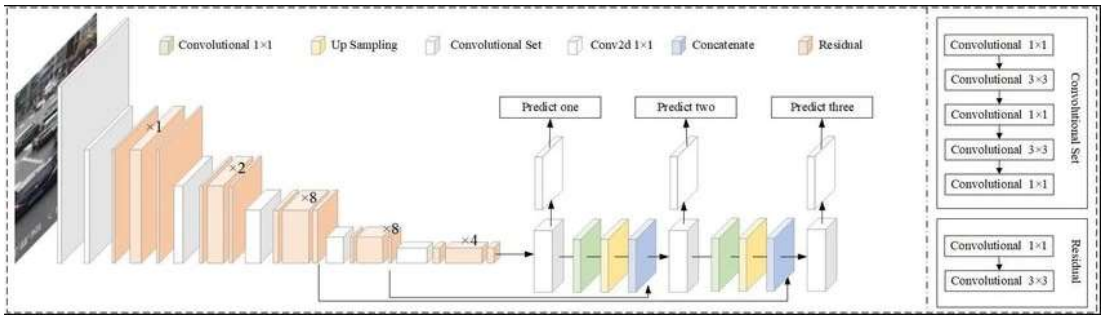

Figure 1 YOLO architecture

With use of the proposed system another goal is to minimize the time and the cost required to identify and manage diseases and pests. For those who does not have the knowledge about the organic treatments, they will have to do some research by looking on internet, reading a book or having a discussion with a well-known person about the specific field. So, unlike other available systems this will provide the necessary measures without any time delay with the help of knowledge-based system. According to the proposed system, user will be able to interact through a web-based application and get the necessary solutions.

3 RESEARCH PROBLEM

Even though there are so many chemicals available for the pest and disease management in the market, now a day's people think about the quality of the product and healthiness of the product. Therefore, there is a market place for the organic products. Some of the main reasons are listed below [11,12].

- Affects in a good way for the environment
- Fresh foods
- Fewer pesticides
- Genetically Modified Organisms (GMO) free products
- Richer in nutrients
- Defoliation through natural seasonal freezing

At the same time usage of chemical pesticides can affect both human and environmental health. Therefore, the end result will be unhealthy product for the market. So that the usage of non-chemical pesticides should not be encouraged for both enterprise level cultivations as well as domestic cultivations [13]. Below are four of the major problems of chemical pesticides usage.

- Water pollution
- Human health (Cancer, diabetes, asthma, Parkinson, oxidative stress, genital syndrome)
- Soil pollution
- Food stuffs

The proposed system is capable of providing organic and non-chemical pesticides solutions to mitigate the above-mentioned problems.

4 RESEARCH OBJECTIVES

4.1. Main Objectives

The main objective is to provide a smart web-based system to examine and identify the pests or diseases based on the provided images and provide with the necessary non-chemical solutions to mitigate those identified diseases or problems. So that the system will be able to provide decisions through the examine them.

4.2. Specific Objectives

Below mentioned points are some sub objectives about the research.

- To capture and understand the visual impacts on plants by the pests
- To understand some techniques related to machine learning like custom vision and train a model
- To understand about the traditional organic crops and non-chemical pesticides for a productive cultivation.
- To provide a smart solution to provide decisions to the user.

5 METHODOLOGY

5.1. System Overview

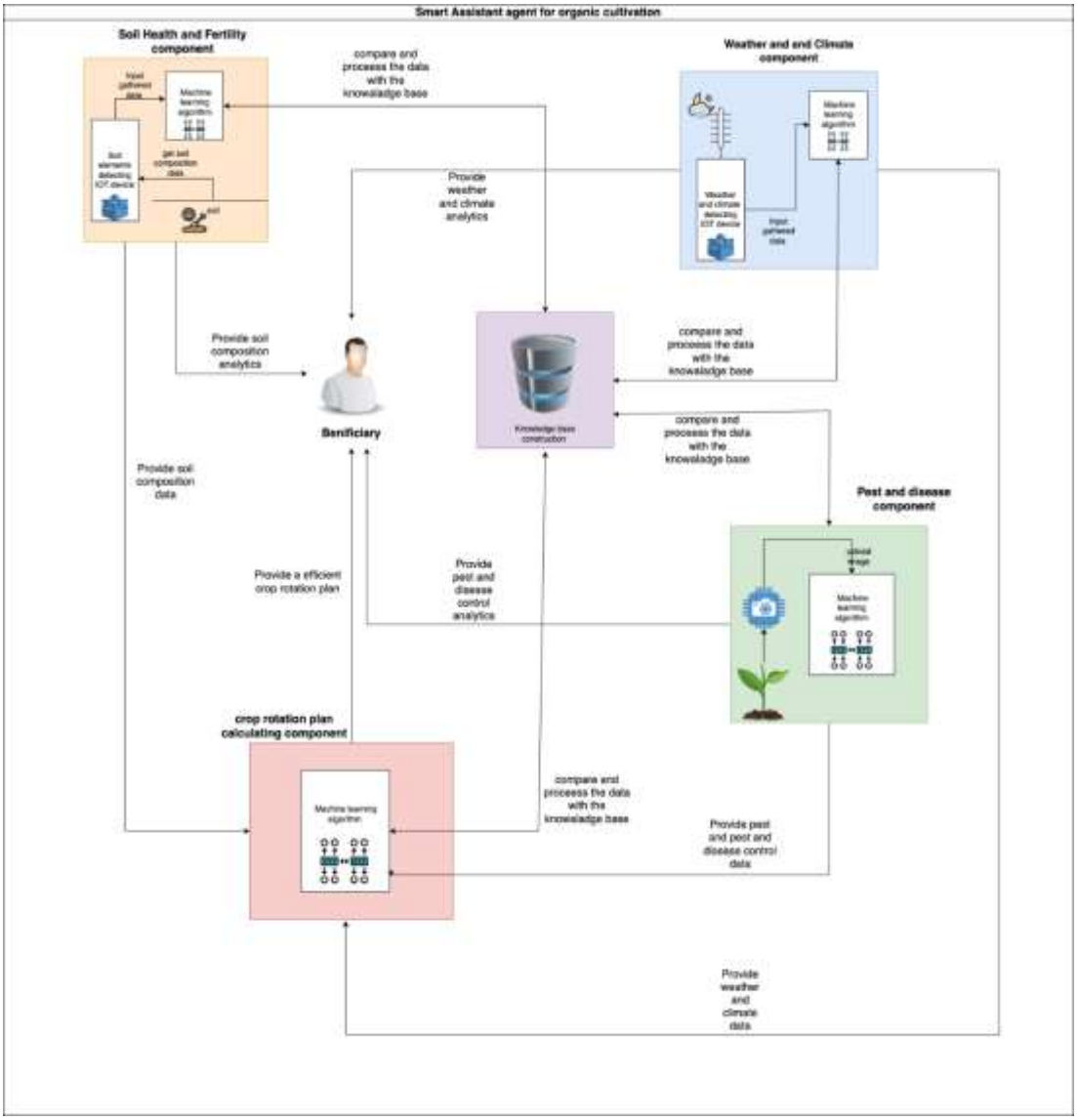

Figure 5.1 Overall system diagram

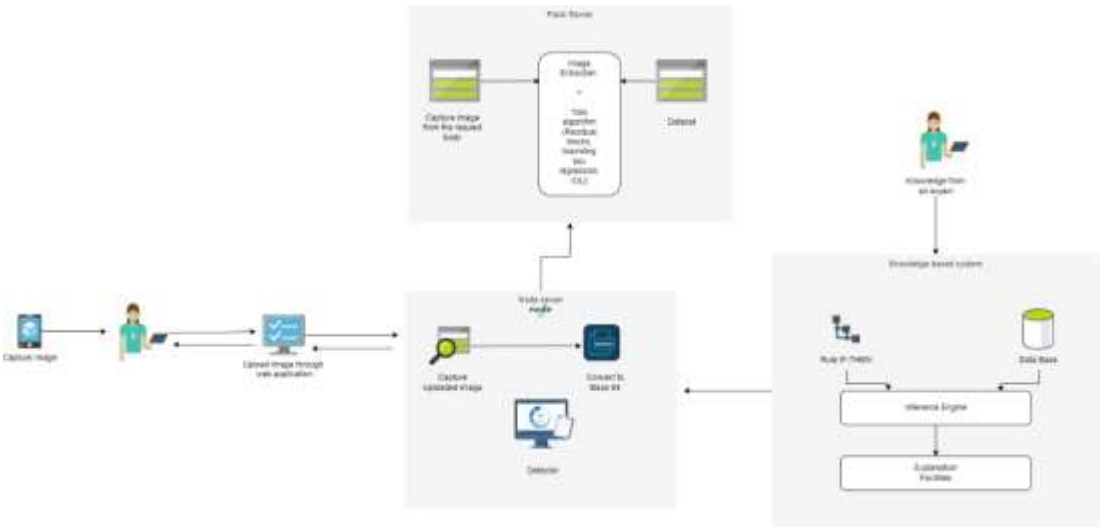

Figure 5.1 Individual System overview

The main intention of this component is to provide a web-based application to capture the unknown pests and diseases through a trained model and provide the user with the necessary non-chemical or natural solutions with the concept of crop rotation. Once the image is provided it will go through a trained model and identify the creatures or defected areas with the YOLO algorithm object detection with the use of flask server. Then the necessary data will be filtered and displayed according to the identified results from the knowledge-based system. Other than that, yolo algorithms are planned to use to identify the colors of the leaves and necessary Nitrogen usage for those crops. As a summarization we can mention the below points about the methodology of this component.

- Identify the pests and leaf diseases through YOLO algorithm trained model.
- Identify the leaves color differences with the YOLO algorithm.
- Provide collected organic or natural solutions through a knowledge-based system according to the identified results.
- Provide valuable information and decisions for the crop rotation of the field.

5.2 Software Methodology

Agile development will be used for the system implementation process in order to increase the flexibility and responsiveness. This methodology is consisting of continuous interaction with the requirement gathering and stakeholders. And the system will be implemented in smaller components which leads to better responsiveness and the reusability of the individual components.

- Define project scope – identifying features of the systems through stakeholders' interactions like farmers and people who are involving in crop production.
- Plan and development
- Develop and test
- Review and gather feedbacks
- Iterate, refine and release and maintenance

Figure 5.3 Agile method

5.3 Functional requirement

- The system should be able to identify the pests based on the provided image.
- The system should be able to identify the green color percentages according to the provided image and provide the necessary results.
- The system should be able to provide the necessary information about the identified object and give decisions based on the knowledge base system.

5.4Non-functional requirement

- User friendly interfaces
- Availability through a well-recognized cloud partner
- Should be able to work without any delay. So, the technical stack should be decided according to the requirements.
- The system should be more efficient to use with better user experience.

5.5. Project Technology Stack

Table 5.1 Technologies

Cloud platform	Azure
Language	JavaScript, python
Database	MongoDB, Azure storage
Editor	VS Code

Frameworks/Libraries	React, NodeJS
Other	Yolo, flask

5.6. Feasibility Study

5.6.1. Technical feasibility

According to the paper, the application will be developed with the use of machine learning techniques and image processing techniques. Therefore, it is required to have a knowledge about the machine learning algorithms and their usages. In addition to that web development knowledge and cloud computing knowledge is required. Since the members are familiar with the above technologies, this project is technically feasible to develop.

5.6.2 Scheduling feasibility

The system is considered according to each individual component and will build with the agile methodology. So, each part will have their own timeline. Therefore, the system will approach the final stage according to the predefined timeline.

5.7. Requirement Gathering

5.7.1 Gannoruwa agriculture research center

As one of the key requirements gathering areas, we have identified Gannoruwa agriculture research center to gather information and data about the organic crop

production and crop rotation. Since they are involving in the organic cultivation the research center is capable of providing the necessary data about the

5.7.2 External supervisor

As the initial step or requirement gathering and analysis, we contacted Mr. I.H Dissanayake who is the former assistant director of Presidential secretariat in the program of organic cultivation. In this meeting most of the requirements, usability of them for this project and also some data regarding each component were gathered.

5.7.3 survey

Presenting a questionnaire for the stakeholders to gather information about the specific areas.

6 DESCRIPTIONS OF PERSONAL AND FACILITIES

- Dr. Nuwan Kodagoda – Sri Lanka Institute of Information Technology (SLIIT)
- Mr. Udara Samarathunge - Sri Lanka Institute of Information Technology (SLIIT)
- Mr. I.H Dassanayake – Former assistant director of Presidential Secretariat national food (organic) program

6.1 Commercialization

The trained system for identifying pests and diseases of crops and to provide the solutions with natural and non-chemical treatments will be useful not only for the enterprise level users, but also this system can be very useful for the domestic users. This application can access as a web-based solution by the farmers, agriculture professionals or any person in the crop production.

The system will be developed using datasets of crop diseases, pests and their solutions. So, machine learning algorithms and the cloud computing concepts will be used to provide the user with the accurate and valuable information. On the other hand, the system will be implemented in a user-friendly manner for the users to increase the user attraction.

Target audience

- Researches
- Farmers
- Agriculture students
- Organic crop production companies
- Stakeholders
- All of the domestic users

Market Space

- No age limitations for the users
- No prior knowledge is required
- Basic knowledge would be enough to use the web application

7. BUDGET AND BUDGET JUSTIFICATIONS

Table 0.1 Estimated Budget Plan

Reason	**Amount (Rs)**
Stationaries	3000
Azure	Student Ambassador Account
Drive	Free

Database	Free
Other	3000
Total	**6,000**

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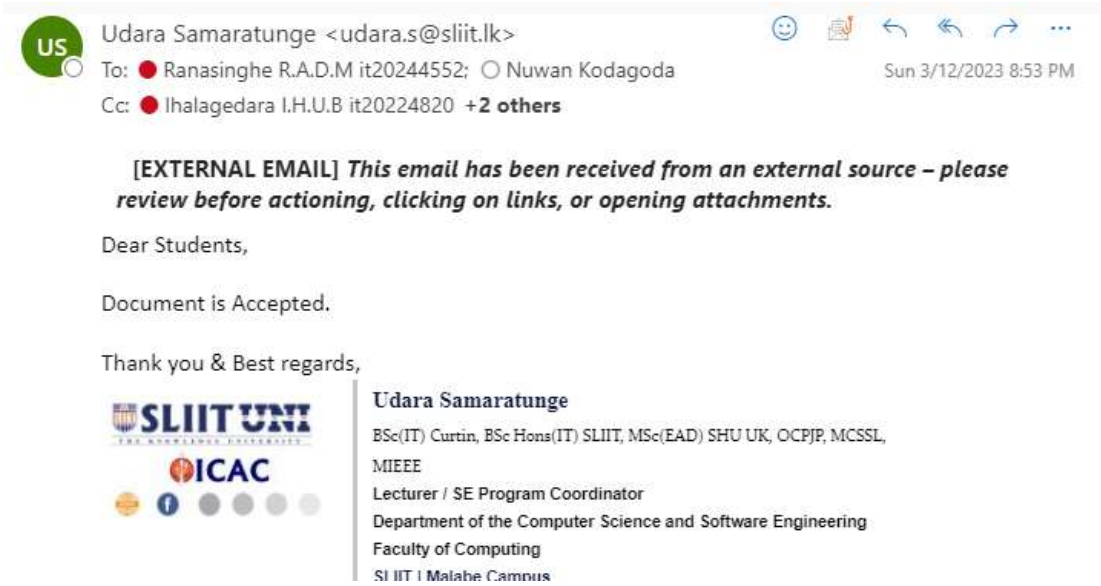
APPENDIX



Udara Samaratunge <udara.s@sliit.lk>

To: Ranasinghe R.A.D.M it20244552; Nuwan Kodagoda

Cc: Ihalagedara I.H.U.B it20224820 **+2 others**

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Dear Students,

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Thank you & Best regards,

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Upendra Ihalagedara
Proposal report
Abstract
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